2016

University of Arkansas

Introduction to STEM Education

Student Developed

Curriculum Projects

Contents

Construction Blocks

Construction Blocks Assignment

Constructing a structure based off the film *Cloudy with a Chance of Meatballs*

Teacher Copy

By: Lily Alexander and Melanie Keller

Title: "Graham Cracker Builder"

Grade Level: 1st

Disciplinary Area: STEM, Construction

Stem Content Standards:

Science Standard:

PS.5.1.1Compare and contrast objects according to the single properties of

•Size

•Color

•Shape

•Texture

•Magnetism

Math Standard:

AR.Math.Content.1.NBT.B.3

Compare two two-digit numbers based on meanings of the tens and ones digits, recording the results of comparisons with the symbols >, =, and <

Technology Standard:

Standard 2: Students will develop an understanding of the core concepts of technology.

D. Different materials are used in making things.

E. People plan in order to get things done.

Big Ideas:

- Correct use of the Design Loop/Design Process
- Pre-plan ideas and decide on best avenue to take
- Using creativity to successfully build a structure
- Understanding that different objects that have different properties can aid or hinder in the construction of a structure
- Different materials are used in making things.
- Compare numbers using the symbols >,=, and <.
- Display teamwork

Essential Question:

How can you and your partner construct a building using provided materials that will withstand the storm of meatballs (represented by mini-marshmallows)?

Scenario:
Oh no! Meatballs are falling from the sky again! Before Flint and his team can destroy the machine you and your partner have to create a structure that you, your friends, and family can take refuge in that can withstand the giant meatballs.

Challenge:
After watching a specific clip from the movie, *Cloudy with a Chance of Meatballs,* students will be challenged to construct a structure that can withstand the weight of mini-marshmallows falling from the sky. Before the students begin constructing, they must first evaluate their materials and brainstorm possible ideas using the design loop (handout provided). Students will have the opportunity to compete with other groups to see which group's structure can withstand the most meatballs (aka marshmallows).

Tools, Materials, and Resources:
Each set of partners will receive the following materials:

- A sleeve of graham cracker cookie squares
- Marshmallow goo
- Peanut butter
- Frosting
- *Cloudy With a Chance of Meatballs* movie clip

Content Information:
Before the students begin building, as a class we review comparing two digit numbers. This will include a conversation on what symbols to use when two numbers are either greater than, less than, or equal to one another. To demonstrate this knowledge the students will keep track of the amount of materials they are using while constructing their creative structure. For instance, if the group decides to use 10 graham cracker squares to build a house, and then 12 squares to build a surrounding fence, they will record their data on the provided handout demonstrating that 10<12. Ultimately we will answer the following questions:

- Looking at the symbol (>) and using what we know about math and numbers what do you think this symbol means?
  - A number is larger
- Looking at the symbol (<) and using what we know about math and numbers what do you think this symbol means?
  - A number is smaller
- Looking at the symbol (=) and using what we know about math and numbers what do you think this symbol means?
  - The numbers are equal to one another

Deliverables:
The students will need to deliver a structure built out of graham crackers that was creatively constructed with the provided materials which demonstrates that they understood what was asked of them. The structure will need to be able to withstand the weight of mini-marshmallows falling on it, and the groups whose structure can withstand the most marshmallows will win. The students will also turn in their design

loop/brainstorm handout, the number comparison worksheet that expands their knowledge on the math standard, as well as the partner evaluation.

Parameters or Constraints:
The boundaries for the students includes use of the limited materials provided, the allotted 50 minutes to complete this activity, and a structure that must withstand the weight of the mini-marshmallows. The students must demonstrate and apply their knowledge of comparing two two-digit numbers, as well as complete the design process.

Evaluation:
The students will be evaluated with a rubric that addresses all the areas in which the students need to show learning and understanding. They will also be evaluated based on their teamwork through the process of a partner evaluation, so that one student is not left doing all the work or providing the ideas.

Graham Cracker Builder

(Student Copy)

Oh no!!! Meatballs are falling from the sky again! Before Flint and his team can destroy the machine, you and your partner have to create a structure that you, your friends, and family can take refuge in that can withstand the giant meatballs.

But wait! Before you begin construction, you and your partner must evaluate marshmallow goo, peanut butter, and frosting and decide which substance you think will be the strongest. Brainstorm possible building ideas together using the design loop worksheet.

You and your partner will have the opportunity to compete with other teams to see which group's structure can withstand the most marshmallows!

Materials:

Each set of partners will be provided with:

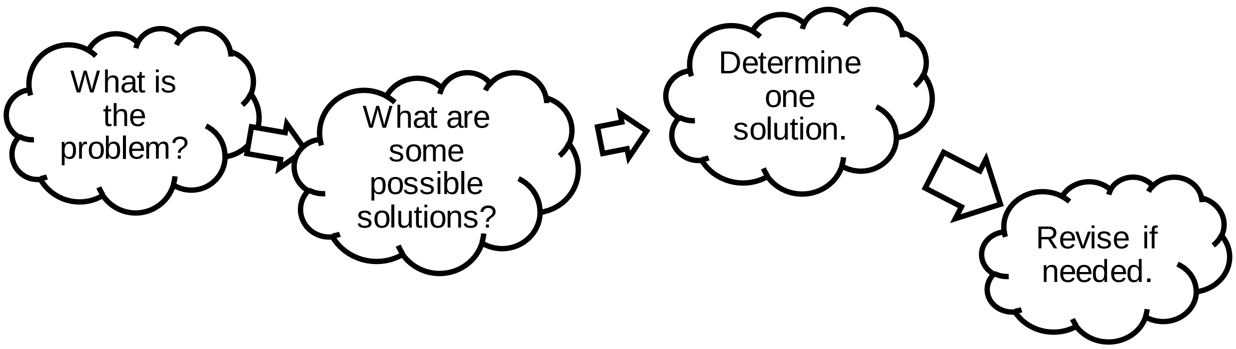
- A sleeve of graham cracker cookie squares
- Marshmallow goo
- Peanut butter
- Frosting

Parameters:

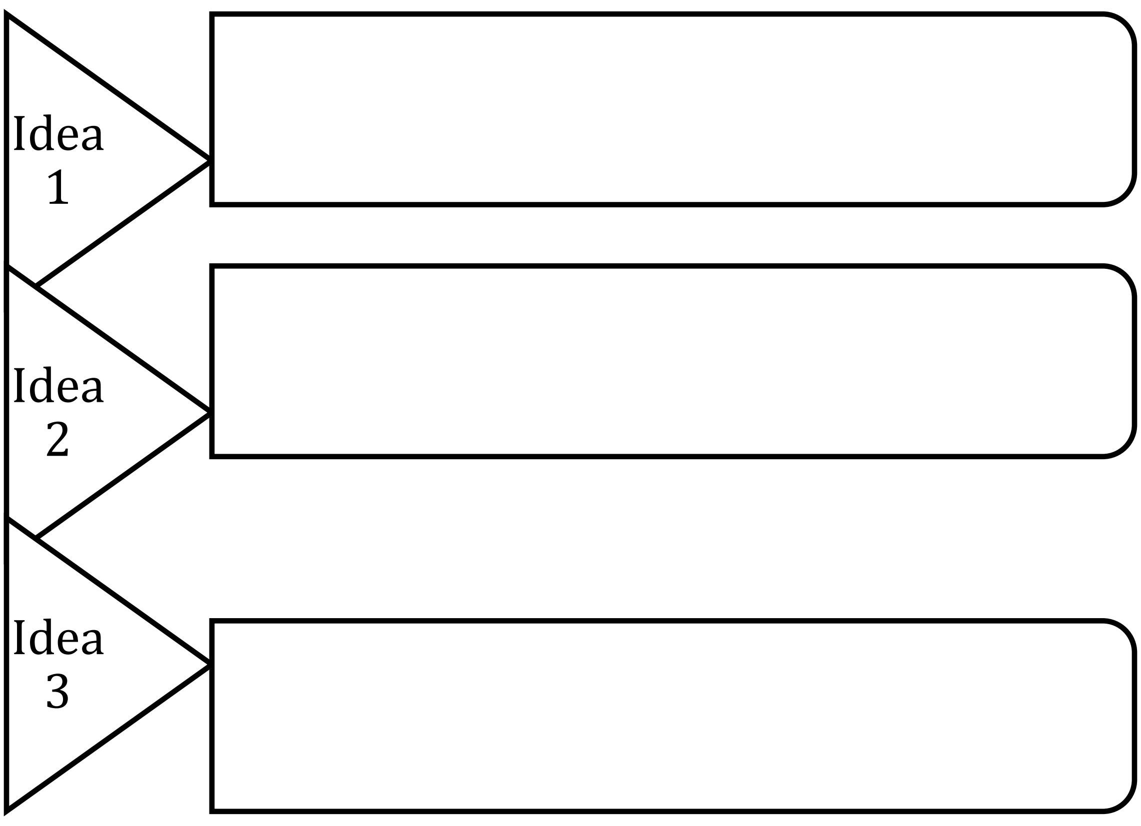
- You may only use the materials provided.
- You must brainstorm and construct within the 50-minute time period.
- Your structure must withstand the weight of at least 15 falling marshmallows at once.
- Your structure must be creative!

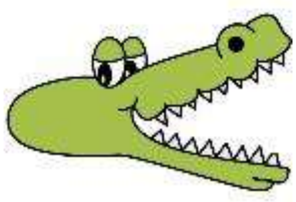
Design Your Structure!

Below brainstorm some ideas and travel through the design process to your friends and family stay safe from the giant meatballs!

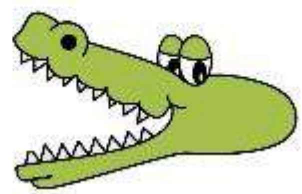


Ideas for our structure:





Comparing Numbers



1. We used ______ graham cracker squares for the **roof**.

2. We used ______ graham cracker squares for the **walls**.

______ (# of roof squares)   _______ (<,>, =)   _______ (# of wall squares)

Compare another aspect of your graham cracker structure.

3. We used ______ graham cracker squares for the

   _________________ (insert structure name other than roof or walls).

_____ (# of roof or wall squares) _____ (<,>,=) ______(# of _________squares from problem #3)

Partner Evaluation

Your Name: _______________

Partner's Name: _____________

Circle "Yes" or "No" for the following questions:

1. Was your partner kind and respectful? Yes/No
2. Did your partner offer ideas? Yes/No
3. Did your partner help clean up? Yes/No
4. Was your partner a team player? Yes/No
5. Did you and your partner understand the project? Yes/No

"Graham Cracker Builder" Rubric

Group Members: _________________

Name of Structure: _______________

Criteria of the Structure:

1. The structure is capable of withstanding the marshmallows. __/15
2. The group only used the materials given. __/10
3. The group turned in the design loop worksheets. __/15
4. The team turned in the number comparison worksheets. __/15
5. The structure is creative and unique. __/10
6. The structure follows the design process you established. __/10
    i. With revisions allowed and encouraged
7. Teamwork was used to create the bridge. __/10
8. The team showed an understanding of the meaning greater than, less than, and equal to when comparing numbers. __/15

Total: __/100

Hold a Live Load
Construction Blocks
Grade: 3rd
Teacher Guide

Stem Content Standards:

Science Standards:

- ESS2.D: Weather and Climate
  3-ESS2-2: Obtain and combine information to describe climates in different regions of the world.
- ESS3.B: Natural Hazards
  3-ESS3-1: Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.

Standards for Technological Literacy:

- Standard 8: Students will develop an understanding of the attributes of design.
  C. The design process is a purposeful method of planning practical solutions to problems.
  D. Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.
- Standard 9: Students will develop an understanding of engineering design.
  C. The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.
  D. When designing an object, it is important to be creative and consider all ideas.
- Standard 20: Students will develop an understanding of and be able to select and use construction technologies.
  C. Modern communities are usually planned according to guidelines.
  D. Structures need to be maintained.
  E. Many systems are used in buildings.

Mathematics Standards:

- AR.Math.Content.3.OA.A.1
  Interpret *products* of *whole numbers* (e.g., interpret 5 × 7 as the total number of objects in 5 groups of 7 objects each)
- AR.Math.Content.3.MD.C.5

Recognize area as an *attribute* of plane figures and understand concepts of area measurement:

- A square with side length 1 unit, called "a unit square," is said to have "one square unit" of area, and can be used to measure area.

- AR.Math.Content.3.MD.D.8
  Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters

Big Ideas:

- Understand and use the design process
- Understand there are multiple solutions to a problem
- Measurement
- Understand that different climates effect human habitats
- Understand live and dead loads on a structure

Scenario:
You are a homebuilder. Your family has decided to move to Reykjavik, Iceland. Because it snows in Reykjavik December through March, you need to design a home that can hold the weight of the live load.

Essential Question:
How could Keva planks be used to construct a house that will hold a 20-pound weight?
How do different climates effect human habitats?

Challenge:
In teams of four, you will construct a house out of Keva planks.

Constraints:

- You will be given 600 Keva planks. You do not have to use all of the blocks.
- Your house must be at least 24 inches tall.
- Your house must be able to hold 20 pounds. This will be tested using a 20-pound weight, representing the weight of the live load.
- You will be given two 50-minute blocks of time to design and complete the challenge.

Tools, Materials, and Resources:

- 600 Keva planks for each team
- 1 ruler for each team
- 20-pound weight
- 1 Design journal for each team
- 1 Student check list for every student
- 3 team member evaluations for each student
- 1 Building block challenge rubric completed by teacher for every team

Content Information:
Weather and climate in different regions of the world:

- Climate is the characteristic condition of the atmosphere near the earth's surface at a certain place on earth. It is the long-term weather of that area (at least 30 years). This includes the region's general pattern of weather conditions, seasons, and weather extremes like hurricanes, droughts, or rainy periods. Two of the most important factors determining an area's climate are air temperature and precipitation.
- World biomes are controlled by climate. The climate of a region will determine what plants will grow there, and what animals will inhabit it. All three components, climate, plants, and animals are interwoven to create the fabric of a biome.
- Reykjavík has a humid, subarctic, continental climate with cool summers and no dry season.
- Over the course of a year, the temperature typically varies from 27°F to 57°F and is rarely below 16°F or above 62°F.
- The warm season lasts from June 10 to September 6 with an average daily high temperature above 53°F. The hottest day of the year is July 26, with an average high of 57°F and low of 49°F. The cold season lasts from November 10 to April 3 with an average daily high temperature below 40°F. The coldest day of the year is January 28, with an average low of 27°F and high of 36°F.

Weather related natural hazards:

- The types of natural disasters that cause worldwide losses are many. Earthquakes, tsunamis, volcanic eruptions, forest fires, blizzard, and landslides are just a few of the non-weather types of natural disasters. Weather disasters include tornadoes, hurricanes, flooding, and droughts. Many of the non-weather disasters have overlaps with severe weather. For instance, many landslides are caused by excessive rainfall. As another example, forest fires often start as a result of dry thunderstorms.
- Snow is formed from condensed water in the atmosphere. Water vapor in clouds condenses to form droplets. Cold air then freezes the water to form ice crystals. As these ice crystals bind with more water vapor they become heavier. Eventually, the ice crystal falls from the cloud, collecting more water vapor as it falls. As the ice crystal descends, and the air temperature increases the ice crystal can melt slightly. This melting can cause crystals to bind together to form larger flakes. Snow will remain on the ground if the temperatures are cold enough to keep it from melting.

Technology and Engineering
Construction technologies:

- Live loads refer to loads that do, or can, change over time, such as people walking around a building or movable objects such as a flower pot on a deck. In addition to live loads, what is known as <u>environmental loads</u> are loads that are created naturally by the environment and include wind, snow, and seismic and lateral soil pressures.

- Dead loads refer to loads that typically don't change over time, such as the weights of materials and components of the structure itself (the framing, the flooring material, roofing material, etc.) ,and the weights of fixed service equipment (plumbing, HVAC, etc.).
- Building in different climates
    - https://www.teachengineering.org/lessons/view/cub_china_lesson02

Mathematics:
Whole numbers:

- The numbers {0, 1, 2, 3, ...} etc.
- There is no fractional, decimal part, or negatives.
- Example: 5, 49 and 980 are all whole numbers.
- Accomplished by: counting Keva planks

Plane figures:

- Plane figures are flat two-dimensional (2D) shape. A plane figure can be made of straight lines, curved lines, or both straight and curved lines.
- Accomplished by: determining the shape of the team's "house"

Perimeter of polygons:

- http://www.mathgoodies.com/lessons/vol1/perimeter.html
- Accomplished by: measuring the parameter of the team's "house"

Deliverables:

- 1 design journal per team
- 1 student check list from every student
- 1 team member evaluation for every team member (completed by every student)

Evaluation:

- Building block challenge rubric
- Team member evaluation
- Design journal
-

Extensions:

- Students could write a creative writing or informative piece about natural disasters.
- This design challenge could be used in a science unit about regional climates and appropriate construction practices.

Hold a Live Load

Grade: 3^{rd}
Student Copy

<u>Scenario</u>**:** You are a homebuilder. Your family has decided to move to Reykjavik, Iceland. Because it snows in Reykjavik December through March, you need to design a home that can hold the weight of the live load.
<u>Essential Question</u>**:** How could Keva planks be used to construct a house that will hold a 20-pound weight?
<u>Challenge</u>**:** In teams of four, you will construct a house out of Keva planks.
<u>Constraints</u>**:**

- You will be given 600 Keva planks. You do not have to use all of the blocks.
- Your house must be at least 24 inches tall
- Your house must be able to hold 20 pounds. This will be tested using a 20-pound weight, representing the live load.
- You will be given two 50 minute sessions to design and complete the challenge.

<u>Tools, Materials, and Resources</u>**:**

- 600 Keva planks for each team
- 1 ruler for each team
- 1 Design journal for each team
- 1 Student check list for every student
- 3 team member evaluations for each student

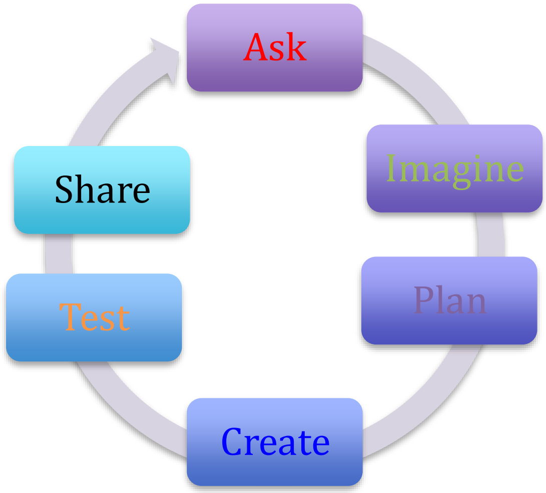
<u>Deliverables</u>**:**

- 1 design journal per team
- 1 student check list from every student
- 1 team member evaluation for every team member (done by every student)

<u>Evaluation</u>**:**

- Success of solution to the design challenge
- Completion of the design journal
- Team member evaluation

Hold a Live Load
Grade: 3rd
Student Design Journal



ASK:

1. What is the problem?

IMAGINE:

2. My first ideas:

PLAN:

3. What is the best solution?

What does the solution look like?

4. Create: Build your design!

TEST:

5. How did you test your solution?

How do you know if your idea works?

IMPROVE/SHARE: Share your idea with at least one other group. Allow the group to give your ideas to improve your design.

6. How would you change your idea?   What did you learn?   What ideas did another group give you to improve your design?

Hold a Live Load
Grade: 3rd
Student Checklist

Student Checklist

I understood the problem.	
I made drawings to show my ideas.	
I used my time wisely.	
My project met the constraints.	
I used materials and tools correctly.	
I wrote my ideas in my design challenge journal.	
I worked well with my group.	
My project was neat and attractive.	

Hold a Live Load

Grade: 3rd
Team Member Evaluation

Your Name____
Team Member's Name_____________________________________

Statement	Yes	No
Contributed ideas to the project		
Listened to and respected others in the group		
Did his/her fair share of the work		
Helped gather materials		

What did this team member do to help complete the design challenge?

Comments:

Hold a Live Load

Grade: 3rd
Teacher Rubric

	Points Possible	Points Awarded
Student worked well with teammate.	20	
The group's design met the requirements.	25	
The team completed their design journal.	30	
The team's design was successful.	25	

Comments:

Can We Build It?
By: David Parkes

Grade Level: 9-12

Discipline: STEM

Unit: Construction Technologies

Hours: 25

Content Standards:

Technology:

1.0 Design Applications of Construction Technologies
1.1 Understand how the engineering design process is used in construction technology
1.2 Identify the appropriate measurement device for the application
1.3 Identify common construction tools and materials as well as appropriate techniques and applications
1.4 Recognize the importance of building codes and standards in construction
1.5 Identify, design, and construct a structure to serve a need in the community

2.4 Recognize the elements of a corporate identity package

3.1 Describe the need for safe work environments in the Engineering and Technology Educational classroom and laboratory
3.2 Describe specific procedures such as reporting illness, injuries, safety violations, etc.
3.3 Use appropriate and required personal protection equipment (eye protection, ear protection, etc.)
3.4 Describe machine and tool safety practices and procedures

Big Ideas:

Students will have a deeper understanding of how design and engineering works in a real world application. Students should become fluent in the terminology that is present with a common structure. Students will have the opportunity to discover new possibilities for their future in the job market.

The students should be given the challenge in the beginning of this unit. The purpose of this is so that they can work on their own designs of the challenge. They can learn to draft with their designs and then when the time is right the students should be placed into teams. Students can then use their already brainstormed ideas and collaborate with a team. After the team has decided on what their design is going to be by using each other's ideas. Then the teacher can grade each student's individual designs. This will serve as a good informative assessment.

Essential Question:

How does a good engineering design make for a smooth build, low cost, and practical application? Also, how does modern technology help in making the process easier?

Previous Knowledge:

Basics of drafting

- Elevations
- Front view
- Side view
- Top view
- Lettering
- scaling

Terminology of building materials and processes of construction

- Stud
- Joist
- Cripple
- King stud
- Framing corners
- Headers
- Window sills
- Rafters
- Trusses

Scenario:

A church in town that also manicures a small cemetery is in need of a small shed to store lawn equipment in. The zero turn radius mower they own has a 48" mowing deck which is the widest part of the mower. They also own 2- weed eaters, a push mower and few gas cans. We have been ask to build a shed for them that will accommodate their needs and for the least amount of money.

Challenge:

Working in groups of 4 (approximately) you will design a shed that will be structurally sound and be the most cost effective way to build it. The shed needs to have a door and a window in the design. Also the structure needs to be able to be moved from the schools location where the building will be made, to the location on the church's property.

The challenge is to make a scale 18" model of your design with a cost analysis to present to the class on a certain date. This is your opportunity to sell the product. The class will then pick the team with the best solution. The teacher is the tie breaker.

The winner will have their design built by the class. In the 2nd semester

Tools, Materials, and Resources:

- Wood blocks that are 1/8" scale to that of real building materials 2x4x8, 2xs4x8 studs, 2x6x8, etc. (These blocks will most likely be made by the teacher.)
- Wood glue
- Construction paper (plywood)
- Cardboard
- Small pieces of rubber band for door hinges
- Scissors
- Small hand saws
- Design journals
- Spreadsheet for cost analysis to fill out
- Information on cost of building materials
- Video of Tacoma Narrows Bridge Collapse https://youtu.be/j-zczJXSxnw 5 minutes long
- Video Death by Design Part 1 https://youtu.be/0hylKoeUuo0 14 minutes long
- Video Death by Design Part 2 https://youtu.be/b3SIaYfP_W4 15 minutes long
- Images of real architectural models found online. Also might be a good idea and visit an architecture firm and view real life models. U of A has excellent models in the architecture department.

Content information:

The students will gain a deeper understanding of the design loop as they work in teams. They will discover the importance of an accurate drawing and an accurate model.

The students will discover types of buildings and why they are built in the way they are. Students will become fluent in using basic terminology in construction. Students will learn how to make accurate drawings of a structure. They will learn different building materials and some of the uses for them.

Deliverables:

Individually

Proof of using the design loop, Blue prints, cost analysis of materials on your own design.

As a Team

Detailed blueprints of front side and top views, detailed cost analysis, and presentation as a group

Parameters or constraints:

The design is supposed to be the most economical and practical. Model structure must be built on a piece of card board so that structure can be transported easily.

Evaluation:

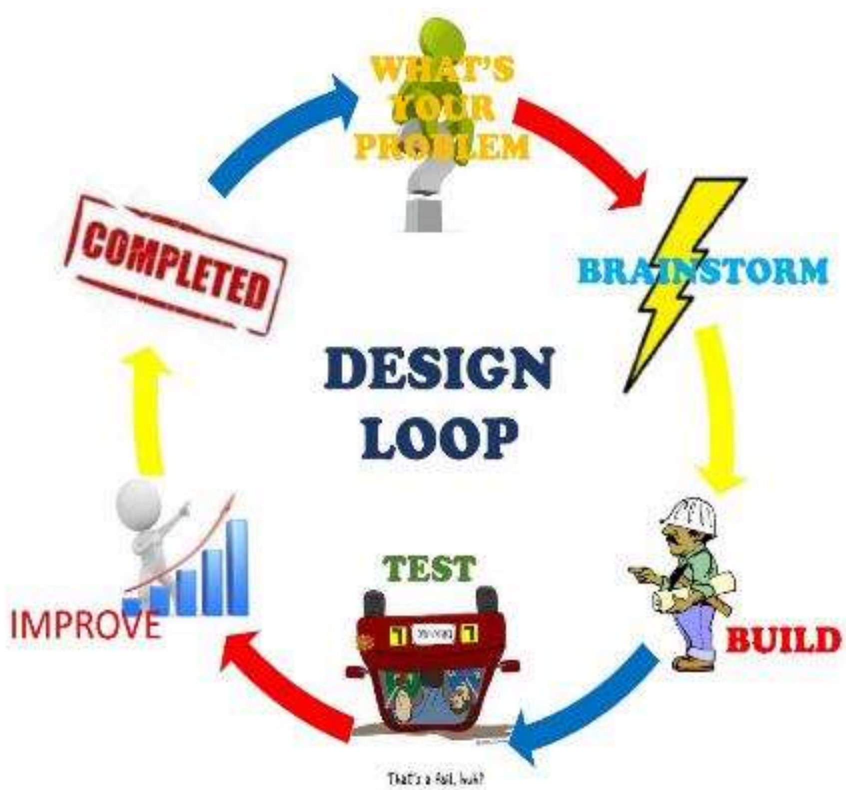
There will be evaluations done throughout this unit. Each student need to turn in a design they made in the brainstorming process of the design loop. This design should be well thought out and show the student contributed to their team. The teams will combine

Final Presentation Rubric

Key Factors	Points	Score
Team showed evidence of use of the design process.	10	
Team submitted a detailed blueprint of their design. That gave a front, side, and top view.	10	
Team also submitted the material list and cost analysis	10	
Team constructed a 1/8" scale model of their design.	10	
Model is clean and detailed oriented.	10	
All team members presented in the bid process. (presentation)	10	
The presentation was clear and easy to understand. It was also effective in arguing why the design is a better choice.	10	
All team members showed awareness and safety throughout this assignment.	10	
All team members were able to show that they could use the tools that were needed to accomplish model.	10	
Team demonstrated the ability to work together to accomplish the activity.	10	

Individual Design Rubric

Key Factors	Points	Score
Showed use of the design process.	5	
Blueprint is clean and detailed oriented. Also give front side and top view.	5	
Cost was considered during the design process.	5	
Design showed knowledge of construction terminology.	5	



Material List and Costs

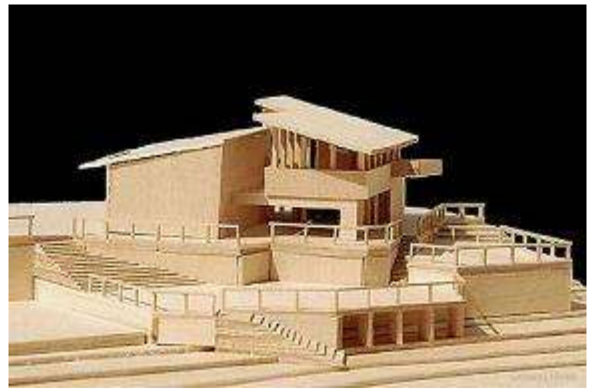
Material	Cost	Amount	Total
2x4x8 Pressure Treated (PT)	$3.17		
2x4x10 PT	$5.47		
2x4x12 PT	$6.37		
2x4x16 PT	$9.47		
2x6x8 PT	$6.57		
2x6x10 PT	$8.47		
2x6x12 PT	$9.57		
2x6x16 PT	$13.47		
2x4x8 STUD	$2.38		
2x4x8	$2.38		
2x4x10	$3.98		
2x4x12	$6.37		
2x4x16	$7.25		
2x6x8	$4.33		
2x6x10	$6.36		
2x6x12	$7.42		
2x6x16	$9.79		
¾” Plywood PT	$31.57		
7/16” Oriented Strand Board (OSB)Sheathing	$11.55		
23/32” OSB tongue and Groove subfloor	$18.58		
3 ¼” coated sinker nails 5 lbs.	$9.87		
2 3/8” coated sinker nails 5 lbs.	$9.87		
3 ¼” pneumatic gun nails QTY. 4,000	$39.85		
2 3/8” pneumatic gun nails Qty. 5,000	$47.98		
Cinder blocks 16”x8”x8”	$1.39		
Solid block 4”x8”x16”	$2.19		
Solid cap block 2”x8”x16	$1.19		

Student Copy

Scenario:

A church in town that also manicures a small cemetery is in need of a small shed to store lawn equipment in. The zero turn radius mower they own has a 48" mowing deck which is the widest part of the mower. They also own 2- weed eaters, a push mower and few gas cans. We have been ask to build a shed for them that will accommodate their needs and for the least amount of money.

Challenge:



Working in teams you will design a shed that will be structurally sound and be the most cost effective way to build it. The shed needs to have a door and a window in the design. Also the structure needs to be able to be moved from the schools location where the building will be made, to the location on the church's property. So the design needs to take into account this factor.

The challenge is to make a scale 18" model of your design with a cost analysis to present to the class on a certain date. This is your opportunity to sell the product. The class will then pick the team with the best solution. The teacher is the tie breaker.

The winner will have their design built by the class. In the 2nd semester

Note:
Every student will give to the teacher their idea for accomplishing the challenge. This includes the blueprints of front side and top of structure, material list, and cost analysis.

Tools, Materials, and Resources:

Tools needed:

Small Hand Saw, scissors, engineering scales

Materials available:

After you show a finished blueprint with a material list you can then pick up your materials from the teacher.

- Wood, glue, scales, cardboard, and construction paper

Resources:

Materials list with cost of each material
Design loop journals.

Stopping the Winds

Construction Block Challenge

By: Caroline Bestard and Mary Engledow

Grade Level: 2nd

Unit: Physical and Earth Science

STEM Standards:

Arkansas Science Standards**:**

- ESS2.A: Earth Materials and Systems - Wind and water can change the shape of the land.

    - 2-ESS2-1 Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.

- ETS1.B: Developing Possible Solutions - Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.

- ETS1.C: Optimizing the Design Solution - Because there is always more than one possible solution to a problem, it is useful to compare and test designs.

Arkansas Math Standards**:**

- AR. Math.Content.2.MD.C.8 Solve word problems involving dollar bills, quarters, dimes, nickels, and pennies, using $ and ¢ symbols appropriately

- AR.Math.Content.2.MD.A.1 Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes

Standards for Technological Literacy:

- Standard 7. Students will develop an understanding of the influence of technology on history.
    - B. The way people live and work has changed throughout history because of technology.

- Standard 8. Students will develop an understanding of the attributes of design.
    - A. Everyone can design solutions to a problem.
    - B. Design is a creative process.

- Standard 9. Students will develop an understanding of engineering design.

A. The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.
B. Expressing ideas to others verbally and through sketches and models is an important part of the design process.

Big Ideas:

- The use of the engineering design loop
- Creating a model within specific parameters
- Properties of materials to create a structure to prevent wind erosion on soil

Content Information & Resources:

Definitions:

* **Soil erosion** is a naturally occurring process that affects all landforms. In agriculture, soil erosion refers to the wearing away of a field's topsoil by the natural physical forces of water and wind or through forces associated with farming activities such as tillage.

*__Wind erosion__ is a serious environmental problem attracting the attention of many across the globe. It is a common phenomenon occurring mostly in flat, bare areas; dry, sandy soils; or anywhere the soil is loose, dry, and finely granulated.

*http://www.omafra.gov.on.ca/english/engineer/facts/12-053.htm

Video with images from the Dust Bowl:
http://video.scholastic.com/services/player/bcpid858992059001?bctid=1466663974001

Design Loop

Essential Question:
How can you create something to stop wind erosion on soil?

The Scenario:
Imagine you are a farmer during the 1930's Dust Bowl. When a severe drought hits the Great Plains region, the dry terrain and heavy winds created large cloud of dust. These dust storms greatly affected the agriculture in these areas making farming very hard.

Your Challenge:
In groups of 4-5, you will brainstorm a solution to keep wind from eroding soil and destroying your crops. Use your design loop and journal to work through your design method. You will also have to purchase any supplies you use. Each group will be given $4.00 to spend on clothes pins and wooden craft sticks. Make sure you use any supplies and money wisely! Once you purchase your supplies, you will use them to create a structure that will prevent the wind from blowing the sand, simulating soil erosion by wind.

Test your solution by using the small fan to blow the sand into the structure. When you are done building, measure the height and width of your creation and record your measurements in your journal. When you have completed your model and journal we will test our creations as a class and each group will share their design.

Tools:

- ★ Ruler
- ★ Small Fan

Materials:

- ★ Wooden Craft Sticks (standard ¼ inch width) - enough that each group could have as many as 20-25
- ★ Clothespins - enough that each group could have as many as 10-15
- ★ 1 14" x 16" Cookie Sheet for each group - this will help contain the sand somewhat (***Note:** a cookie sheet without edges will work best in testing the sand blowing through the structures and not interfering with the sand piling.)
- ★ 1 Quart Sand for each group

Deliverables:

- ★ Team Rubric
- ★ Completion of Final Design
- ★ Engineering Journal

Parameters: Your completed structure must:

- ★ Be completed after two 45 minute periods
- ★ Be 16 inches (or the width of the cookie sheet)
- ★ Use no more than $4.00 of materials

Evaluation: Students will be evaluated individually on their documentation in their journal as well as their team rubric. Additionally, as a team, students will receive a grade for their finished project and presentation.

Design Journal	Team Rubric	Final Design
_____ /15	______ /10	______ /25

Stopping the Winds
Construction Block Challenge
Student Copy

The "Big Ideas":

- The use of the engineering design loop.
- Creating a model within specific parameters.
- Properties of materials to create a structure to prevent wind erosion on soil

The Scenario:

Imagine you are a farmer during the 1930's Dust Bowl. When a severe drought hits the Great Plains region, the dry terrain and heavy winds created large cloud of dust. These dust storms greatly affected the agriculture in these areas making farming very hard.

Essential Question:

What can you create that will protect your growing crops from damage from soil particles and keep your soil from eroding?

Your Challenge:

In groups of 4-5, you will brainstorm a solution to keep wind from eroding soil and destroying your crops. Use your design loop and journal to work through your design method. You will also have to purchase any supplies you use. Each group will be given $4.00 to spend on clothes pins and wooden craft sticks. Make sure you use any supplies and money wisely! Once you purchase your supplies, you will use them to create a structure that will prevent the wind from blowing the sand, simulating soil erosion by wind.

Test your solution by using the small fan to blow the sand into the structure. When you are done building, measure the height and width of your creation and record your measurements in your journal. When you have completed your model and journal we will test our creations as a class and each group will share their design.

Tools:
☆Ruler ☆Small Fan

Materials:
☆Wooden Craft Sticks ☆Clothespins ☆Cookie Sheet ☆Sand

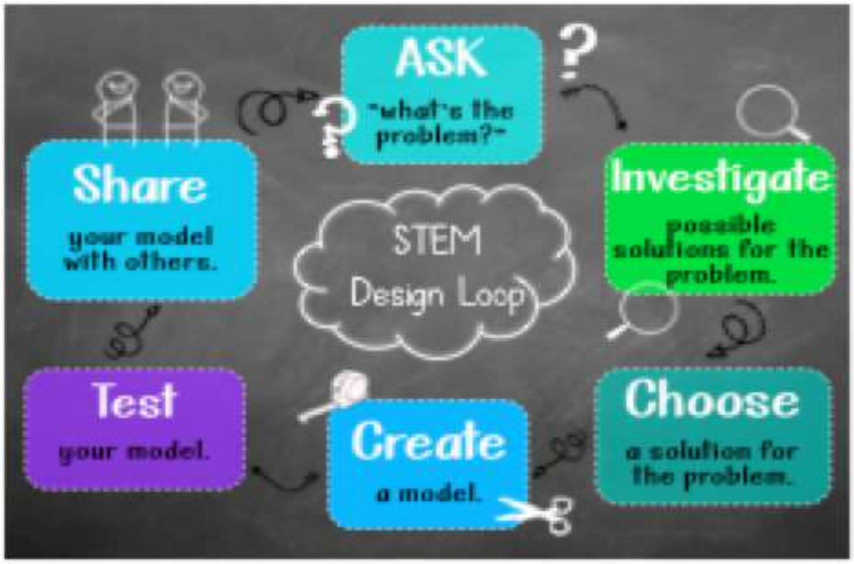
Material Prices

Material	1 Wooden Craft Stick	1 Clothes Pin
Price	10 ¢	25 ¢

Deliverables:
- ★ Team Rubric
- ★ Completion of Final Design
- ★ Engineering Journal

Parameters:
Your completed structure must:
- ★ Be completed after two 45 minute periods
- ★ Be 16 inches (or the width of the cookie sheet)
- ★ Use no more than $4.00 of materials

Name: ____________________________'s Design Journal



Ask: "What is the problem I need to solve?"

Investigate

What are some of my ideas?	What are some of my ideas?

I know that __________ cents = $1.00. We think we will need _________ wooden craft sticks. Each craft stick costs 10¢. How much money will we spend on wooden craft sticks?

Show Work Here:

Remember to pay attention to dollars ($) and cents (¢).
We think we will need ________ clothespins. Each clothespin costs 25¢. How much money will we spend on clothespins? Pay attention to dollars ($) and cents here!

Show Work Here:

We will spend this much money on supplies. (Add together your total for wooden craft sticks and clothespins.) Be sure your final amount is written in ***dollars*** ($) and is less than

Show Work Here:

$4.00 total!

Choose: This is my group's final idea!

Create: We will use these materials to create our model:

Self-Evaluation:

How did you create a structure to help keep your crops safe from soil erosion and keep the soil from eroding in the future?

If you could do the challenge again, would you make any changes? If so, what?

Team Rubric

Name: ______________________________

Teammate(s): ____

Please rate your partners on their performance by placing an X in the appropriate box and add any comments as necessary.

Partner #1 Name:	Excellent Performance	Okay Performance	Bad Performance
My partner helped with the design process.			
My partner stayed focused to help finish the design/model on time.			
My partner gave helpful and original ideas.			
My partner did his/her fair share of the work on the whole project.			

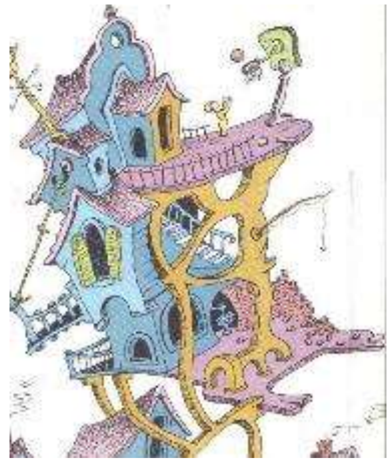
Partner #2 Name:	Excellent Performance	Okay Performance	Bad Performance
My partner helped with the design process.			
My partner stayed focused to help finish the design/model on time.			
My partner gave helpful and original ideas.			
My partner did his/her fair share of the work on the whole project.			

Partner #3 Name:	Excellent Performance	Okay Performance	Bad Performance
My partner helped with the design process.			
My partner stayed focused to help finish the design/model on time.			
My partner gave helpful and original ideas.			
My partner did his/her fair share of the work on the whole project.			

Partner #4 Name:	Excellent Performance	Okay Performance	Bad Performance
My partner helped with the design process.			
My partner stayed focused to help finish the design/model on time.			
My partner gave helpful and original ideas.			
My partner did his/her fair share of the work on the whole project.			

Title: Small City, Big House

Teacher Guide



Grade Level: 5th

Disciplinary Area: STEM

Lesson Hook:

Dr. Seuss House video on YouTube

https://www.youtube.com/watch?v=FL4BfoacSWs

Standards:

Science:

Arkansas Science Frameworks:

- 5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

Technology and Engineering:

Standards for Technological Literacy:

- Standard 11: Students will develop abilities to apply the design process. As part of learning how to apply design processes, students should be able to:

  A. Identify and collect information about everyday problems that can be solved by technology, and generate ideas and requirements of solving a problem.

  B. The process of designing involves presenting some possible solutions in visual form and then selecting the best solutions(s) from many.

  C. Test and evaluate the solutions for the design process.

  D. Improve the design solutions.

Math:

Arkansas Mathematics Standards:

Measurement and Data: Convert like measurement units within a given measurement system

- AR.Math.Content.5.MD.A.1
  - Convert among different-sized standard measurement units within the metric system For example: Convert 5 cm to 0.05 m.

    - Convert among different-sized standard measurement units within the customary system For example: Convert 1 ½ ft. to 18 in.
    - Use these conversions in solving multi-step, real world problems

Big Ideas:

- Area
- Measurement and data
- Students will create the largest building they can, with the most area, but with the smallest foundation using Popsicle sticks, plastic cups, and small wooden blocks.

Essential Questions:

- Did the students understand the real-world situation they had to solve?
- Did the students use the design loop to guide their process of coming up with a solution to the problem?
- Were the students able to measure their building in centimeters?
- Were the students able to convert their measurement from centimeters to inches?
- Did the students record their data and conversions?
- Were the students able to discuss and support their building with evidence from their data?
- Were the students able to defend why their design would or wouldn't work in an overpopulated city?

Scenario:

You are in a town that is overpopulated, and area to build your home is limited. You must create a structure for you and your family to live in that uses the smallest foundation possible. Then you must build up instead of out like you would normally see houses on the street. For example, apartment buildings generally have multiple floors.

Challenge:

Because of the limited ground area and high population in your town, you have to find a way to build your new house with the maximum amount of area possible and with the smallest foundation.

Materials:

- Small clear plastic cups
- Wide popsicle sticks
- Small wooden cube blocks
- Measuring tape

Content Information:

- Science: Students are given the problem of overpopulation in their city. They must figure out a way to provide their family with a home by building them a structure with the smallest foundation possible.
- Technology and Engineering: Students will use the design process to look at the problem at hand and plan out different ways they can successfully create their building with the smallest foundation. The students will test their different ideas by

constructing these buildings and figuring out which building best solves the problem they are given.

- Math: The students, after constructing their building and recording their sketches on their Design Loop Activity Log, will measure their building's foundation in centimeters. After measuring the height and length of their base, they will convert their measurements into inches recording this in their activity log. After finding the measurements of the base in inches, they will then calculate the area of the base. They will repeat these steps for the bigger part of their building using the area formula for a square and record this in their activity logs. They will know basic conversions:

  2.54 centimeters = 1 inch

  They will use ratios to convert their centimeter measurements to inches.

Deliverables:

- Design Loop Activity Log
- Explanation of why their structure will work in this overpopulated society while being able to provide for your family.
- Team Member Evaluation

Parameters:

- Time
- Space to build their buildings

Assessment:

Students will be assessed on their activity log, using the rubric provided.

Title: Small City, Big House

Student Guide

Scenario

You are in a town that is overpopulated and area to build your home is limited. You must create a structure for you and your family to live in that uses the smallest foundation possible. Then you must build up instead of out like you would see houses in our everyday lives. An example of this would be like apartment buildings and also the home you saw in the video!

Challenge

Due to this limitation of not enough ground area for everyone in your town, you have to find a way to build your structure with the maximum amount of area possible and with the smallest foundation. Example:

Materials you will be using:

- Small wooden blocks
- Small plastic cups
- Popsicle sticks

Design Loop Activity Log

Group Member names:

Design Loop:

Possible Design ideas:

Once your group has decided on a design for your building…

<u>Length of foundation in inches</u>-

<u>Height of foundation in inches-</u>

***What is the area of the base?**

<u>Length of building in Inches-</u>

<u>Height of foundation in inches-</u>

***What is the area of the building?**

Once your measurements are complete, explain to the mayor in a letter describing why your house will do the best in the city regarding the problem of overpopulation and use your evidence you have recorded to support your answer

Peer Evaluation

Directions: Put a 3 in the box if your group did what the statements say on the left side. Put a 1 in the box if they did not do what the statement says. And put a 2 in the box if you are unsure if they did what the statement says.

	Group Member 1 name:	Group Member 2 name:	Your name:
My group member helped with the building and planning of our building.			
My group member helped gather the measurements and worked together to find out the area of our building.			
My group member respected other people's ideas and listened to what they said.			

Rubric

1) The design loop is effectively and correctly used to create a building that solves the problem at hand.	________/25
2) Students demonstrated creative, thoughtful and intentional use of materials to construct a building that solves the problem.	________/15
3) Students worked well together and respected each other	________/15
4) Peer review completed and handed in on time	_________/5
5) Design Loop Activity Log is completed for each team member, containing sketches of plans, measurements,	________/20
6) Demonstrated understanding of learning through explaining why or why not their building would be efficient in a town with overpopulation using the data collected regarding measurements as **evidence** (the writing prompt letter to the mayor)	________/20
	Total__________/100

San Andreas

Construction Block Challenge

Teacher Copy

Grade Level: 4th Grade

STEM Content Standards:

Science Standards - Next Generation Science Standards:

A. 4-ESS3-2 Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans

Technology and Engineering Standards:

B. Standard 11: Students will develop abilities to apply the design process.
   1. As part of learning how to apply design processes, students should be able to:
      a) 3-5 Benchmarks
         (1) Identify and collect information about everyday problems that can be solved by technology, and generate ideas and requirements of solving a problem.
         (2) The process of designing involves presenting some possible solutions in visual form and then selecting the best solutions(s) from many.
         (3) Test and evaluate the solutions for the design process.
         (4) Improve the design solutions.

C. Standard 13: Students will develop the abilities to assess the impact of products and systems.
   1. As part of learning how to assess the impact of products and systems, students should be able to:
      a) 3-5 Benchmarks
         (1) Compare, contrast, and classify collected information in order to identify patterns.
         (2) Investigate and assess the influence of a specific technology on the individual, family, community, and environment.
         (3) Examine the trade-offs of using a product or system and decide when it could be used.

Mathematic Standards - Arkansas Mathematic Standards:

D. AR.Math.Content.4.MD.C.5
   1. Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement:

a) An angle is measured with reference to a circle with its center at the common endpoint of the rays, by considering the fraction of the circular arc between the points where the two rays intersect the circle
b) An angle that turns through 1/360 of a circle is called a "one-degree angle," and can be used to measure angles
c) An angle that turns through one-degree angles is said to have an angle measure of n degree
(1) Note: Use the degree symbol (e.g., 360°).

Big Ideas:

- Use design loop to solve a problem.
- Learn how to work with others to create a solution to the problem.
- Students will learn how to recognize and measure angles.
- Students will build a structure that can withstand the elements of earthquakes.

Essential Question:

- What is the process of the design loop?
- How does the design loop help us create a solution to a problem?
- What forms an angle?
- How do you measure and record angles?
- How do earthquakes affect structures?

Scenario:

You are a well-known home architect in Colorado who has built several award winning homes. The head of the real estate company you work for decides to expand the company to California and have you be the head architect! Before going to California you decide to do research on earthquakes and use this knowledge to help design a house that will survive an earthquake!

Challenge:

Build a house using Lincoln Logs to design a 2 story house that will survive through an earthquake

Tools and Materials:

Materials for student groups of 3

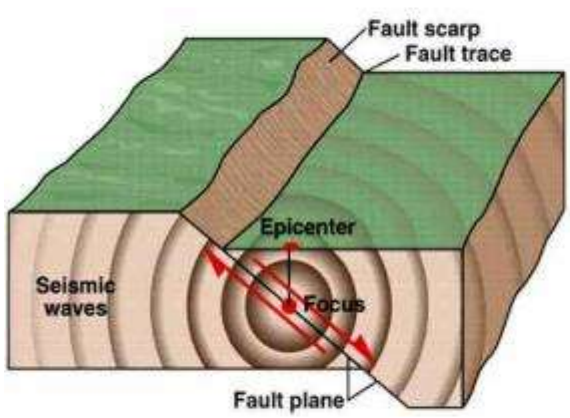
1. 1 tin of Lincoln Logs (111 pieces)
2. Protractor

3. Ruler
4. Pencil
5. Design Loop worksheet

Materials for earthquake testing

6. 1 storage tub (2'x3'x2')
7. 2 yards of twine
8. rubber bands
9. 1 small storage tub (6"x6"x1')

Content Information:



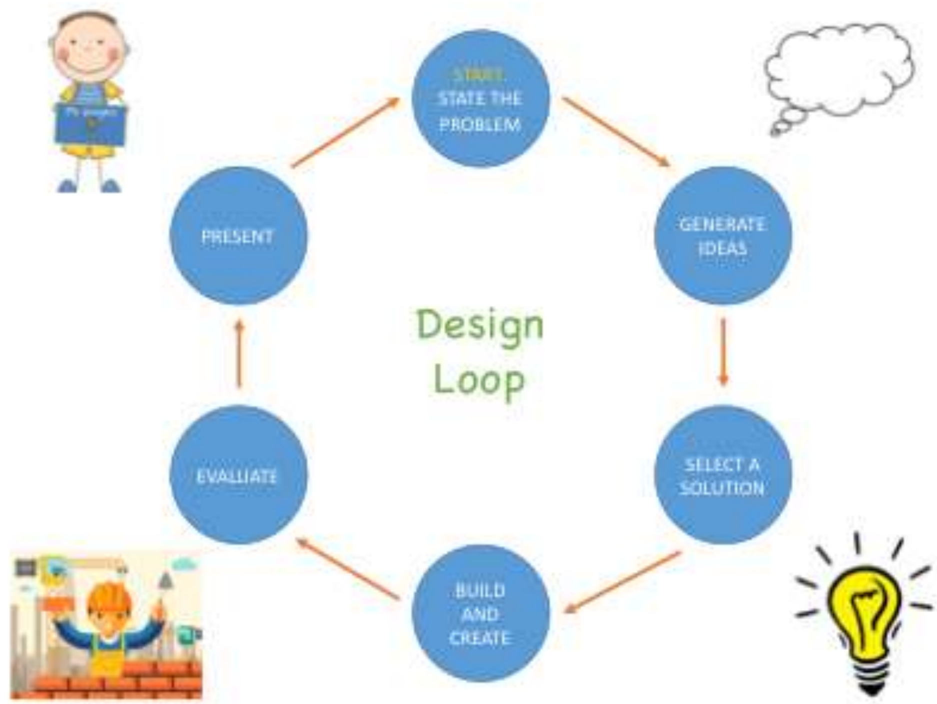
Science:
From: https://nimbofleet.com/blog/gps-helps-develop-early-warning-system-earthquakes

Video: https://www.youtube.com/watch?v=dJpIU1rSOFY

Technology/Engineering:
Step 1: "State the Problem" – This first step helps the students clearly identify what problem they are addressing.
Step 2: "Generate Ideas" – This next step is where the students brainstorm ideas and think about options for solving the problem they just identified.
Step 3: "Select a Solution" – This stage involves careful consideration of how to solve the problem. The students pick one of their ideas and use it as their solution.
Step 4: "Build and Create"– This step is where the students put their ideas into action.
Step 5: "Evaluate" – This stage is where the students will see how well their selected idea or solution worked.

Step 6: "Present" – The students get to present their final product or solution as the final part of the process.

***But, the design is circular for a reason. This design process can keep going as students continue to develop their ideas about what they have done.



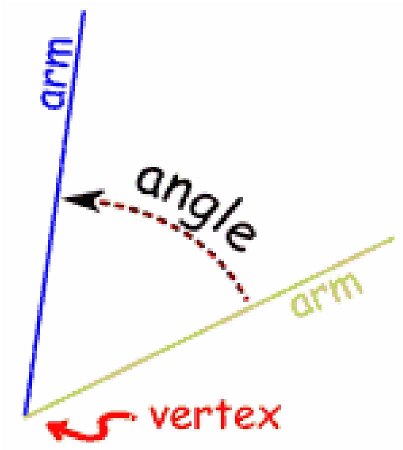
<u>Mathematics</u>-

Definition 1 of an angle= the amount of turn between two straight lines (or rays) that have a common end point (the vertex). From: https://www.mathsisfun.com/definitions/angle.html

Definition 2 of an angle=An angle is a geometric figure formed when two rays share the same endpoint. From: http://theteacherscafe.com/teaching-4-md-c-5-a-b-understand-angles-and-concepts-of-angle-measurement/

Picture from: https://www.mathsisfun.com/definitions/angle.html

There are two commonly used units of measurement for angles. The more familiar unit of measurement is that of degrees. A circle is divided into 360 equal degrees, so that a right angle is 90°. For the time being, we will only consider angles between 0° and 360°. (From: http://www2.clarku.edu/~djoyce/trig/angle.html)



Angles within a circle can be measured by turning the angle through the 360 degrees of the circle. One degree angles are angles that open only one degree. Larger angles are created by a series of one degree angles and can be named for their size. (From: http://theteacherscafe.com/teaching-4-md-c-5-a-b-understand-angles-and-concepts-of-angle-measurement/)

Deliverables:

II. Engineering design loop worksheet (attached)
III. Peer evaluation (attached)
IV. Lincoln Log house Set

Parameters and Constraints:

V. 1 tin of Lincoln logs
VI. must be no more than 6 inches wide and no taller than two stories
VII. Maximum of three students in each group

Assessment: Students will be evaluated using the attached rubric. Each group member will also submit a peer evaluation (attached) about their group members. To test the houses built by the students, the teacher will build an earthquake simulator. The stimulator will consist of a small storage tub tied to a bigger storage tub with twine or rubber band. The smaller tub will be suspended in the center of the big tub and tied tightly to each corner of the big tub. The teacher will push the smaller tub with the house inside of it to cause the movement. Teacher will also assess students' knowledge of angles during their group presentations.

Rubric:

Completed Design Loop Worksheet	___/10
Model follows parameters instructed	___/5
Students Collaborated well throughout the entire project (teacher observed throughout)	___/10
Reflection and Observations of how your prototype did	___/10
Reflection and improvement ideas that could be made to prototype	___/10
During presentation of their house, group identifies four angles formed during the construction of their house. Students demonstrate accurate knowledge of angles.	___/5
Total	**___/50**

Peer Evaluation

Directions: Put a 3 in the box if your group did what the statements say on the left side. Put a 1 in the box if they did not do what the statement says. And put a 2 in the box if you are unsure if they did what the statement says.

	Group Member 1 name:	Group Member 2 name:	Your name
My group member helped with the building of the Lincoln Log house.			
My group member helped is the designing process of our house.			
My group member respected other people's ideas and listened to what they said.			

San Andreas Architect

You are a well-known home architect in Colorado who has built several award winning homes. The head of the real estate company you work for decides to expand the company to California and have you be the head architect! Before going to California you decide to do research on earthquakes and use this knowledge to help design a house that will survive an earthquake!

In groups of 3 you will be designing a home using one tin of Lincoln Logs. You will need to use the design loop when designing your home and come up with a prototype of a house that can withstand an earthquake. Your group will each turn in a completed design loop activity sheet to show your own original ideas and thought processes, a group design loop activity sheet, and a peer evaluation sheet. After everyone has tested and made improvements to their homes, we will be presenting our design to the class. In this presentation you will need to describe your thought process, and identify four angles in your home.

Student Design Loop Worksheet

Sketch your final design of your house on the backside of this paper!

What is the problem/challenge?

____
____
____
____
____

My Idea Sketch

What can I do to make my machine better?

____
____
____
____
____
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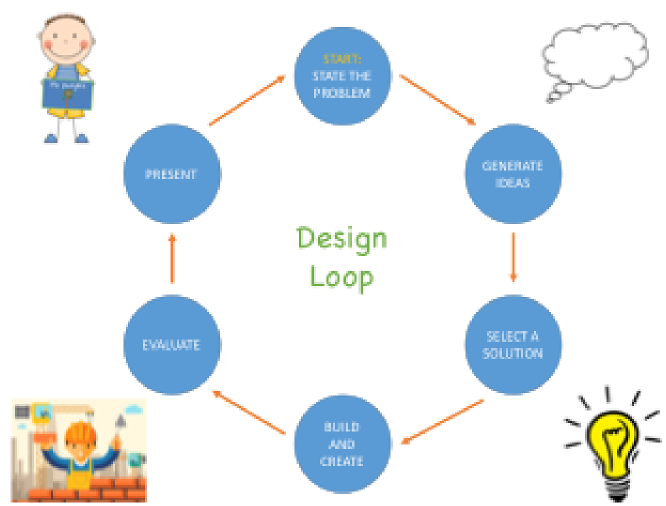
____

Engineering Design Loop



Team Idea Sketch

Was the design loop helpful when thinking of a solution? Explain.

____
____
____
____
____
____
____
____
____
____
____

How did my design work? Was it successful?

____
____
____
____
____
____

Selected Solution/Idea

We Will Not Be Shaken

Construction Block Challenge
Teacher Copy

Grade Level: 6th

Arkansas Mathematics:
AR.Math.Content.6.RP.A.1 Understand the concept of a ratio and use ratio language to determine a ratio relationship between two qualities.

Technological Literacy:
Standard 4. Students will develop an understanding of the cultural, social, economic, and political effects of technology.

> Benchmark**:**
> Technology, by itself, is neither good nor bad, but decisions about the use of products and systems can result in desirable or undesirable consequences.

Arkansas Science Frameworks:
ESS.8.6.10
Identify the effects of *earthquake*s on Earth's surface:

- tsunamis
- floods
- changes in natural and
- man-made structures

Big Ideas:
- Proper use of the design loop
- Be able to construct a structure to withstand an earthquake
- Identify the effect of earthquakes on man-made structures

Essential Questions:
What ratio of toothpicks to marshmallows is needed to withstand the force of an earthquake, and how will you construct them to create the sturdiest structure?

Scenario:
Scientists know that California is about to experience their biggest earthquake within the last decade. Their engineers are trying to figure out how to build buildings that will be least affected by

the damage of the earthquake. They need your help to build a sturdy structure to withstand the upcoming earthquake.

Challenge:
Using marshmallows and toothpicks build a structure that will withstand a 15 second jello earthquake.

Materials:
A maximum of 30 toothpicks
A maximum of 30 marshmallows
For the whole class to share:
1 eight by eight baking dish filled with pre made Jell-O.

Content Information:

- Students have been learning how the effects of mother nature can affect man-made structures and the different categories of the earthquakes
- Read the scenario to the class as a whole
- Divide students into groups of two
- Hand out the materials to the class
- Make it known that they get to use their creativity and the materials handed to them to construct whatever kind of structure they want to, so that it can withstand the earthquake it will be facing
- Have students follow the design look to brainstorm their solution to the problem
- Students will receive a worksheet to write down each group time that their building lasted
- Closure: have each group come to the front of the classroom and demonstrate to the rest of the class how long their building can last during an earthquake

Deliverables:
Each team of three will have to present engineering design loop and their structure. They will have to briefly explain to the class why they built the structure the way that they did and be handed out a sheet to record the time of how long each group's building lasted

Parameters:
Time limit of 15 seconds per earthquake
Five minutes to brainstorm and choose the amount of materials needed
15 minutes to construct the building

Assessment:

Grading Rubric

Demonstrates knowledge of design loop	(____/25) pts
Student is able to work collaboratively with partner	(____/20) pts
Student is able to complete assignment in the give Time	(____/20) pts
Completion of the handouts	(____/25) pts
Presentation to the class	(____/10) pts

Instructions for teacher:

1. Read the scenario to the class
2. Divide the class into groups of 2
3. Pass out the materials to each group and the copy of the design loop
    a. The design loop will be attached just copy the link into the search engine and print one copy out to put on the smart board for them to look at while making their design
4. Instruct the class that they have 5 minutes to brainstorm their ideas for how to build their structure and 15 minutes to actually construct the structure
5. Allow them the time to build their structure
6. After the 20 minutes is up pass out the sheet of paper that they will record every groups times on
7. Have each group come up one by one and set their structure into the jello bowl
8. Set a timer for 20 minutes and shake the bowl with your discretion of how strong you want the earthquake to be

Design loop:

https://1drv.ms/p/s!Almf2N3Z75IKca_zBD8CG62Gws

We Will Not be Shaken

Name: _____________

On this worksheet you will write down the amount of time each group's structure lasted through the earthquake. At the end of the presentations, write a short summary of what you observed on how the earthquakes affected the structures, and how the built of the earthquake depended on how long it lasted or not.

Group 1 time: _______secs

Group 2 time: _______secs

Group 3 time: ______secs

Group 4 time: ______secs

Group 5 time: ______secs

Group 6 time: ______secs

Group 7 time: ______secs

Group 8 time: ______secs

Group 9 time: ______secs

Group 10 time: ______secs

Group 11 time: ______secs

Group 12 time: ______secs

Summary:

Student Guide:

We Will Not be Shaken

Scientists know that California is about to experience their biggest earthquake within the last decade. Their engineers are trying to figure out how to build buildings that will be least affected by the damage of the earthquake. They need your help to build a sturdy structure to withstand the upcoming earthquake.

Essential Questions:
What ratio of toothpicks to marshmallows is needed to withstand the force of an earthquake, and how will you construct them to create the sturdiest structure?

Challenge:
Using marshmallows and toothpicks build a structure that will withstand a 15 second Jell-O earthquake.

Materials:
A maximum of 30 toothpicks
A maximum of 30 marshmallows
For the whole class to share:
1 eight by eight baking dish filled with pre-made Jell-O

Parameters:
Time limit of 15 seconds per earthquake
Five minutes to brainstorm and choose the amount of materials needed
15 minutes to construct the building

Eleanor Jahant & Brittany Larry

Dr. Daugherty- STEM 4033

October 25th, 2016

Construction Block Curriculum Team Development Lesson

Lesson Title: Do You Want to Build a Snowman?

Grade Level: Kindergarten

Disciplinary Area: STEM

STEM Content Standards:

Science:

K-PS2-1 *Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.*

K-ESS3-2 *Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.*

Technology:

Standard 2: Students will develop an understanding of the core concepts of technology.

D. Different materials are used in making things.

Mathematics:

CCSS.MATH.CONTENT.K.CC.B.5 *Count to answer "how many?" questions about as many as 20 things arranged in a line, a rectangular array, or a circle,* *or as many as 10 things in a scattered configuration; given a number from 1-20, count out that many objects.*

CCSS.MATH.CONTENT.K.CC.C.6 *Identify whether the number of objects in one group is greater than, less than, or equal to the number of objects in another group, e.g., by using matching and counting strategies.*

Big Ideas:

- Problem Solving & Design
- Understand 'The Design Loop': understanding that there is more than one correct way/option to build the snowman
- Understand that different snowmen can handle different wind strengths depending on how the snowman was built

Essential Question:

How can your group build a snowman that will stay together/standing when experiencing different strength of forces from the winter wind?

Scenario:

1st Watch Clip → https://www.youtube.com/watch?v=V-zXT5bIBM0

Do you want to build a snowman? Well since Elsa won't help Anna build a snowman will you help her? Can you help Anna build a snowman that stay together during the strong winter winds?

Challenge:

Anna needs help building a snowman that won't fall over in the extreme winter winds. Students are required to build a snowman in their groups with the given materials. The snowman will need to be able to stay together while Anna test the snowman different wind strengths.

Tools, Materials, Resources:

Mini Marshmallows	Toothpicks
Big Marshmallows	Bottled Glue
Donut Holes	Hot Glue Gun
Chocolate Chip Mini Muffins	Tape
Mini Pretzel Sticks	Sticky Tac
Orange Tic-Tacs	Clay
Mini Chocolate Chips	

Content Information:

- What is snow?
- What is wind?
- What causes wind?
- What causes extreme winds when it snows?
- How does the force of the wind impact a snowman?
- What does a snowman look like?
- How do you build a snowman?

Deliverables:

Student will need to turn in:

- The snowman they built
  - The snowman will be graded based on the rubric attached.
- Picture This: Snowman! Worksheet
  - Since the students are extremely young and do not fully comprehend writing I decided to break down the design loop for them. Before we begin building the snowmen we will discuss as a class what the problem is. The problem is that Anna needs a fried to help her build a snowman that won't fall over in the winter winds. Then, I will tell the students to discuss different options they could do when building a snowman. Once they have brainstormed out ideas I will have them pick one idea. Finally, after the select one idea I will pass out the 'Picture This: Snowman! Worksheet' and read the directions to the class. Then, the students will sketch out their solution that the group agreed upon.
- Did We Build a Snowman? Worksheet
  - This worksheet is where students will record the results of the wind tests.
  - After students see their results the students will write down one thing that would change to improve their snowman if needed. If their snowman does not need any improvement than they will write why. There will be a blank lined piece of paper where the student can record this information.
- 1, 2, 3 Count On Me Worksheet
  - This worksheet dives further into the math standard. The teacher will pass out the material to each group. The materials are organized onto a tray. After the students receive their materials the teacher will then pass out the '1, 2, 3 Count On Me Worksheet'. The worksheet has a picture example of each of the items the students need to count. They will count out how many of each different materials and record that number on to the blank below the questions.
- Comparing: Less Than, Greater Than or Equal To Worksheet

- This worksheet always touches on another kindergarten math standard. After completing the '1, 2, 3 Count On Me Worksheet,' the teacher will pass out the 'Comparing: Less Than, Greater Than or Equal To Worksheet'. This worksheet is used to compare one group to another group. Students can write the # of the item in the labeled box. Once they feel in the boxes than the student will decide what sign to put on the line.

Parameters or Constraints:

When building this snowman each group will be given a certain number of materials to use when construction (*10- Mini Marshmallows, 5- Big Marshmallows, 6- Donut Holes, 4- Chocolate Chip Mini Muffins, 4- Mini Pretzel Sticks, 2- Orange Tic Tacs, 6- Mini Chocolate Chips*).

The snowman has to look like a snowman, which we will discuss as a class. Also, the snowman cannot be taller than 4 inches and cannot be wider than 5 inches.

This will be broken up into two days. The first day students will find a solution and build the snowman. Student will have 15 minutes to pick a solution that they think will work. Students will have 20 minutes to build their snowmen. The second day students will have time to conduct tests and complete worksheets. Each group will come up one at a time with their snowman. The teacher will have the 3 different wind sources. The group will test their snowman and record their results. When they are finished the next group will come up and test their snowman.

Suggestions for the Teacher:

This lesson is going to help further children's previous knowledge about weather. We will be discussing snow and wind during this lesson. After completing the lesson, the teacher has some fun math activities. The goal of this lesson is for the snowman to remain together/standing when experiencing extreme winds. The teacher will need to bring a miniature hand fan, a blow dryer, and a fan (pictured below). These devices will be used to test how stable the student's snowman are compared to the winter winds!

Since this lesson is based off of the movie 'Frozen,' if the teacher wants to take it one step further and go above and beyond than she could dress up as Anna when testing the snowman.

Evaluation:

Students will present their snowmen to the class. The teacher will test the snowman with the three different wind sources.

Snowmen Rubric:

	20 Points	**15 Points**	**10 Points**
Solved the task: "Building a Snowman"	*Built a snowman.*	*Attempted to build a snowman.*	*Did not create anything that resembled a snowman.*
Stayed Standing When Tested	*Passed all 3 wind tests.*	*Passed 2 of the wind tests.*	*Passed 1 of the wind tests.*
Explain How They Built Their Snowmen	*Understand how they built their snowmen.*	*Sort of explain how they built their snowmen.*	*Cannot explain how they built their snowmen.*

Student Turned In All The Deliverables Completed	*Students completed in turned in all the deliverables*	*Students turned in all the deliverables, but they were not all completed*	*The student is missing some of the deliverables, and their mostly incomplete*
Everyone in the Group Worked Together	*You were fully engaged and helping at all times.*	*You occasionally gave input on ideas for building the snowman.*	*You did not contribute anything*

Engineering Design Loop:

Since the children are so young the teacher will need to simplify the design loop and step by step through the different stages with the children.

What is the problem? *The problem is that Anna keeps trying to build a snowman, but needs help to build one that can stay standing during the winter winds that are blowing in.*

Think of Solutions: *Students will be placed into groups. In these groups the students will share their thoughts about ideas for building a snowman that can remain standing when experiencing different levels of winds.*

Select a Solution: *After the groups agree on what approach they are going to take the teacher will pass out a simple worksheet to the students. On this worksheet the student is going to sketch a picture of the solution that their group selected.*

Test the Solution: *Now, the teacher will pass out the material to the students. The materials are separated and organized into a tray. The students will begin to develop and build their snowmen.*

Review/Edit the Solution if Needed: *If the students began to visualize ways to modify the snowman to help it pass the tests than groups can do so.*

Present: *The groups will each present one at a time. The group will need to take their snowman and results worksheet. The teacher will test the snowman with all three wind forces. The students will record what thy observed and then go back to their desks. Then the next group will come up.*

PICTURE THIS: SNOWMAN!

Draw a picture in the blank space of what your group decided your snowman will look like:

Did We Build a Snowman?

Directions: *Now, the group of students is going to test their snowman. Students will record the results of their snowmen. For each test the student will either circle YES or NO. The student will circle YES if their snowman survived. The student will circle NO if their snowman could not handle the winter winds.*

TEST #1: Mini Hand Fan

YES or NO

TEST #2: Blow Dryer

YES or NO

Test #3: Fan

YES or NO

1, 2, 3 Count on Me!

Directions: Students will count out how many items they have for each category.

How many 'Mini Marshmallows' do you have?

I have _____ mini marshmallows.

How many 'Big Marshmallows' do you have?

I have _____ big marshmallows.

How many ‘Donut Holes do you have?

I have ____ donut holes

How many ‘Mini Pretzel Sticks’ do you have?

I have _____ mini pretzel sticks.

How many ‘Orange Tic-Tacs’ do you have?

I have ____ orange tic-tacs.

How many ‘Mini Chocolate Chips’ do you have?

I have ____ mini chocolate chips?

Comparing Less Than, Greater Than or Equal To

Directions: After completing the '1, 2, 3 Count On Me' Worksheet students will now compare one group to see if it is greater than, less than, or equal to another group. Write the amount of the item in the box, and then fill in the blank with the correct sign.

Compare the number of Mini Marshmallows to the number of Big Marshmallows.

Number of Mini Marshmallows	________	Number of Big Marshmallows

Compare the number of Chocolate Chip Mini Muffins to the number of Mini Pretzel Sticks.

Number of Chocolate Chip Mini Muffins	________	Number of Mini Pretzel Sticks

Compare the number of Orange Tic-Tacs to the number of Mini Chocolate Chips.

Morgan Kazanovic and Sara Inman
Title: Inside Out: Rescue Riley!
Grade: 3rd
Disciplinary Area: STEM-engineering design
Unit: Construction blocks and Energy

STEM Content Standards:
Next Generation Science Standards:
3-PS2-2: Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
3-ETS1-1: Define a simple design problem reflecting a need or a want that includes specific criteria for success and constraints on materials, time, or cost.
3-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
5-PS2-1: Support an argument that the gravitational force exerted by the Earth on objects is directed down.

Technological Literacy Content Standards**:**
Standard 1: Students will develop an understanding of the characteristics and scope of technology.
B. All people use tools and techniques to help them do things.
D. Tools, materials, and skills are used to make things and carry out tasks.
Standard 2: Students will develop an understanding of the core concepts of technology.
J. Materials have many different properties.
Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
B. Technologies are often combined.
Standard 8: Students will develop an understanding of the attributes of design.
A. Everyone can design solutions to a problem.
B. Design is a creative process.
C. The design process is a purposeful method of planning practical solution to problems.
Standard 9: Students will develop an understanding of engineering design.
C. The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.

Arkansas Mathematics Standards
AR.Math.Content.3.MD.B.4: Generate measurement data by measuring lengths using rulers marked with halves and fourth of an inch
AR.Math.Content.3.G.A.1: Understand that shapes in different categories may share attributes and that the shared attributes can define a larger category.
Big ideas:
- Acceleration

- Velocity
- Kinetic and potential energy
- Conversion of potential energy (gravitational and elastic) to kinetic energy and vise versa
- Using tools to measure
- Proper use of design process
- Share ideas and collaborate with others
- Teamwork
- Understanding how to think creatively

Scenario:
Joy needs your help to get across the Memory Dump and save Riley before she runs away from home.

Challenge:
Using the materials given, follow the design loop and construct a tower that is both tall enough and far enough from the trampoline to launch Joy back to Command Center.

Essential question:
How can you utilize a tower in sequence with a trampoline to launch a marble to a target destination?

Parameters:
Student
- Work in pairs of two
- Divide work evenly between group members
- Only use materials given
- Will not throw marbles
- Will not place marbles in their mouths
- No alterations will be made to the teacher-prepared trampoline
- The tower must be able to support the weight of the marble
- Utilize the design loop provided
- Marble must reach the designated “rescue” area
- Complete functioning tower design in 1 hour

Teacher
- Provide all needed materials.
- Provide students with video recording devices (iPhone, iPad, digital camera)
- Construct similar trampolines for each team of students
- Divide up materials prior to presenting the activity
- Provide copies of engineering design workbook and peer evaluation forms to each student

Tools & Materials: (For each pair of students)
- 2 engineering design workbooks
- 2 activity rubrics

- 100 Keva planks
- Scissors
- Measuring tape
- 24 inches of tape
- 1 medium sized marble
- 1 "trampoline"

STEM Content information:

1. Trampolines that will be used by each group should be as uniform as possible. Teachers will prepare each trampoline by stretching a balloon over the open end of a short cylindrical container. Place weights such as small stones inside the containers if they are easily knocked over. *Note: plastic cups are not recommended because they have small openings.*
2. Introduce potential energy and kinetic energy to the students.

    Explain these points:

- Potential energy is stored energy of position possessed by an object.
- Elastic potential energy is a type of potential energy stored in elastic materials as the result of stretching or compressing.
- The amount of elastic potential energy stored in an elastic material is related to the amount of stretch of the device.
- Gravitational potential energy is the energy stored in an object based on its height above the ground and its mass.
- Kinetic energy is the energy of motion.
- An object that has motion (vertical or horizontal) has kinetic energy.
- Acceleration is an increase in the rate or speed of something.
- Velocity is the rate of change in an object's position. Velocity has a magnitude (speed) and a direction.
- The pivot point is a central point or pin on which something balances or turns.

The video at https://www.youtube.com/watch?v=0BObd3DsNFM explains elastic potential energy through visuals and shows how an elastic materials, such as rubber bands, gain this type of energy.

- Connect the elasticity of rubber bands with the elasticity of trampoline.

3. Introduce the scenario by showing the video at https://www.youtube.com/watch?v=g8FFFbi7RbQ
4. Introduce the scenario statement and the design challenge.
5. Discuss how students will utilize the engineering design loop and design loop workbook.
6. Review procedures for working in groups.
7. Split students into groups of two.
8. Describe how students will complete peer evaluation forms.
9. Provide each student team with a copy of student handout.
10. Provide each student with a Engineering Design Loop Workbook.
11. Provide each student with a peer evaluation form.
12. Designate the distance from the trampoline that will represent the "rescue" destination.

Deliverables:

- Engineering design loop workbook (attached)
- Peer evaluation form (attached)
- Video of working "rescue" including these events:
    a. Tower with marble resting on top
    b. Tower being pushed over
    c. Marble hitting trampoline
    d. Marble reaching destination

Evaluation:

- Teacher Rubric
- Completion of Engineering Design Loop Workbook
- Completion of peer evaluation form
- Presentation of "rescue" video

Student Handout

Scenario:

Joy needs your help to get across the Memory Dump and save Riley before she runs away from home.

Challenge:

Using the materials given, follow the design loop and construct a tower that is both tall enough and far enough from the trampoline to launch Joy back to Command Center.

Essential question:

How can you utilize a tower in sequence with a trampoline to launch a marble to a target destination?

Tools & Materials: (For each pair of students)

- 2 engineering design workbooks
- 2 activity rubrics
- 100 Keva planks
- Scissors
- Measuring tape
- 24 inches of tape
- 1 medium sized marble
- 1 "trampoline"

Parameters:

- Work in pairs of two
- Divide work evenly between group members
- Only use materials given
- Will not throw marbles
- Will not place marbles in their mouths
- No alterations will be made to the teacher-prepared trampoline
- The tower must be able to support the weight of the marble
- Utilize the design loop provided
- Marble must reach the designated "rescue" area
- Complete functioning tower design in 1 hour

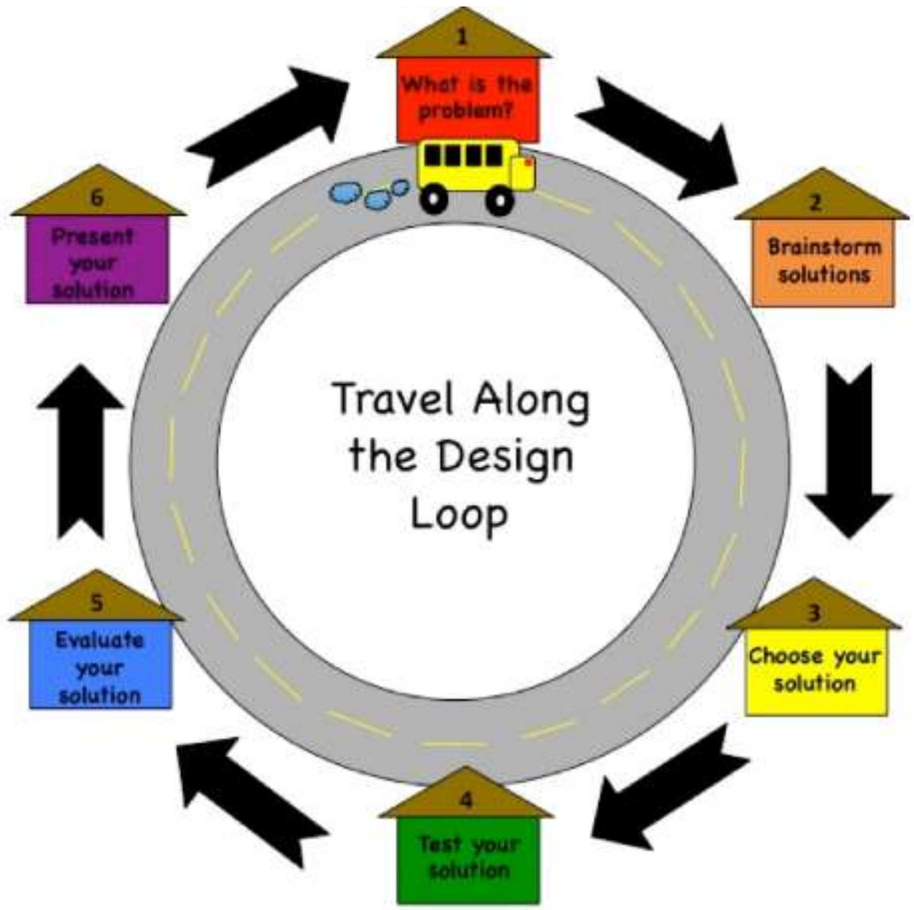
Deliverables:

- Engineering design loop workbook (attached)
- Peer evaluation form (attached)
- Video of working "rescue" including these events:
    a. Tower with marble resting on top
    b. Tower being pushed over
    c. Marble hitting trampoline
    d. Marble reaching destination

Evaluation:

- Teacher Rubric
- Completion of Engineering Design Loop Workbook
- Completion of peer evaluation form
- Presentation of "rescue" video

Engineering Design Loop Workbook



Name: ______________________

Date: ___/_____/____

Design Brief Title: ____

1. Identify the problem:
   - What is the problem?

   - What do I need to do?

2. Brainstorm solutions:

   - What do I already know?

   - What do I need to find out?

   - What did I find out?

My First Ideas: Include Drawings

3. Choose your solution:

- My best idea is ……

- The steps I will use:

- The tools and materials I will use:

4. Test your solution:

- How did you test your solution?

- How do you know if your idea works?

5. Evaluate your solution

- How would you change your idea?

- What did you learn?

- What did you like about this project?

- What did you not like about this project?

Teacher Rubric:

Category	0-3 points	4-6 points	7-10 points	Score
Engineering Design Loop	Engineering design loop was not followed	Some steps of the engineering design loop were followed but not all	Engineering design loop was followed completely	
Engineering Design Loop Workbook	Student has not fully completed the Engineering Design Loop Workbook	Student has completed the Engineering Design Loop Workbook but with minimal detail	Student has completed the Engineering Design Loop Workbook with detail.	
Group Collaboration	Student did not work well with team member and did not contribute to the design	Student worked ok with team member and did not fully contribute to the design	Student worked well with team member and fully contributed to the design	
Parameters	Design parameters were not followed	Not all design parameters were followed	All design parameters were followed	
Video of Working "Rescue"	Video does not feature required events	Video features less than the four required events	Video features all four required events	
Comments:				

Peer Evaluation:

Check the box that applies to how your feel your partner did in each category with one being the lowest and three being the highest.

Category	**1**	**2**	**3**
Communication: my partner communicated effectively with me.			
Teamwork: My partner showed good teamwork by helping me figure out the problem and come up with the best solution.			
Responsibility: My partner shared responsibilities with me. We had equal parts completing the project.			
Respect: My partner respected my opinions and ideas while working on the project.			
Attitude: My partner maintained a positive attitude while completing the project.			

Sierra Logan
Sara Hayman
Engineering Design Curriculum Development Assignment

Teacher Guide

Title: A Box of Happiness

Grade Level: 2nd Grade

Standards:

- Math-- A.R.Math.Content 2.MD.D.10 Draw a picture graph and a bar graph, with single-unit scale, to represent a data set with up to four categories
- Science-- 2-PS1-3 Make observations to construct an evidence based account of how an object made of a small set of pieces can be disassembled and made into a new object
- Technology Literacy—Standard 6 Students will develop an understanding of the role of society in the development and use of technology
    - Benchmark A: Products are made to meet individual needs and wants
- Art—A.2.2 Transfer ideas and feelings to others through original works of self-expression using art elements and principles

Big Ideas:

- Use design loop
- Create a bar graph comparing effectiveness of group projects
- Demonstrate how small pieces can be put together in multiple ways to serve different purposes
- Create a design that can be changed and adapted to meet changing wants and needs
- Use original works of art to transfer feelings of positivity and happiness

Essential Questions:
How can you create a work of art made up of the Keva planks to meet the needs of the residents of your local nursing home?

Scenario (Hook)
Teacher will:

1) Prepare ahead of time different objects that can be created (1 for each group) (a mixture of art and structure)
    a) For example, one group could make a tree house, one could make windmill, a flower (any of these could be 3D or flat on the table)
2) Provide each group of 4 students 20 Keva planks and ask them to create their assigned object in 10 minutes
3) Come together as a class
    a) Ask students what they observe about all of the different creations

b) Introduce the idea that a great variety of objects can be built up from a small set of pieces
4) The Scenario: The local nursing home has reported increased complaints of boredom and sadness when sitting in the common room/game room. They have enlisted the help of our classroom to create an art piece to bring some happiness to the room.

Challenge

Create a 3-dimensional piece of art using 120 Color Keva Planks. Your project must be able to be displayed in a glass display case with dimensions of 18"x18"x18".

Tools, Materials, Resources

- 120 color Keva Planks
- 1 display case
- Design loop booklet
- Excel (teacher material)
- Survey sheets

Content Information

- Bar Graphs: Students should have prior exposure and experience with bar graphs before this lesson, but you should remind students that bar graphs should include a title, a scale (vertical axis), scale label, categories (horizontal axis), category label, and data. It may be helpful to post a bar graph you have made as a class when giving these reminders.
- Sculptures: Sculpture is three-dimensional artwork created by shaping or combining materials. Materials may be worked by removal such as carving; or they may be assembled. --The teacher should say this and make the connection to what the students will be doing with the Keva planks.
- Using Excel to Make a Bar Graph: At the end of the project, as a class create a bar graph displaying the results of your students' surveys (more information in procedures section). The teacher should run through the steps of making a bar graph prior to this lesson to refresh, and when the class makes the bar graph on excel think aloud as you guide your students through the steps. This is process is for exposure to excel, not for students to master the skill

Procedures

1) Introduce the Scenario and Hook activity
2) Give students 30 minutes to handle the keva planks, come up with multiple designs, and choose a final design.
3) Make sure students have filled out their engineering design books up to this point
4) Give students 1 hour to complete design—End of work for the day
5) On another day take a trip to a local nursing home (teacher has communicated with the nursing home, planned a day to visit, and transported students' projects to the nursing home)
6) When there, students will deliver surveys to the residents asking them to choose a project that brought them the most joy (this is the data we will use for the bar graph)
7) Students will spend some time visiting with the residents about their projects

8) Once back in the classroom students will analyze their data, and as a class create the bar graph on excel
9) Have a class exit discussion on what they learned and observed from their experiences

Deliverables

Students will turn in:

- their completed design journal
- their art project
- their survey results
- their peer evaluations
- their self-evaluations

Parameters or Constraints

- Must finish in allotted time
- Must use the 120 keva planks allotted to each group of 4
- Project must fit in display case
- Project may not be glued to allow residents of the nursing home to disassemble and reassemble projects into their own creations

Evaluation/Assessment

Assessment will take place in the form of the self-evaluation and peer-evaluation.

Student Guide

<u>Title:</u> A Box of Happiness

<u>Scenario:</u>

The local nursing home has reported increased complaints of boredom and sadness when sitting in the common room/game room. They have enlisted the help of our classroom to create an art piece to bring some happiness to the room.

<u>Challenge</u>

Create a 3-dimensional piece of art using 120 Color Keva Planks. Your project must be able to be displayed in a glass display case with dimensions of 18"x18"x18".

<u>Tools, Materials, Resources</u>

- 120 color Keva Planks
- 1 display case
- Design loop booklet
- Excel (teacher material)
- Survey sheets

<u>Big Ideas:</u>

- Use design loop
- Create a bar graph comparing effectiveness of group projects
- Demonstrate how small pieces can be put together in multiple ways to serve different purposes
- Create a design that can be changed and adapted to meet changing wants and needs
- Use original works of art to transfer feelings of positivity and happiness

<u>Essential Questions:</u>

How can you create a work of art made up of the Keva planks to meet the needs of the residents of your local nursing home?

<u>Deliverables</u>

Students will turn in:

- their completed design journal
- their art project
- their survey results
- their peer evaluations
- their self-evaluations

<u>Parameters or Constraints</u>

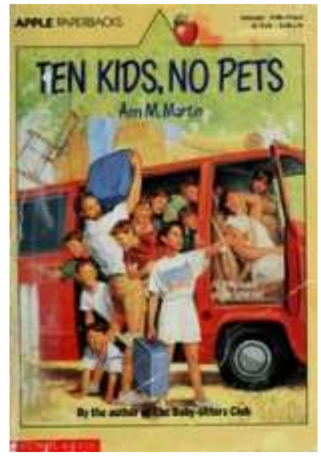
- Must finish in allotted time
- Must use the 120 keva planks allotted to each group of 4
- Project must fit in display case

- Project may not be glued to allow residents of the nursing home to
- disassemble and reassemble projects into their own creation

Peer Review		
Category	Agree	Disagree
<u>Responsibility</u>: My teammate contributed enough effort to help us finish the task		
<u>Contribution</u>: My teammate contributed to the success of the team, completed his/her share of the work, and offered constructive feedback to complete the tasks		
Team Performance: My team completed the task or finished a project accurately, on time, and according to specifications because all members contributed		
Team Collaboration: All members of our team carried out specific roles and contributed equally		
Communication: My teammate contributed to an effective team output, presentation, or communication effort		
My Name:		
My Teammate's Name:		

Self-Assessment		
Category	Agree (Why?)	Disagree (Why?)
<u>Learning:</u> From this assignment I learned that you can make many different things with few objects, and that these things can be disassembled to create completely new things		
<u>Communication:</u> I listened to the ideas my group members had, and really took them into consideration for the assignment.		
<u>Contribution:</u> I did the best I thought I could do on this assignment, and put in extra effort to make it great.		
This activity was engaging and really got me thinking about many different solutions.		
I felt like I was held accountable to get my portion of the work done, and felt like group work was helpful for my learning.		
Comments:		
Comments:		

Cami Martin
Teachers Guide



Title: Build a Home, Get a Pet!

Disciplinary Area: STEM

Unit: Engineering with Construction Blocks

Grade Level: 2

STEM Content Standards:

Science Standards:
Strand 1: Nature of Science Standard: Characteristics and Processes of Science Students shall demonstrate and apply knowledge of the characteristics and processes of science using appropriate safety procedures, equipment, and technology:
NS.1.2.7 Use age appropriate equipment and tools in scientific investigations (e.g., balances, hand lenses, rulers, and thermometers)

Math Standards:
AR.Math.Content.2.MD.A.1
Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes
AR.Math.Content.2.MD.A.2
Measure the length of an object twice with two different length units.

Technological Literacy Standards:
K-2 Benchmarks
Standard 6: Students will develop an understanding of the role of society in the development and use of technology: In order to realize the impact of society on technology, students should learn that: A. Products are made to meet individual needs and wants.
Standard 11: Students will develop abilities to apply the design process. As part of learning how to apply design processes, students should be able to: B. Build or construct an object using the design process.

Teacher's Instruction Guide:
1. Read Book *Ten Kids, No Pets*
2. Discussion over book (also, check students understanding of levels/stories)
3. Read scenario, essential question, and the challenge
4. Discuss the materials to be used
5. Tell how students will be evaluated, and that they will need to evaluate their partner
6. Review the design loop and its purpose
7. Go over how to correctly use a ruler, and measuring tape
8. Show students on the board how to measure a houses length, width, and height
9. Pair students up (2 in each team)

10. Provide materials, tools, and worksheets
11. Monitor students
12. Assess students

Hook (Schema Activation): *Ten Kids, No Pets*, Written by: Ann M. Martin

Deliverables: Design worksheet, measurement worksheet, evaluation, proper use of design loop to build a house for the family of twelve and their pet.

Content Information: Hook the students with the book (Ten Kids, No Pets). Discuss the book as a class. Check students understanding of levels/stories within homes. Read the scenario, essential question, and then discuss the materials to be used and how the students will be evaluated. Review how to use the engineering design loop and its purpose. Then, go over how to correctly use a ruler, and a measuring tape so that students can properly measure their house. Show the students how to measure a houses length, width, and height (label on the board for reference). Provide students with all of their necessary materials and tools. Students will use the design process, the design loop, discuss their understanding and complete worksheets to reinforce ideas. Assess students based on performance, participation, and their product.

Big Ideas:

- Students will know how to accurately use a ruler, and measuring tape to measure their houses length, width, and height.
- Students will use a ruler and a measuring tape to measure the height of their house in feet and inches.
- Students will use the engineering design loop to construct and improve ideas for their house.
- Students will learn how to build a house while taking many contributing factors into consideration.
- Students will use technology, the design loop, math, science, and engineering to build their house out of construction blocks.
- Students must meet the needs and wants of the family to accurately build their house.

Teacher and Student Design Activity Guide

Scenario:
The large family is moving to the country, and building a house. The kids want to have a pet in their new home, but the parents are worried there won't be enough room. The parents finally decide that if the kids build a big enough house, they can get a pet! Help the kids by designing and building a house big enough for everyone. Remember, the family has 12 members and need space for their pet. The parents want their own story, and don't want anyone living in the bottom level. The kids need a roof over their heads, and their pet to have its own room.

Essential Question:
How can you build a house that is big enough to fit all twelve people and their pet?

Challenge:
Using the provided materials, and following the design loop, design and build a house for the family and their pet while following parameters and meeting the family's wants and needs.

Parameters:
The house has to fit twelve people and their pet (13 one pound washers) for at least one minute. The house must be at least 2 feet tall, and have a roof. The parents must have their own story, and the pet must have its own room, and no one is allowed to live on the bottom level. The house must be built on the floor. Students must only use the provided materials, 100 blocks are provided per group. The design loop must be utilized. Only 40 minutes are allowed for construction. Use the stop watch to see if your house stays intact for at least one minute.

Assessment:
Performance, presentation, and worksheet based. Students should demonstrate accuracy and understanding when completing the design process and the design loop. Students will need to measure their house with accuracy, and with different units of measure. Students must design and construct a house that will hold 13 one pound washers for at least one minute. Students must discuss the follow up questions, and meet the needs and wants of the family when producing their final product. Students must evaluate their peer on their effort put into the house.

Materials:
100 Homemade construction blocks per group
Construction paper for the walls
Tape (only to be used on the walls)
Cardboard
13 one pound washers per team (to represent each family member, and their pet's weight).

Tools:
Ruler, Measuring tape
Stopwatch/timer/I-pad

Resources:
I-pads for research (only when completing the Design a House worksheet)

Questions to consider before you get started:

How many people will be living in the house?

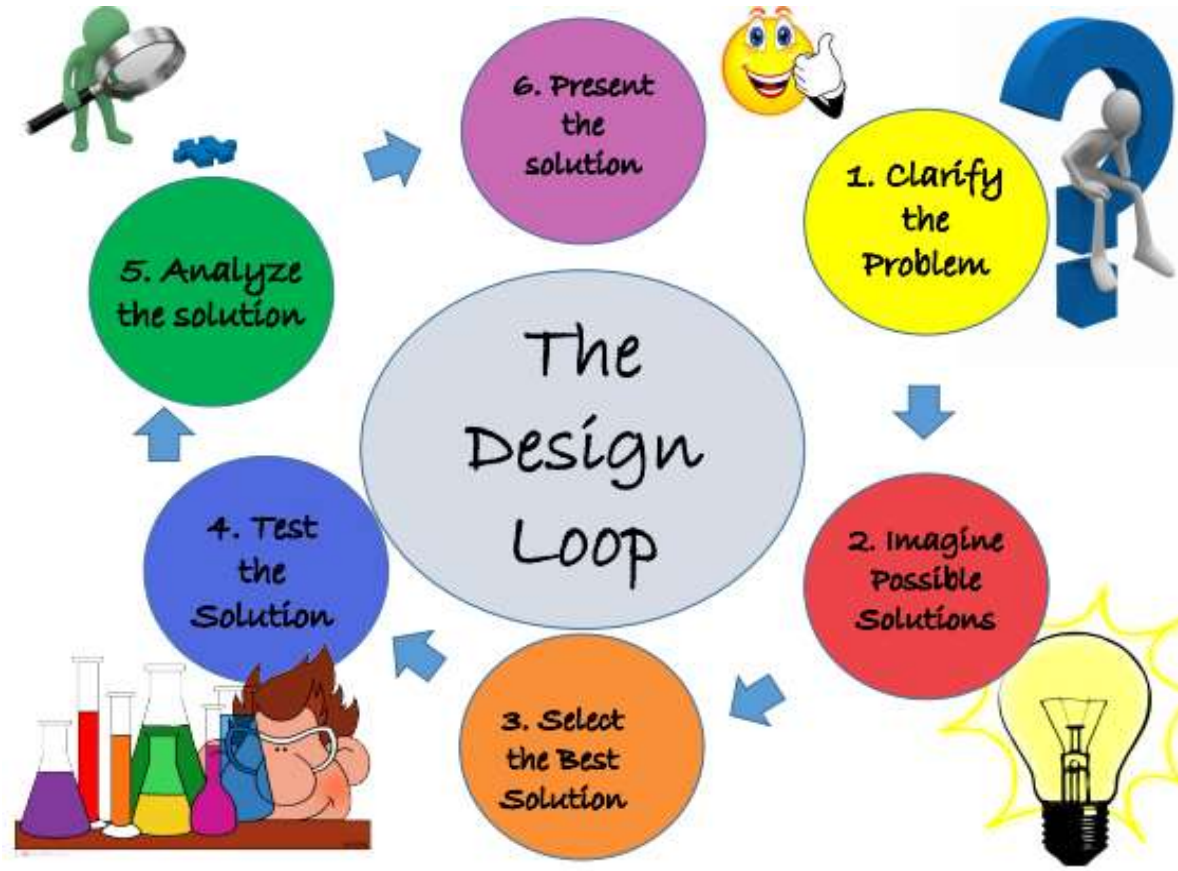
How do I represent the family and their pet?

What materials do I have to use?

How long does the house need to stay intact?

How tall does the house have to be?

The Design Loop Student Worksheet



1. What is the problem?

2. On the next page, brainstorm possible solutions to the problem.

3. Build your solution!

4. Test your solution and use the stop watch to make sure it stays intact for at least one minute!

5. Analyze your solution (Make improvements & retest, if necessary).

6. Present your solution!

Design a House Student Worksheet

Brainstorm: Sketch the design of your house, and draw all of the materials used. You may use I-pads for research. *Remember to consider the parameters when brainstorming ideas.

Idea 1

Idea 2

Idea 3

Circle the best housing design with your partner!

Student Measurement Worksheet

Use a measuring tape, or a ruler to answer the following questions.

*Label the units of measure.

1. What is the length of your house in inches?

2. What is the length of your house in feet?

3. What is the width of your house in inches?

4. What is the width of your house in feet?

5. What is the height of your house in inches?

6. What is the height of your house in feet?

Student Follow up Questions to discuss with your partner:

*Make sure that you have discussed the following questions before presenting your final design to the class.

Did you meet the needs and wants of the family?

How did you meet the needs and wants of the family and their pet?

Did you use the design process?

Which tool(s) did you use to measure and why?

Did you build your house on the floor?

Did your house meet the one minute time requirement?

Did your house hold all 13 one pound washers? If yes, why do you think that is? If no, why do you think that is?

What would you change with your design? Why?

Student Assessment:

Design loop & Design a House Worksheet accuracy (1-5 points)

Measurement Worksheet accuracy (1-5 points)

Discussed Follow up Questions (1-5 points)

Built a house that successfully holds 13 one pound weights (1-5 points)

Met all of the needs and wants of the family (1-5)

Proper use of design loop & design process (1-5 points)

Good participation (1-5 points)

Performed well (1-5 points)

Total Score: /40

Peer Evaluation:

Did share of the work (1-5 points)

Communicated well (1-5 points)

Did their best (1-5 points)

Total Score: /15

Final Score: /55

Teacher Copy

Title:
"The Drought Drain!"

Grade Level:
Grade 2

STEM Content Standards:

<u>Arkansas Science Standards</u>
2-ETS1-2: develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem

2-LS2-1: Plan and conduct an investigation to determine if plants need sunlight and water to grow.

<u>Standards for technological literacy</u>
Standard 1:

K-2 B: All people use tools and techniques to help them do things\

Standard 2:

K-2 A: Some systems are found in nature and some are man-made

<u>Arkansas mathematics standards</u>
AR.Math.Content.2.MD.A.1 Measure the length of an object by selecting and using appropriate tools such as rulers, yard sticks, meter sticks and measuring tapes

Big Ideas:
Major concept delivered through design brief: Students will work to create a drain that will transport rainwater directly to the base of the plant rather than being caught on top of the plant.

Essential Question:
How can you build a drain that is certain dimensions that will effectively transport water to the base of the plant without losing any water

Scenario:

There is a drought in your town in Nevada and you need to take advantage of all the rain that you can get. Your plants are dying and need water! You are searching for a solution and all you can find are typical housewares. Using the materials provided, decide on an appropriate drain model to bring the most rain water to the base of the plant without losing any along the way.

Challenge:
You will be given paper towel rolls and various "liners" to build your drain with. Create a drain that is 36 inches if stretched out flat. You can choose how tall and wide to make your drain most effective. The goal is to not lose water as it travels down the drain, so decide on what material to line the inside of the drain with.

Tools, Materials, and Resources:

- Paper towel rolls
- Scissors
- Tape
- Glue
- Aluminum foil
- Parchment paper
- Plastic wrap
- Masking tape
- Wax paper
- Tissue paper
- 2 measuring cups
- Water

Content information:

1. Discuss why plants need water to grow, and why it must go through the roots, and not the top of the plant
2. Talk about how to plan using sketches prior to building your structure
3. Discuss other tools that are used in farming and irrigation
4. Discuss with students different measuring tools. Show them how to use a measuring tape
5. Discuss how different liners are of different absorbencies. By using different liners, talk about how much water may be absorbed, and how much will slide off.

Deliverables:
Students will deliver their completed drains and we will test them. Students will also turn in a project guide that aligns with the engineering design loop.

Parameters or constraints:

- 36 inches when stretched out (use measuring tape)
- Must use paper towel rolls (they can be cut)

- Choose one liner or decide to not use a liner
- Has to have a method of catching the rainwater

Evaluation:
Students will be evaluated on their rationale for design and presentation to classmates of their drain. They must have a reason behind their design and have followed the guidelines (used appropriate materials) as well as the measuring and material constraints. When we test the designs we will put certain amount water down the top and measure at the end how much gets through the drain. A scale/ rubric will be created for these forms of evaluation. There is also a design loop guide attached that will be turned in.

Student Copy

The Drought Drain!

What's the problem?

There is a drought in your town in Nevada and your plants are dying. You need to catch as much rainwater as you can to help your plants live. While searching for a solution all you can find are typical housewares. Using the materials provided, decide on the best drain model to bring the most rainwater to the base of the plant without losing any along the way.

YOUR challenge is. . .

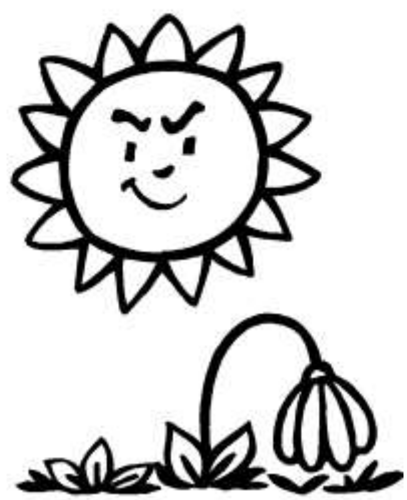
You will be given paper towel rolls and various "liners" to build your drain with. Create a drain that is 36 inches if stretched out flat. You can choose how tall and wide to make your drain most effective. The goal is to not lose water as it travels down the drain, so decide on what material to line the inside of the drain with. Follow the design loop to develop this drain!

Limitations

- 36 inches when stretched out (use measuring tape)
- Must use paper towel roles
- Choose one liner or decide to not use a liner
- Has to have a method of catching the rainwater

Resources

- Paper towel rolls
- Scissors
- Tape
- Glue
- Aluminum foil
- Parchment paper
- Plastic wrap
- Masking tape
- Wax paper
- Tissue paper
- Measuring cup
- Water



Directions

1. Brainstorm and sketch 3 possible drain designs that would solve your problem the best way.
2. Decide with teammates which of the three drains would work best
3. Evaluate liners and determine which will bring the most water to the base of the plant
4. Construct your drain and install the liner
5. Test your drain 3 times and determine what adjustments you can make to get the most water the base of the plant
6. Record improvements made to your drain
7. Share final product with classmates and reason behind why you designed it this way

Drought Drain Challenge Guide

Name: ___________________________________

What is the problem?

____

____

____

Possible Solutions: Star the one you are going to pick

How Much Water was lost?

Trial 1: ____________________________________

Trial 2: ____________________________________

Trial 3: _____________________________________

How could you re-design your cage to make it better? (Sketch it)

The Drought Drain Rubric

Science standards

2-ETS1-2:

________ (5 points) Sketch or drawing created prior to building that shows how the structure will work and solve the problem

________ (3 points) Sketch or drawing created prior to building but does NOT show how the structure will work or solve the problem

________ (0 points) No sketch has been created

2-LS2-1:

________ (5 points) Students show a complete understanding while providing rationale for why this drain is important. They understand that they water must be brought to the base of the plant in order for it to take it in

________ (3 points) Somewhat of an understanding of why the drain is necessary is shown in rationale

________ (0 points) No understanding is demonstrated

Technological literacy standards

________ (5 points) Students showed that they understood why tools and techniques are used to help us in nature.

________ (3 points) Students somewhat showed that they understood why tools and techniques are used to help us in nature

________ (0 points) Students did not show any understanding of why this tool/ technique is helpful

Math standards

________ (5 points) Students followed the measurement constraints and used a tape measure to complete their calculations

________ (3 points) Students somewhat followed the measurements and attempted to use a measuring tool to complete their calculations

________ (0 points) Students did not follow the measurement constraints or use any tools for measurement

Design loop

________ (5 points) Students followed the design loop, and completed each stage

________ (3 points) Students somewhat followed the design loop but didn't do each step

________ (0 points) Students did not follow the design loop

_______/ 25 points

Put a Stop to the Drop!

Grade level: 4th grade

Unit: STEM Uniform Construction

STEM Content Standards:

Next Generation Science Standards**:**

Properties of the Earth: ESS.8.4.1

- Locate natural divisions of Arkansas: The students will have to determine an appropriate place to install their water system.

Natural Resources: ESS.8.4.4

- Evaluate the impact of water pollution: the students will gain an understanding on the importance of clean water as well as the affects of polluted water.

Standards for Technological Literacy:

Standard 7: Students will develop an understanding of the influence of technology on history.

- 3·5 Benchmarks: People have made tools to provide food, to make clothing, and to protect themselves.

Common Core State Standards**:**

AR.Math.Content.4.MD.A.2

- Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money including the ability to make change; including problems involving simple *fractions* or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit.

Big Ideas:

- Constructing a large object out of a series of smaller objects
- Engineering design loop
- Role of brain storming to problem solve
- Applied creative thinking for innovation
- Ability to measure liquids
- Understanding the importance of measurements when constructing
- Understanding the importance of water and water systems
- Understand the geographic locations of where bodies of water can be found.
- Ability to work with peers

Essential Question:

How can you construct a water system so that water can be continuously transported from the top of the mountains to the valley?

Scenario:

Oh no! The river valley is experiencing a water shortage and needs water to be transported down to the valley. They need your help constructing a water system that will allow water to continuously flow to the valley so that the people will have clean and usable water.

Instructions:

For the hook assignment, the teacher will supply the students with a variety of water such as tap water, soda water, mineral water, and distilled water. Provide each student with small cups filled with each water type and have them write down the water's differences and similarities on the worksheet provided. Next, the teacher will conduct a class discussion on the students' observations and will have the students explain the importance of clean water. They should then discuss the history of water and water treatment. The teacher should also display a world map to show the different types of bodies of water and their locations. After the hook activity, the teacher will divide the students into groups of two and then review the instructions and expectations of the activity. Once the children have an understanding of the assignment, they will begin to construct their water systems using the design loop. Once the children have selected their final model, they will need to present the model to the teacher and collect the materials needed. This is a uniform construction project, so each group must use a uniform construction block to build their water system such as a series of straws or tinker toys. Once the groups have finalized their solution, they will pour eight ounces of water down their water system and determine the amount of liquid that successfully traveled to the valley. Using this measurement, the students will then calculate the amount of leakage their water system had. If water leakage occurred, the students will have one chance to alter their water system using the design loop. Then they must repeat the testing process and recalculate their results. After conducting this experiment, the students will complete the worksheets and peer evaluation form provided.

Materials & Resources:

Tinker Toys	Straws	String	Foil
Mini Cups	Tape	8 ounces of water	Scissors
Tap water	Soda water	Mineral water	Distilled water
World map	Measuring tape	Measuring scale	

Parameters: The water system must…

- Be six feet long
- Be constructed using a uniform construction block (series of straws or tinker toys)
- Carry water from the top of the mountain to the valley
- Be created using the engineering design loop
- Be documented by each group member
- Be able to transport eight ounces of water without any leakage

Content Information:

The students will need to have background knowledge of the importance of water. They must also know the locations of the different types of bodies of water. Students will need to be able to measure using inches, feet, and yards as well as measuring liquids using ounces and cups. The teacher will need to educate the students about the history of treating and transporting water. To give students an idea of how water can be transported, the teacher should provide them with examples such as troughs or pulling systems that carry water buckets. To deepen the students' understanding on the importance of clean water, the teacher can discuss how untreated or polluted water has impacted children across the world such as in Africa. Additional links are provided below.

Additional resources:

https://www.youtube.com/watch?v=bNWuQD7QHBc

https://www.youtube.com/watch?v=rl0YiZjTqpw

https://www.youtube.com/watch?v=BCHhwxvQqxg

Water Worksheet

Instructions: Answer the following questions in complete sentences.

1. Why is clean water important?

Clean water is vital to not only human health but to our environment. People rely on clean water because it allows them to stay healthy and hydrated. We use water for many things such as cooking, drinking, cleaning, bathing, watering our crops and feeding our animals.

2. What types of water can you drink? Ocean water? Lake water? Spring Water?

The United States collects water from lakes, springs, wells, and rivers. It must properly be treated to remove any harmful chemicals, particulates, and bacteria.

3. Can polluted water be harmful? Explain.

Yes, polluted or untreated water is very harmful. If water is not treated properly then it could carry chemicals or bacteria that can lead to diseases and even death.

Circle the number of cups that make up two pints, a quart and a half a gallon.

Two Pints (4 cups)

One Quart (4 Cups)

Half a Gallon (8 Cups)

Label the bodies of water:

River

Ocean

Lake

Put a Stop to the Drop!

Student Copy

Scenario: Oh no! The river valley is experiencing a water shortage and needs water to be transported down to the valley. They need your help constructing a water system that will allow water to continuously flow so that the people will have clean and usable water.

Challenge: How can you construct a water system so that water can be continuously transported from the top of the mountains (tables) to the valley (floor)?

Deliverables: At the end of this challenge, each group will need to present their water system to the teacher. Each group member will also need to turn in his worksheets and peer evaluation form.

Parameters: The water system must:

- Be six feet long
- Be constructed using a uniform construction block (series of straws or tinker toys)
- Carry water from the top of the mountain to the valley
- Be created using the engineering design loop
- By documented by each group member
- Be able to transport the water without any leakage

Materials:

Tinker Toys	Straws	String	Foil
Mini Cups	Tape	8 ounces of water	

Each team will have access to a pair of scissors, measuring tape, and a measuring scale

Test: (remember to document the process and findings in your design loop journal)

1. After constructing the water system, you will need to measure the length of the system to make sure it is six feet long.

2. Each team will test out their solution by attaching the water system from top of the mountain (table) to the valley (ground).
3. Have one team member pour 8 ounces of water down the water system, while the other team member holds a cup at the bottom of the system to catch the water.
4. After collecting the water, the students will need to measure the amount of liquid that successfully traveled down to the valley. Using this measurement, they will then need to figure out the amount of water leakage, if any, that their water system had.
5. If your team's water system leaked, then the team must use the design loop to alter the system so that it will not leak. Make sure each member documents these changes.
6. After conducting the experiment and calculating the results, the student's will need to determine where the water system could be placed in Arkansas. They will also need to complete the worksheets and peer evaluation forms that are provided.
7. Each group will share their findings and design loop process with the class.

Don’t waste it, just taste it!

Instructions: The teacher will provide you with different types of water. Taste each type of water and write down your observations. Was the water fizzy, bubbly, salty, and plain, etc.? Which one do you prefer? Were any of the waters similar?

Tap Water:

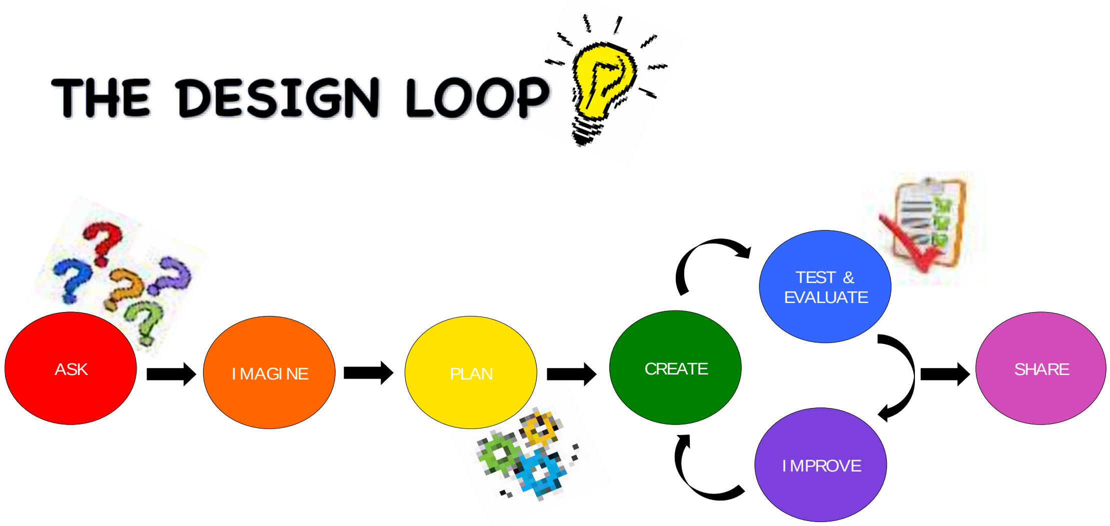
Soda Water:

Mineral Water:

Distilled Water:

Why is clean water important? What can it be used for? Where can water be found?

Documentation: Each team member will complete the engineering design loop that is provided below.



My problem is:

My goal is:

My model will look like:

Or this…

Or this…

The materials I need are:

The best solution is:

My group member's duties are:

My results are:

The adjustments needed:

The final results are:

Water Worksheet

Instructions: Answer the following questions in complete sentences.

1. Why is clean water important?

2. What types of water can you drink? Ocean water? Lake water? Spring Water?

3. Can polluted water be harmful? Explain.

Circle the number of cups that make up two pints, a quart and a half a gallon.

Two Pints

One Quart

Half a Gallon

Label the bodies of water:

Peer Evaluation:

Name: ____________________

Group Number: _______________

Group Members' Name	Brain Storming (1-5)	Creating Model (1-5)	Collecting Data/Testing/ Presenting (1-5)

Rate your group member and yourself from 1-5.

1 = did not participate and 5 = took the lead/extremely helpful

Additional Comments:

Teacher Evaluation

Student's name: ___________________

Group Number: ____________________

Water system was submitted on time	/5
The group demonstrated their understanding of the design loop	/20
The water system displayed uniqueness and creativity	/10
The group presented their findings clearly to the class	/15
The system successfully transported the water with little to no leakage	/25
Documentation of the design loop, worksheets, and peer evaluation	/25
The water system was created using uniform construction blocks	/10
The group demonstrated their understanding of measuring liquids and length	/10
Total	**/120**

Additional Comments:

Teacher Guide
Katie Sanders

Dory's Tunnel Vision

Disciplinary Area: STEM

Grade Level: Kindergarten

STEM Content Standards:

Science:

PS.6.K.1
Demonstrate spatial relationships, including but not limited to
- over
- under
- left
- right

PS.6.K.2
Demonstrate various ways that objects can move, including but not limited to
- straight
- zig-zag
- back and forth
- round and round
- fast and slow

PS.6.K.3
Demonstrate the effects of the force of gravity on objects

Technology:

Standard 11: Students will develop abilities to apply the design process.
As part of learning how to apply design processes, students should be able to:
K-2 Benchmarks
A. Brainstorm people's needs and wants and pick some problems that can be solved through the design process.
B. Build or construct an object using the design process.
Investigate how things are made and how they can be improved.

Standard 9: Students will develop an understanding of engineering design.
In order to comprehend engineering design, students should learn that:
K·2 Benchmarks
A. The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.

B. Expressing ideas to others verbally and through sketches and models is an important part of the design process.

Mathematics:

AR.Math.Content.K.G.A.1
Describe the positions of objects in the environment and geometric shapes in space using names of shapes, and describe the relative positions of these objects
Note: Positions could be inside, outside, between, above, below, near, far, under, over, up, down, behind, in front of, next to, to the left of, to the right of, or beside.

Big Ideas:

- Students will be able to use the STEM Design Brief Template Worksheet
- Students will be able to express their design using the spatial intelligence they have learned
- Students will be introduced to the idea that some problems have multiple solutions
- Students will be able to verbally describe their design using proper vocabulary learned in this lesson.

Essential Question:

How can we set up Dominos to act as a guide through a given maze?

Scenario:

Dory needs our help! She is trying to find the open ocean to get back to her parents! Unfortunately, Dory has a hard time remembering! Let's help dory make a trail she can follow to the exit of the pipes! Using the Dominos from yesterday, let's make a trail through the maze of pipes to lead Dory to the exit!

Materials:

- Each Group Will receive a box of Dominos
- The teacher should print, draw, or outline the maze to be large enough for the dominos to fit inside.
- Pencils to draw in their designs on the design worksheet

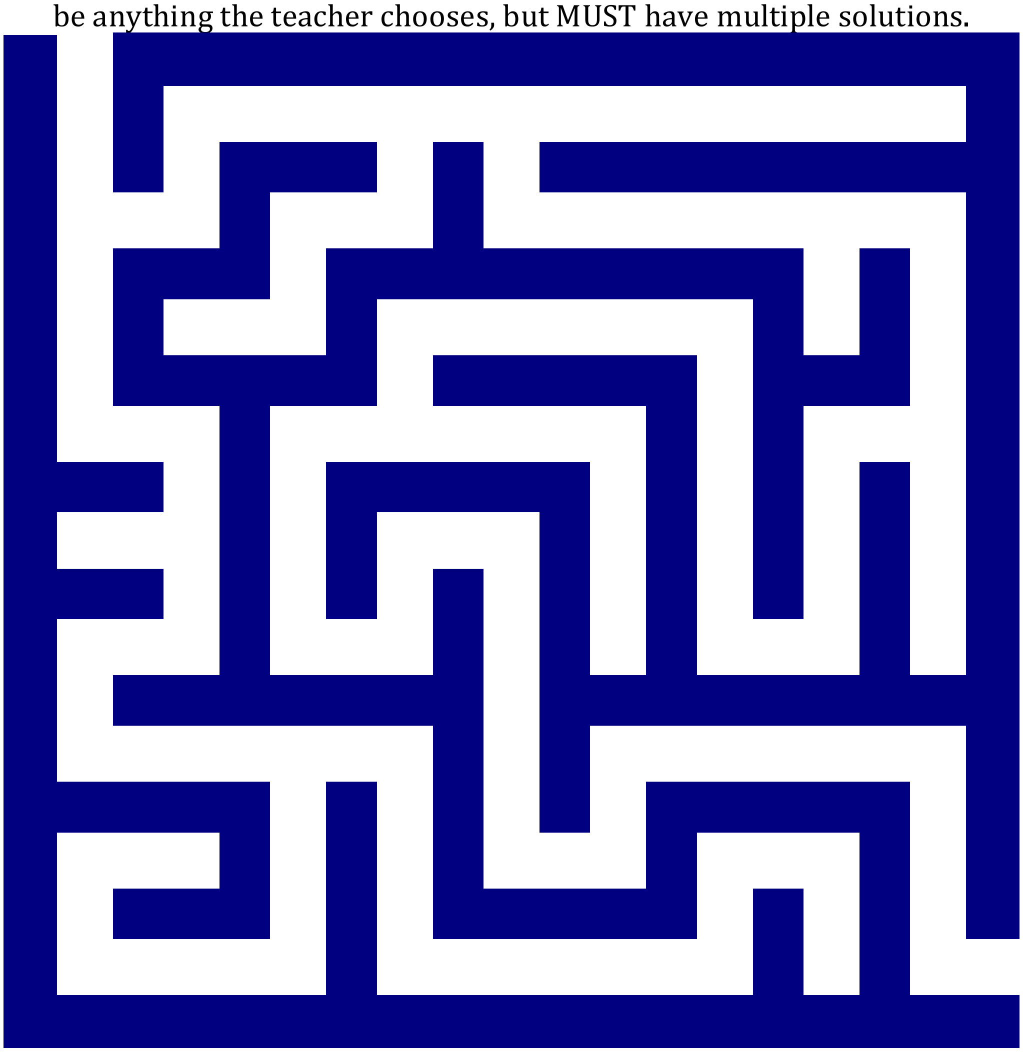
Content Information:
Student will learn some new terminology to be able to describe the way in which their solution works. This will be delivered in a PowerPoint Presentation format (see attached). This presentation is to be shown after they make their design so not to overwhelm the students. Students will also need to see a demonstration of Dominos falling in the same matter as desired for the outcomes. (see video in PowerPoint). This lesson will have to be walked through due to the level of reading/ readiness of the Kindergarten classroom. This lesson will be broken up into three sections on three days so students can fully grasp all the new knowledge. The PowerPoint is organized as such.

Parameters:

- The Design Worksheet must have two solutions drawn out and the students must be able to explain why they chose the solution they did verbally.
- Must be done in groups of 4 (assigned by the teacher)- TeamWork will have to be evaluated by the teacher due to the level of reading Kindergarten is on they will not be able to fill out a performance rubric.
- Can only use Dominos given to their group to create the solution to the maze
- Must be able to explain their design using new terminology.

Evaluation:
See Attached Rubric

The Maze: Here is an example of the maze I chose to use for this assignment. The maze can be anything the teacher chooses, but MUST have multiple solutions.



Rubric

1. Did the group make a solution to the maze using their Dominos? /20

2. Did the student participate in the group work? /20

3. Did the student turn in the design worksheet? /20

4. Did the student complete two sketches of a solution? /20

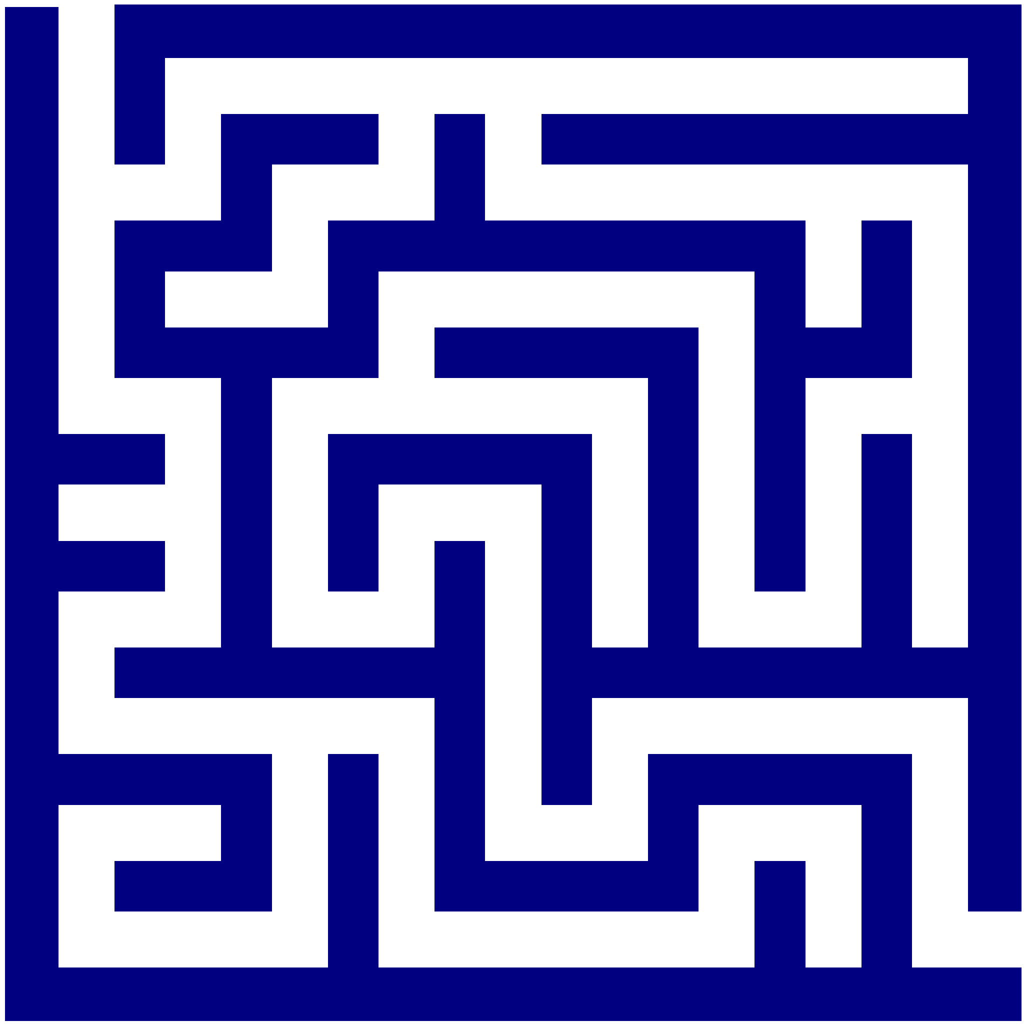
5. Was the student active in the explanation of the design? /20

Comments:

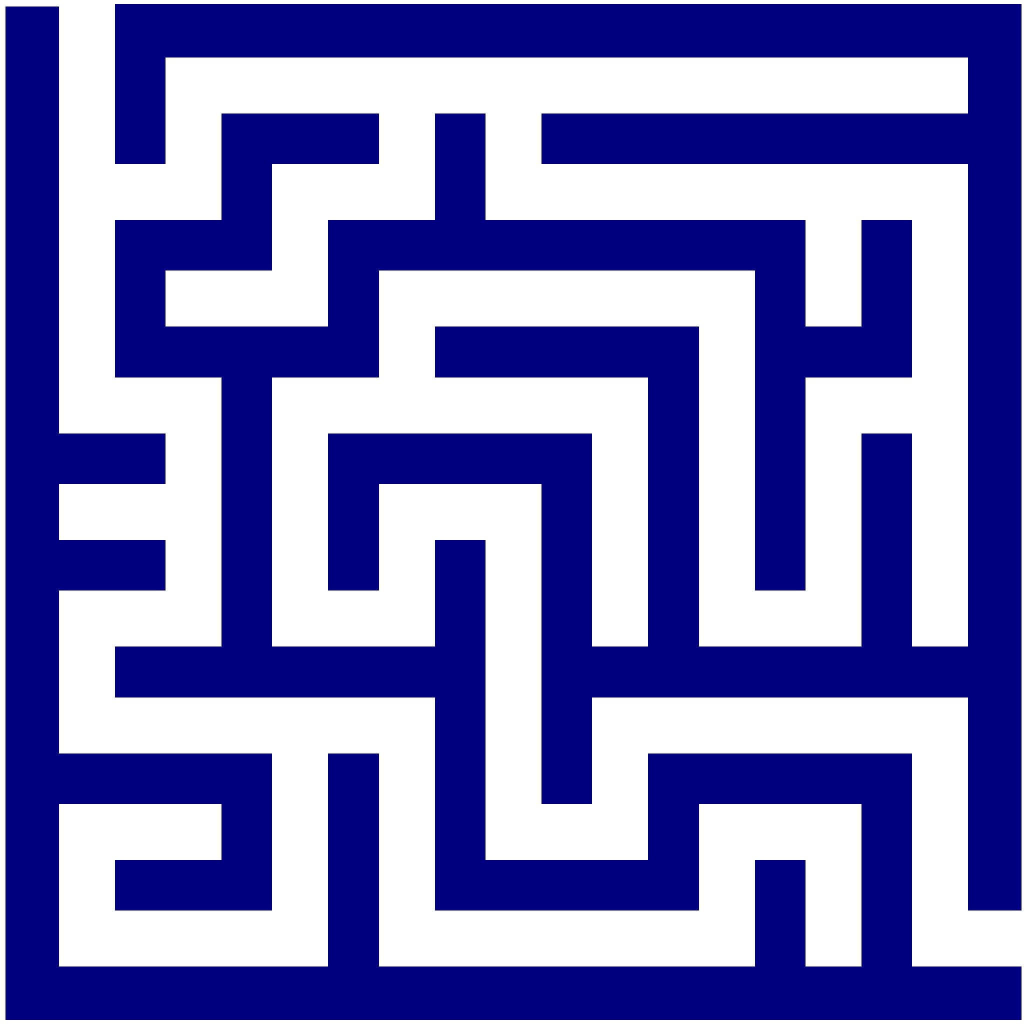
Total: /100

Design Worksheet

1.



2.



Habitat Happenings
Rikki Ann Zink and Alex Boggs

Teacher Lesson Plan

I. **Grade level**: 3rd grade
II. **Standards**
   a. Arkansas Science Standards
      i. 3-LS4-3 construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
      ii. 2-LS4-1 Make observations of plants and animals to compare the diversity of life in different habitats.
      iii. 2-PSI-3 Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.
   b. Arkansas Math Standards
      i. 3.MD.A.2 Measure and estimate liquid volumes and masses of objects using standard units such as: grams (g), kilograms (kg), liters (l), gallons (gal), quarts (qt.), pints (pt.), and cups (c)
      ii. 3.MD.C.5 Recognize area as an attribute of plane figures and understood concepts of area measurement
      iii. 3.MD.C.6 Measure areas by counting unit squares (square cm, square m, square in, square ft., and improvised units)
      iv. 3.G.A.1 Understand that shapes in different categories may share attributes and that shared attributes can define a larger category
      v. 2.MD.A.1 Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes
      vi. 2.G.A.1 Recognize and draw shapes having specified attributes (e.g., number of angles, number of sides, or a given number of equal faces)
   c. Standards for Technological Literacy
      i. Standard 8 Students will develop an understanding of the attributes of design
         1. C. The design process is a purposeful method of planning practical solutions to problems
         2. D. Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design
      ii. Standard 9 Students will develop an understanding of engineering design
         1. C. The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solutions, making the item, evaluating it, and presenting the results

2. D. When designing an object, it is important to be creative and consider all ideas
3. E. Models are used to communicate and test design ideas and processes

iii. Standard 11 Students will develop the abilities to apply the design process.

1. D. Identify and collect information about everyday problems that can be solved by technology, and generate ideas and requirements for solving a problem
2. E. The process of designing involves presenting some possible solutions in visual form and then selecting the best solutions from many
3. F. Test and evaluate the solutions for the design problem
4. G. Improve the design solutions

III. Big Ideas

a. Collaborating with others is important because it helps us come up with a variety of ideas.
b. Redesigning old ideas can improve results.
c. Know how to measure and calculate area.
d. Understand and identify different habitats and what they are for.
e. Gain experience with building blocks and the design process.

IV. Essential Questions

a. Essential questions for the students will be provided in the student design journal. Questions to consider as an instructor are:
   i. What do you need to understand about habitats prior to this activity?
   ii. What do you need to understand about measuring and calculating area prior to the activity?
   iii. What questions do you have about the materials or the process you will use? How can I provide clarification?

V. Scenario

a. Students will be asked to build a habitat for an animal of the teacher's choosing after learning about animal habitats from one of the three books (information provided under Materials/Resources). Students will work in pairs to build a sturdy habitat for the animal, and the habitat will undergo three tests to check its stability. The teacher will create the test by making a wrecking ball contraption held at a 90-degree angle that will ram into student's habitats (Hint: picture something similar to a tetherball pole). The wrecking ball can be made by attaching a piece of string onto a dowel rod and sticking the dowel rod into a Styrofoam block. For the three tests, the instructor will attach: a ping-pong ball, whiffle ball, and water balloon to the loose end of the string. The instructor should use the opportunity to briefly discuss how the volume of the liquid in the water balloon determines its mass and weight, and therefore it's force against their habitat. Students should be told how much water will be in the water balloon prior to the third test.

VI. Materials/Resources

a. Materials

i. For students: construction blocks (rectangles (1in x 1in x 4in), squares (3in cube), and triangle blocks (4.5in x 1in width), all uniform (all rectangles the same size, all squares the same size, all triangles the same size) and a ruler

ii. For instructors: ping-pong ball, whiffle ball, water balloon, one cup (8 ounces) of water, dowel rod (can be replaced with a pvc pipe if stronger rod is needed), Styrofoam block, and masking tape.

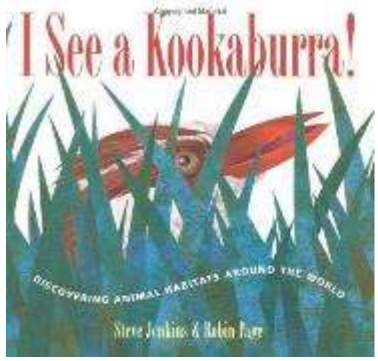


b. Resources

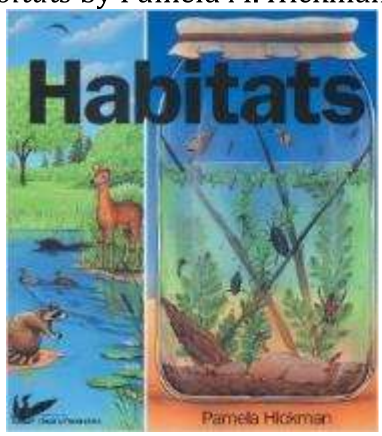
i. Instructors can choose to share content from any of these three books about habitats (all age appropriate):

1. *Welcome Home Bear* by II Sung Na

2. *I See A Kookaburra: Discovering Animal Habitats Around the World* by Steve Jenkins



3. *Habitats* by Pamela M. Hickman



VII. Deliverables

a. Students will be required to fill out a design journal documenting their ideas, calculations, and results throughout the activity. They will present this to the instructor at the end of the activity as well as their peer evaluation.

VIII. Parameters

a. Students can use no less than 20 blocks total and no more than 100 blocks total.
b. Students will have to complete the entire activity in an hour and a half.

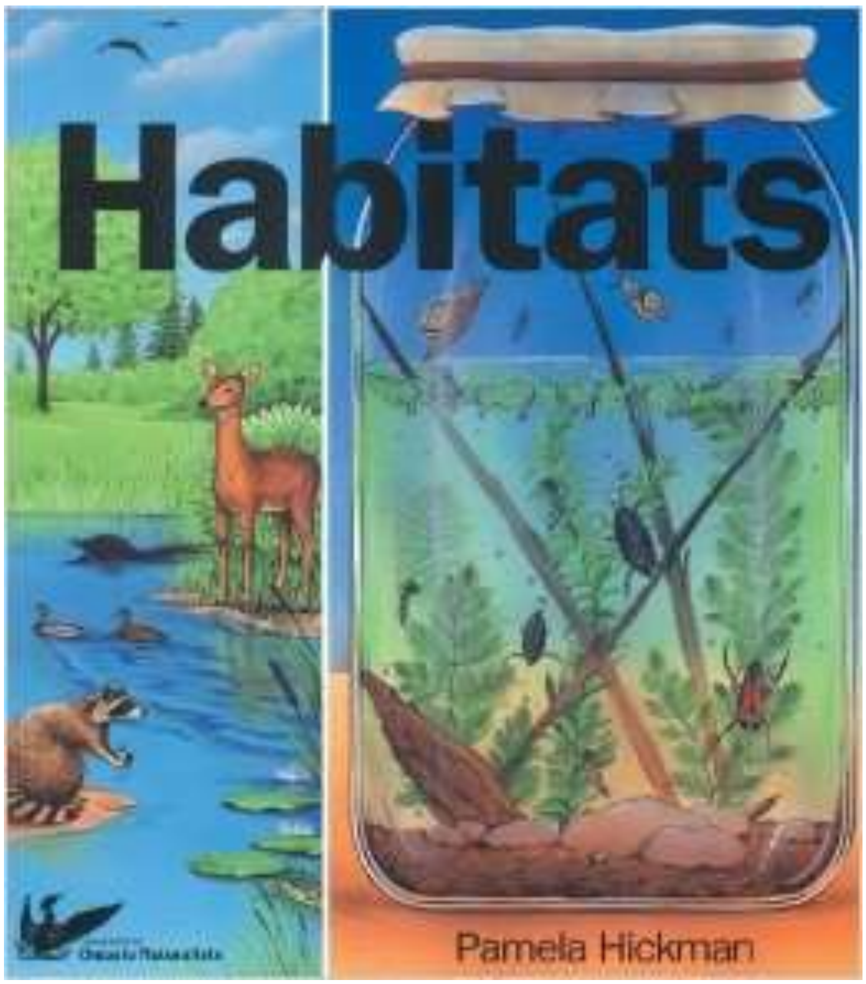
IX. Assessment

a. Students will be assessed by how thorough their design journals are and by the peer evaluation of their partner.

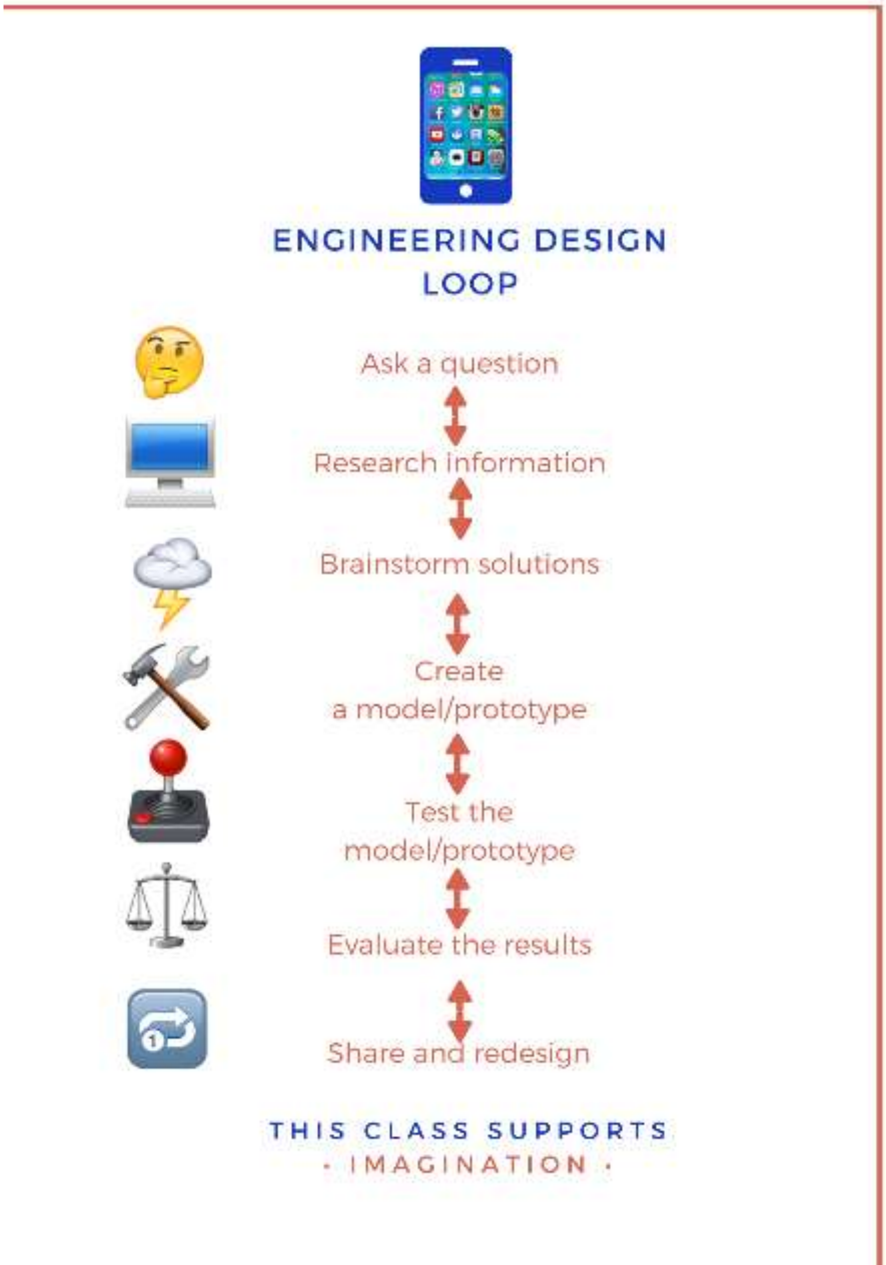
HABITAT HAPPENINGS

Design Journal

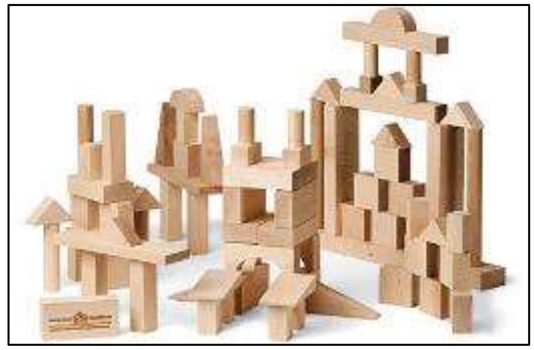
Name: ______________________________



Design Loop Process



Challenge:



Habitats are the natural homes or environments for animals. With a partner, choose a habitat from the text to build using wooden construction blocks. Use no less than 20 blocks total and no more than 100 blocks total. You may use any combination of rectangle, square, or triangle blocks to create a habitat that will protect your team's animal and withstand nature's wrecking ball!

Materials:

1. Rectangle construction blocks #__________
2. Square construction blocks #___________
3. Triangle construction blocks # __________

Questions to think about…

1. What do we need to understand about animal habitats before we build our own?
2. What measurements will we take and consider before building?
3. Why would the shape, size, and area of our habitat matter?
4. Why does the mass of the wrecking ball matter? How should we consider this when we are designing our habitat?

RESEARCH

Take some time to write about what you have learned about habitats:

BRAINSTORM

Draw pictures of potential habitats you could build

IDEA #1

IDEA #2

FINAL IDEA

MATH AND MEASUREMENTS

Use this space to calculate the area of your blocks and total area of your habitat

(*Hint: measure and calculate the area of the rectangle, square, and triangle blocks first. Ask for help if you need it!*)

Total number of blocks: rectangle ______ square _____ triangle_____
Area of Final Habitat:

RESULTS

PING PONG TEST

Describe what happened to your habitat.	Draw improvements you will make.

WHIFFLE BALL TEST

Describe what happened to your habitat.	Draw improvements you will make.

WATER BALLOON TEST

Describe what happened to your habitat.	What improvements could you still make?

PEER EVALUATION

On a scale of 1-10, 10 being "absolutely yes" and 1 being "not so much"
Please circle one…

1. Was your partner helpful in brainstorming habitat designs?
    a. 1 2 3 4 5 6 7 8 9 10
    b. Explain why you gave them this number

2. Was your partner helpful in building and re-building habitats?
    a. 1 2 3 4 5 6 7 8 9 10
    b. Explain why you gave them this number

3. Did your partner treat you and your ideas with respect during the Habitat Happenings activity?
    a. 1 2 3 4 5 6 7 8 9 10
    b. Explain why you gave them this number

Construction Block assignment

By: Meghan Richardson and Sarah Chism

Teacher & Student Guide:

Title: Earth Roller Coaster

Grade level: 4th

STEM Standards:

Science**:**

Energy: 4-PS3-1

- Use evidence to construct an explanation relating the speed of an object to the energy of that object.
- *PS3.A:* Definitions of Energy The faster a given object is moving, the more energy it possesses. (4-PS3-1)

Math:

Measurement and Data: Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit

AR.Math.Content.4.MD.A.1

- Know relative sizes of measurement units within one system of units including km, m, cm...yd., ft., in....

Technology Literacy/ Engineering:

The Nature of Technology: Standard 1: Students will develop an understanding of the characteristics and scope of technology.

3-5 Benchmarks:

- Things that are found in nature differ from things that are human-made in how they are produced and used.
- Tools, materials, and skills are used to make things and carry out tasks.

- Creative thinking and economic and cultural Influences shape technological development.

Technology and Society: Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.

3-5 Benchmarks:

- When using technology, results can be good or bad.
- The use of technology can have unintended consequences.

Technology and Society: Standard 5: Students will develop an understanding of the effects of technology on the environment.

3-5 Benchmarks:

- Waste must be appropriately recycled or disposed of to prevent unnecessary harm to the environment.
- The use of technology affects the environment in good and bad ways.

Content:

Science**:**

Students will be able to:

- Explain in physics terms how their model roller coasters work.
- Discuss the effects of gravity and friction in the context of their roller coaster designs.
- Use the principle of conservation of energy to explain the design and layout of roller coasters.
- Identify points in a roller coaster track at which a car has maximum kinetic and potential energy.
- Identify points in a roller coaster track where a car accelerates and decelerates.

Math:

Students will work together to discuss which unit of measurement will be the most effective to represent the conversion from small scale plot location map.

Students should consider their model created within the same unit of measurement.

Technology Literacy/ Engineering:

Students will be able to understand the effects of human-made technology can be harmful for the environment. The students will be able to relate this challenge within creative thinking, economic, and cultural influences.

Students will understand that specific tools, materials, and skill are necessary to be used properly to finish the task at hand.

Students will develop an understanding of the cultural, social, economic, and political effects of technology.

Students will develop an understanding of the effects of technology on the environment.

Big Ideas: Student will divided into groups to work together in making the ultimate Earth Roller Coaster by following the design loop. Students will create their group's roller coaster through the restrictive and provided materials in order to begin to understanding the effects of human interference within the environment. Subconsciously students should make the connection of building the group model cantilever rather than, a consistent ventricular support system. Students will be able to apply all required features that are needed to be incorporated in their group's roller coaster.

Essential Question: After dividing into either groups of four or five, can your group design the ultimate Earth Roller Coaster? The goal is to convert the scaled down plot location map into a larger unit of measurement to create a model roller coaster. What unit of measurement would be the most success for your group? Can your group design an ultimate roller coaster that does not harm the environment?

Scenario: An amusement park is being built in _______________ (each groups will have a different location), and your group has been hired to design the rides. The landscape architect mentioned the Earth Roller Coaster should be built first, so it is a key landmark in the center of park. The owner of the amusement park wants not only certain features designed within the roller coaster but wants to preserve the most trees as possible. Can your team design an ultimate Earth Roller Coaster, by using the design loop, to preserve the tree population?

Challenge:

Students will be in groups of four or five to create an Earth Roller Coaster out of the provided materials and tools. The roller coaster is X number of inches/feet high and so many inches/feet wide as long as it's base structure fits within a poster size (22x28). Students will be focusing on environmental science as well as, force and motion. The goal is to design a roller coaster with two loops, and three turns. Two of the turns must include the following angles one between 10-90 degree and one from 90-140 degree (the third turn is the group's choice). The roller coaster must also include a landing strip and an enclosure for the marble (keep in mind all parts need to connect together)....the roller coaster needs to be constructed in a manner that kills as few trees as possible on the plot location. In order to not kill a tree the obstruction can be lower than 2 inches tall. The structure beams for the roller coaster can only be created with 2x4 or 2x6 Legos, but students can build cantilevers with any Lego size. Let's see which group can build the best roller coaster by having the smoothest ride and lengthiest time!

Tools & Materials:

Tools	**Materials**
Scissors	Cup (1)
Masking tape	Legos (unlimited)
Protractor	Tubes 6' (2)
Ruler/Yard Stick	Poster grids 22 x 28 (1)
Map 8 ½ x 11 (1)	Marble (1)

Resources:

Tablet/Computer	
Library Materials	

Deliverables:

Students will be placed in a group of either four or five to construct a roller coaster using insulation pipe tubing, with the design loop. Students will have to collaborate on a design and method on how to construct their model by understanding what focus' are being applied. The group who is able to create a model that preserves the most trees, smoothest ride, and longer ride wins the challenge.

Parameters or Constraints:

The completed roller coaster must contain:

- Fit on poster plot location
- Two loops
- 1 turn between 10-90 degree angle
- 1 turn between 90-140 degree angle
- 1 turn open ended
- Landing strip
- Enclosure
- Structure base is constructed with either (or both) 2x4/2x6 Lego pieces
- All parts of track link together
- Can only use two 6' insulation pipe tubing for track pieces

Pre-Req. Knowledge[1]

Students need basic prior knowledge about forces, particularly gravity and friction, as well as some familiarity with kinetic and potential energy. They should also know Newton's second law of motion and understand basic concepts of motion, such as position, velocity

1 *Teach Engineering-* https://www.teachengineering.org/activities/view/duk_rollercoaster_music_act

and acceleration. Prior to conducting this activity, students should research the physics and engineering concepts in the Physics of Roller Coasters lesson.

Learning Objectives

After this activity, students should be able to:

- Explain in physics terms how their model roller coasters work.
- Discuss the effects of gravity and friction in the context of their roller coaster designs.
- Use the principle of conservation of energy to explain the design and layout of roller coasters.
- Identify points in a roller coaster track at which a car has maximum kinetic and potential energy.
- Identify points in a roller coaster track where a car accelerates and decelerates.

Evaluation:

Group evaluation:

Peer Evaluation Form

Name____Class Period______Date________________

Write the names of your group members in the numbered boxes. Then, assign yourself a value for each listed attribute. Finally, do the same for each of your group members and total all of the values.

Values: 1=Strongly Agree 2=Agree 3=Disagree 4=Strongly Disagree

Attribute	Yourself	1.	2.	3.
Was dependable in attending group meetings.				
Willingly accepted assigned tasks.				
Contributed positively to group discussions.				
Completed work on time or made alternative arrangements.				
Helped others with their work when needed.				
Did work accurately and completely.				
Contributed a fair share to weekly papers.				
Worked well with other group members.				
Overall was a valuable member of the team.				
Column Totals ▷				

Student evaluation**:**

Cooperative Learning Self Evaluation

Name______________________ Team______________________ Date__________

Project Topic or Title:

Briefly describe your contribution to the cooperative learning project:

If you were doing this project again, what would you do differently to improve your work?

How could your team work together more effectively next time?

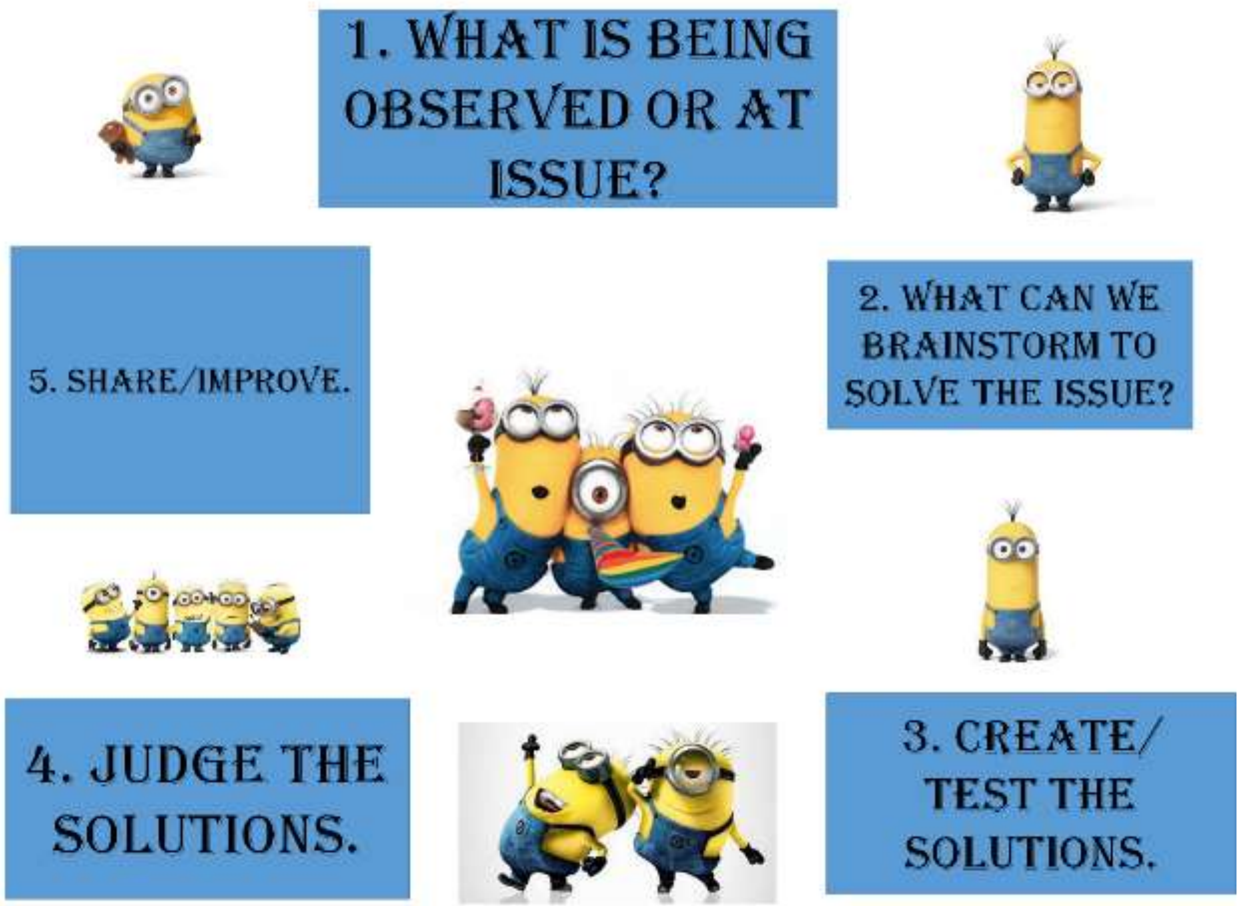
Your Teacher's Comments:

Your Grade for Yourself:

Your Teacher's Grade for You:

Design loop:

Students will have two weeks to complete this challenge. The whole class will be working with their group in fifty minute increments each day to complete the challenge. Within each group, students will need to assign jobs for the following roles: principal investigator (only student to ask questions during activity), material manager (only student to get supplies), and recorder/reporter (main student to make sure engineering journals are being used in proper steps of the activity). All students will be responsible for cleaning up their areas each day.



Students guide:

Day 1:

Introduce students to the design loop challenge:

Students will be collaborating within groups of four-five to create the ultimate Earth Roller Coaster (all members of the group needs to have at least one idea present on the model). Students will be accountable to complete the design loop process by collaborating for a possible affect schedule. To help with this responsibility jobs will be picked within the group.

Within each group, students need to assign jobs for the following roles; principal investigator (only student to ask questions during activity), material manager (only student to get supplies), and recorder/reporter (main student to make sure engineering journals are being used in proper steps of the activity). All students will be responsible for cleaning up their areas each day.

Students will be given the Engineering Journal to help plan keep a schedule in completing the challenge on time. The teacher will walk through all aspects of each material pieces. All students are allowed to ask any questions or concerns during this time. Once all students' questions and concerns are resolved students may begin working.

NOTE: to avoid group models getting damage as a

Main goals:

-Jobs assigned

-Research collected for ideas and information

-Convert small plot location map onto large poster board

Day 2:

Main goals:

-Continue researching

-Conversion completed

-Begin working in Engineering Journals

-Groups should:

Have pages 1-3 completed (end of day)

Begin working on pages 4-15

Day 3:

Main goals:

-Continue working in Engineering Journals

-Groups should:

Be working on pages 4-15

-Begin building model

Day 4:

Main goals:

-Continue working in Engineering Journals

-Groups should:

Be working on pages 4-15

-Building model (continued)

-Testing ideas

-Recording results

-Referring (or finding additional) research

Day 5:

Main goals:

-Building model

-Testing ideas or retesting ideas

-Recording results

-Finding solutions to challenges

-Referring to new or old discovered research

<u>Day 6</u>

Main goals:

-Building model

-Continue working in Engineering Journals

-Testing model

<u>Day 7:</u>

Main goals:

-Model should be close to completion

-Testing full roller coaster model

-Continue working in Engineering Journals

-Groups should be close to completion

<u>Day 8:</u>

Main goals:

-Test full roller coaster model

-Completing Engineering Journal

-Except for pages 29-32.

<u>Day 9:</u>

-Last work day to finish component, and testing.

-Completing Engineering Journal

-Except for pages 29-32.

Day 10:

Have all students observe all group models and form a brief discussion of what other groups have done. Have students sit during group presentations. Each group will be allowed three test and one quick fix.

The teacher will record all of the results:

- Which group saved the most trees?
- Which group saved the least?
- Which group had the smoothest ride?
- Which group had the longest ride?
- Which group had the shortest ride?

After each group has tested their model, have students return to community zone to reveal results, students should have their Engineer Journal with them. Have a class discussion through any aspects they wish to share from their Engineer Journal. *Goals in grand conversation*: how is this activity applicable in the real-world aspects? Have students finish the remaining pages in engineering journal. **Students will be mainly evaluated through observations and engineering journals**

Engineer Journals:

Name: ________________________

Date Started: ____/_____/_____

Design Brief Title: ____

1. What is the problem?

What do I need to do?

____

____

____

2. Brainstorm solutions –

What do I already know?

____

____

____

What do I need to find out?

What did I find out?

My First Ideas: *where should your group start?*

What is your geographic map?

How did you convert the scale?

My ideas: *roller coaster, turn angles, loops, structure, etc…*What are you thinking?

Group ideas:

Group ideas: *What do you like?*

Take away thoughts:

3. Choose a solution:

My best idea and groups best idea is …

Take away thoughts:

Thoughts about angles sizes:

Researched information about angle sizes:

______________________________ ______________________________ ______________________________
______________________________ ______________________________ ______________________________
______________________________ ______________________________ ______________________________
______________________________ ______________________________ ______________________________

Angle Ideas:

Angle Ideas:

What angle ideas will be tested? Draw the angles that your whole group as decided to test.

What happened? Changes needed?

What needs to happen?

Take away thoughts:

Problems with design:

We will approach the problem with ______________by focusing on: *What is your group having problems with?*

Our goal is:

Thoughts

We will approach the problem with ________________ by focusing on: *What well help your group not lose so many trees?*

Our goal is:

Thoughts

4. Testing-Full roller coaster:

What happened? Changes needed:

What worked well?

What was redesigned?

What forces are being applied within the roller coaster?

How do you know: *research or observation?*

Take away thoughts:

How many 2x4 Legos did your group's use?

How many 2x6 Legos did your group use?

How many trees were cut down? How many trees were not cut down?

Take away thoughts:

1. What was the most challenging?

2. What is one thing you would like to change about your group's design?

3. Based on your research, is your group's model realistic? Why or why not?

After presentations:

Which group saved the most trees? ______

Which group saved the least? _____

Which group had the smoothest ride? _____

Which group had the longest ride? ______

Which group had the shortest ride? ______

Which group's design is one you want to ride? Why?

Assessment:

1. Was your group able to convert the plot location onto poster board?

Yes Moderately No

2. Did your group save majority of the environmental features?

Yes Moderately No

3. Did all group members' ideas get added to the roller coaster?

Yes Moderately No

4. Does your group's roller coaster have three turns?

Yes Moderately No

5. Does your group's roller coaster have two loops?

Yes Moderately No

6. Does your group's roller coaster have an angled turn between 10-90 degrees?

Yes Moderately No

7. Does your group's roller coaster have an angled turn between 90-140 degrees?

Yes Moderately No

8. Does your coaster have a landing strip?

Yes Moderately No

9. Does your group's roller coaster have an enclosure for the marble?

Yes Moderately No

*10. *Bonus:* Did your group design a roller coaster that kept the most trees?

Yes No

Teacher Copy

Perfectly Balanced

Grade Level

3rd grade

Disciplinary Area

Innovation and Math

Standards

Arkansas Science Standards

3-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Arkansas Mathematics Framework

AR. Math.Content.3.MD.A.2 Measure and estimate liquid volume and masses of objects using standard units of grams (g), kilograms (kg), and liters (l).

Standards for Technological Literacy

Standard 10. Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Materials

Per Group

- 10 Plastic cups
- 10 Popsicle Sticks
- 15 Standard 1 inch counting cubes
- 50 Pennies
- 1 Basic Scale

Challenge

Within groups, students will apply the design loop process to create a balance scale of some sort. They will then use the scale they have created to informally measure each object—the cups, cubes, and pennies. As a class, we will then measure one object on an accurate scale and use its mass to determine the mass of all other objects.

Essential Question

How might I build a scale to informally weigh my objects?
How can I implement multiplication into my calculations?

Procedures

1. Have students group up into groups of 2 or 3
2. Announce to students that they will be building a "balance scale" of some sort.
3. If students need examples, refer them to the pictures in Figure 1.
4. Pass out materials and worksheets to students.
5. Students will use the Design Process Worksheet to develop their scale as a group. The back of the page can be used if more room is needed for their sketches.
6. They will then attempt to balance (or informally weigh) one of the objects and analyze how well their scale worked.
7. Once students are confident in how well their scale works, have them weigh their objects and log their findings on the Who Weighs What Worksheet.
8. After students complete the worksheet, convene as a class and weigh one of the objects on the accurate scale. (example: 1 counting cube is 5 g)
9. Students will use the Who Weighs What Worksheet to then calculate the weight of all other objects.
10. Once they have calculated the objects' weights, use the accurate scale to weigh each object to see how close the students' answers were to the real mass.

Deliverables

- Design Process Worksheet—1 per group
- Who Weighs What Worksheet—one per student

Parameters & Constraints

- Students may only use the materials given to them to build a scale BUT still have enough materials to weigh.
- Students must complete the Design Process Worksheet before they begin to build their scale
- Students must show their work when calculating mass and work individually.

Evaluation

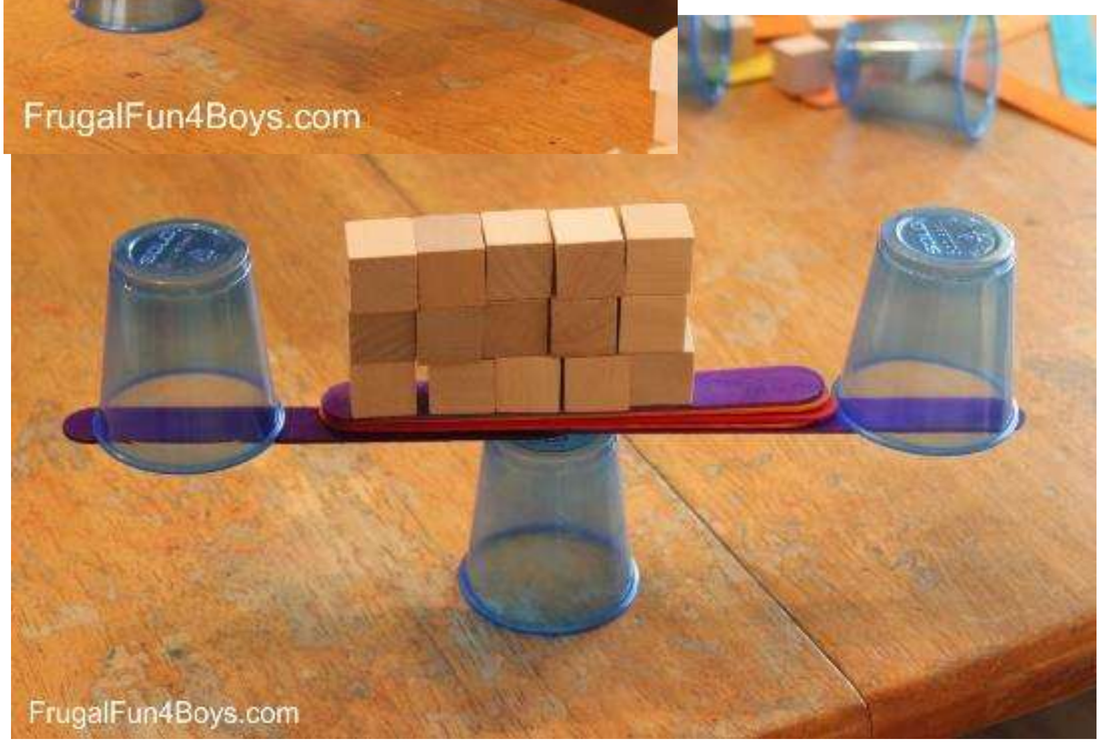
Have students use their Science Notebook (or just spare paper, if notebooks are not used) to explain what they learned from this activity. How close was their calculations to the real mass? Must we always weigh objects conventionally? What was hard about this task? Did they enjoy it?

The worksheet that are listed under Deliverables are also a form of evaluation.

Adapted from http://frugalfun4boys.com/2015/06/11/4-engineering-challenges-kids/

Figure 1

Note: Students do not have to build it up with so many cups or blocks, since they are looking for the informal weight of just one cup (or block or penny)



Student Copy

PERFECTLY BALANCED

CHALLENGE	Within groups, students will apply the design loop process to create a balance scale. You will then use the scale you have created to informally measure each object—the cups, cubes, and pennies. As a class, we will then measure one object on an accurate scale and use its mass to determine the mass of all other objects.
MATERIALS	10 Plastic Cups 10 Popsicle Sticks 15 Counting Cubes 50 Pennies
PLEASE REMEMBER	• You may only use the materials given to you to build a scale BUT still have enough materials to weigh. • You must complete the Design Process Worksheet as a group, before you begin to build your scale.

LET’S SEE HOW CLOSE TO THE REAL MASS YOU CAN GET!!

Group Members:____

Design Process Worksheet

Recognize the objective:

How can it be achieved?

Sketch solutions:

Results of design:

How might you improve it?

Name:____

Who Weighs What?

1 cube=________ pennies

Which has a larger mass, the cube or the plastic cup? How do you know?

1 cup=_________ pennies

After accurate scale measurement

What was chosen to be weighed? _____________________________

What was its mass in grams? ____________________________

Show your work

Penny=______g

Cube=_______g

Cup=________g

Bonus: Can you write a number sentence that represents how many pennies it

Holiday Themed Electricity Curriculum Projects

Frosty The Snow Man

Holiday Circuit Activity

Materials:

- 1 Large Paper Plate
- 3 Small Paper Plates
- String of 3 white lights
- 1 orange light
- Googley eyes
- Black felt
- 2 Popsicle sticks
- 1 3x5 Note Card
- 3 small Styrofoam balls
- 3 led batteries
- 3 to 4 strands of wire

Tools:

- Scissors
- Stapler
- Wire cutters
- Glue
- Electrical Tape
- Shiny foil tape

Directions:

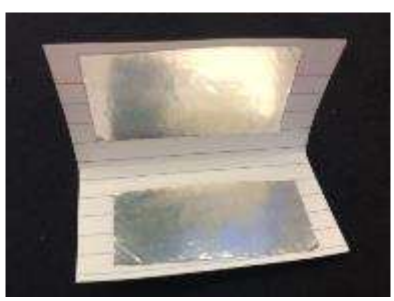
1. Begin by stapling all three of the plates together in a vertical line. This may require 1 or two staples per plate.

2. Using, your scissors, carefully puncture 3 holes in the middle plate. The holes should be about 1 inch apart and in a straight vertical line. These are going to be Frosty's buttons. On the top pate, puncture one hole near the center of the plate, this will be Frosty's nose.

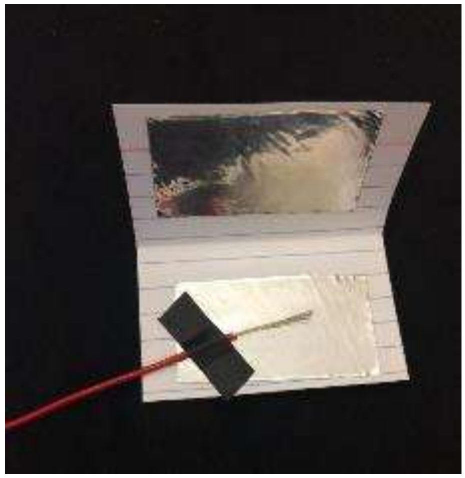
3. Put the 3 white lights through the holes on the middle plate.

4. Put the orange light through the hole on the top plate.

5. Next we are going to create our flip switch. Fold the note card directly in half. Cover the two inner flaps with the shiny tape.

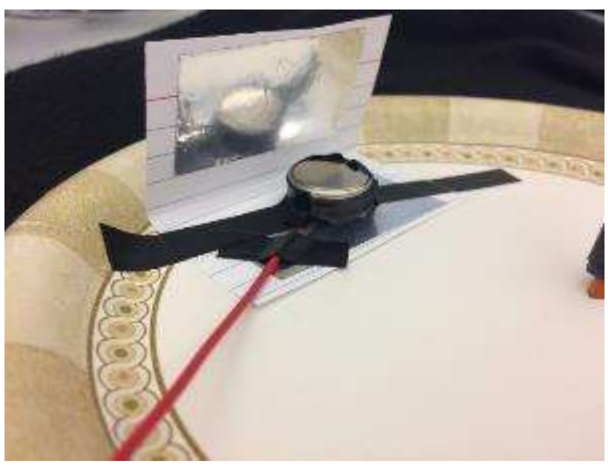


6. Take one of your wires and lie it flat on one of the flaps so the exposed wire is making contact with the shiny tape. Using the black electrical tape, attach the wire to the note card.



7. Stack your 3 batteries on top of one another. Use the black electrical tape to secure the batteries together by lining the outer rim of all 3 batteries. *note: the tape should not be covering anything besides the edges.

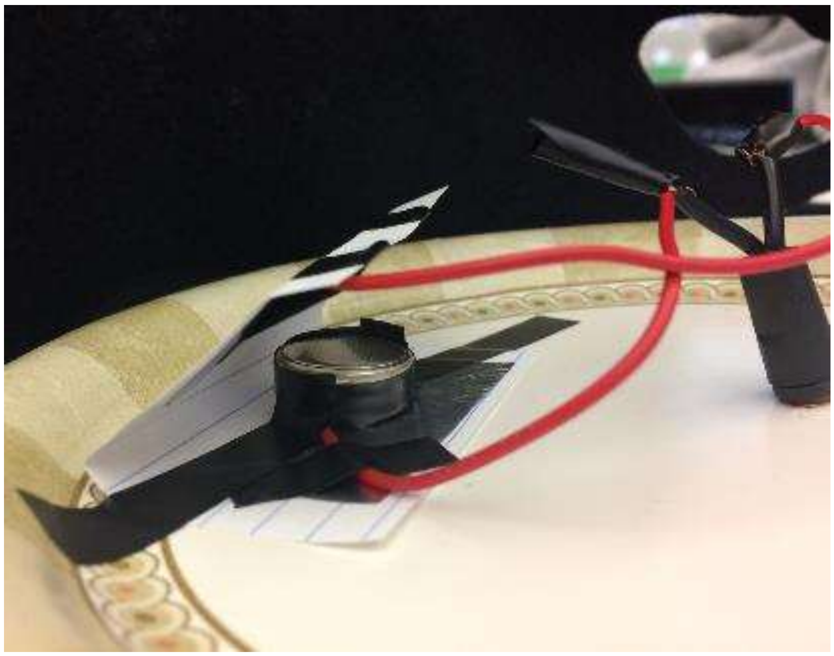
8. Place the stacked batteries on top of the wire you previously attached to the flip switch. Make sure the wire is making good contact with the battery.



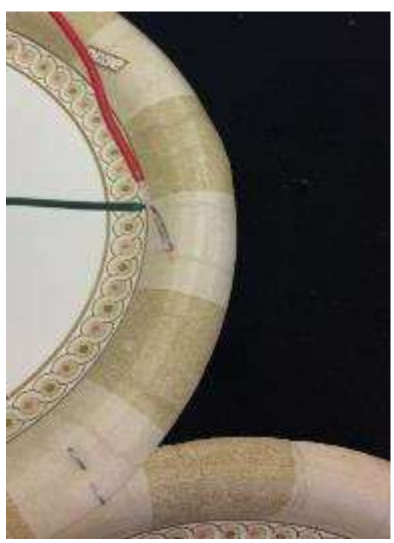
9. Use 2 thin pieces of the black electrical tape (you can do this by cutting the tape in half vertically) to secure the batteries to the flap. Again, make sure the tape is not touching the top of the battery. The tape should only connect to the sides.

10. Once your battery is secure, you are going to want to attach your flip switch to the top plate (Frosty's head). You can use tape to do this.

11. Next, you will wrap the exposed end of the red wire around the exposed end of the orange light's wire (as shown below). Then wrap black electrical tape around that connection.

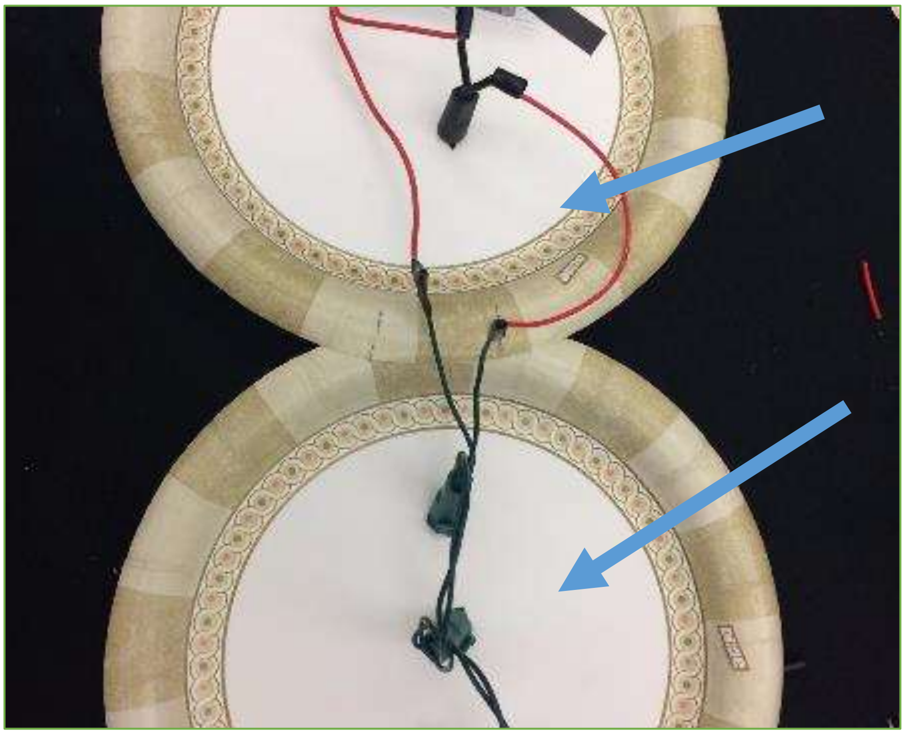


Here is an example of what your wire connections should look like:

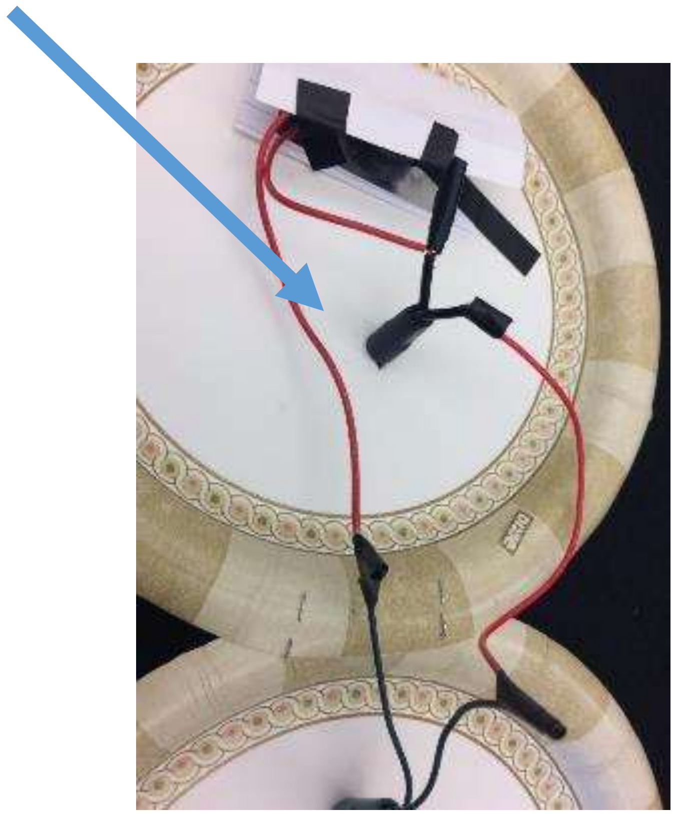


12. Then, you will use a longer red wire to connect the other orange wire to one of the ends of the strand of lights.

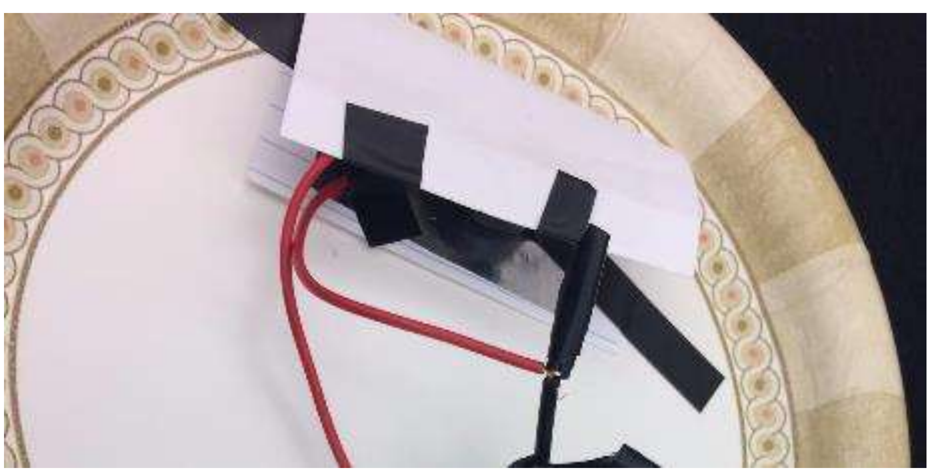
13. You will need to be sure that you use the wire strippers to strip enough of the ends to expose the wire. Then you will wrap the wire around each other. And then use the electrical tape to wrap the exposed wire.



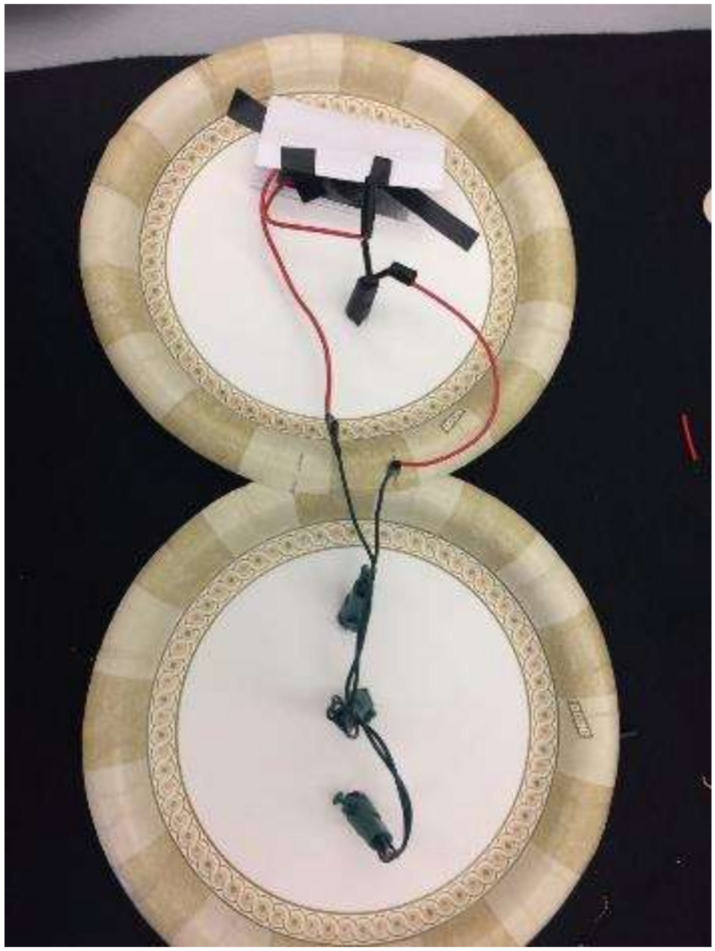
14. Next, use another long strand of wire with exposed ends and attach it to the remaining wire from the strand of lights. Then wrap it with electrical tape.



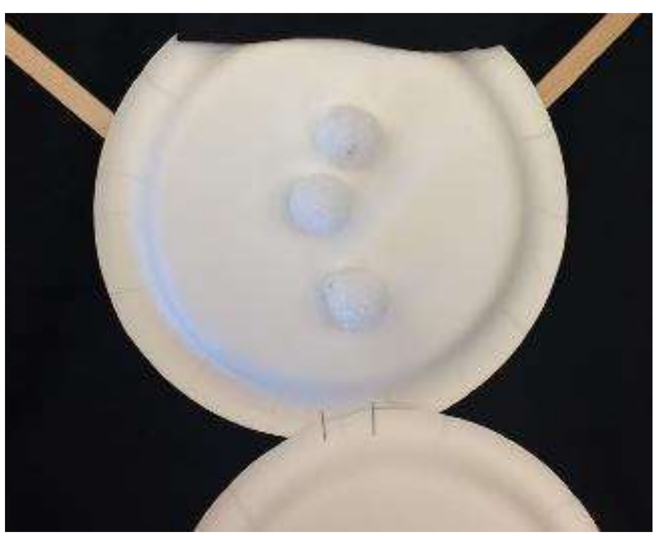
15. Now attach the other end of the wire you just connected to the upper part of the flip switch with electrical tape. But you must attach it so that when you push the flap down, the wire will lay on the battery and light up your snowman's nose and buttons. This should complete your circuit.



16. Be sure to check all of your connections and wrap them each with tape. Here is a picture of how your final circuit should look:



17. Next, be sure to put each of the three Styrofoam balls on top of the white lights.



18. The next part of the project is adding a hat, eyes, a smile, a scarf, and arms to Frosty. Use the Popsicle sticks and glue to add arms to frosty. And the two googly eyes with glue to Frosty's face. Using paper or a paper plate, cut out a hat for Frosty. Then glue the hat on Frosty. You can add felt to the hat if you want. Then cut out a scarf out of the black felt and glue it on Frosty. And lastly, add a smile to Frosty! ☺

Alex Boggs
Abby Bailey
STEM 4033

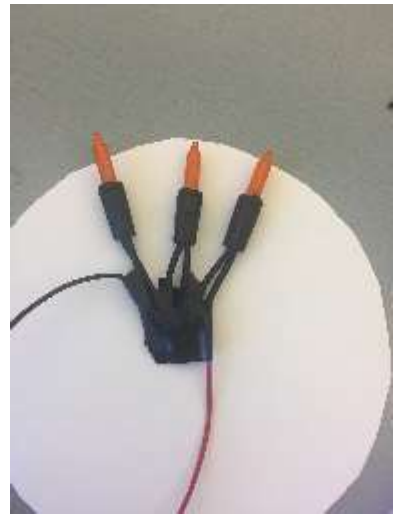
Turkey Circuit Project

Materials

- red wire (positive)
- 2 black wires (negative)
- 4, 3 volt batteries
- paper plate
- electrical tape
- aluminum tape
- 2 nails
- wood block
- safety pin
- 3 orange christmas lights
- popsicle stick
- colored construction paper
- toilet paper roll
- rubber cement
- wire strippers/cutters
- hole punch
- scissors
- hammer
- safety glasses

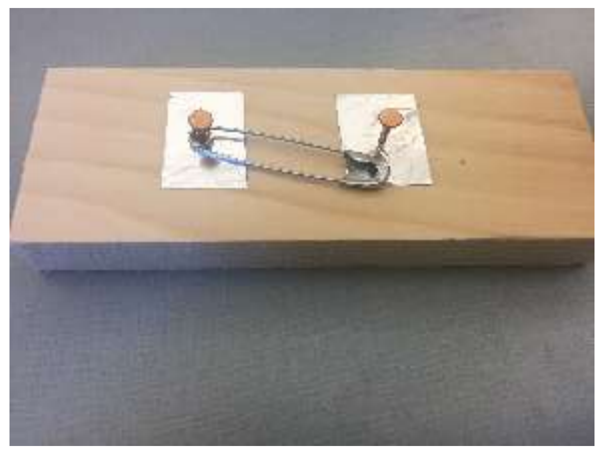
1.) You will start by linking your 3 orange lights together, you may have to strip the wires on these a little bit to get them to join together. Twist the wires together so that they 3 lights are joined together in a chain.

2.) Next strip both ends of your red and black wires and then attach both of them to either end of the chain. Secure all of these wire joining with the black electrical tape.



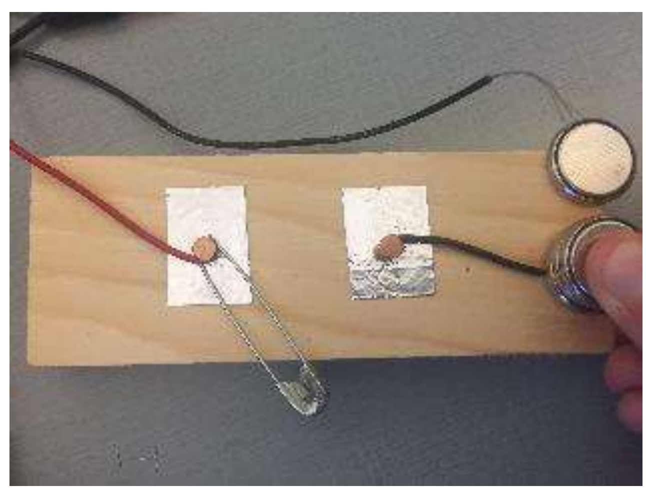
3.) Cut 2 small squares of aluminum tape and place them about an

inch apart on the wood block.



4.) Using your hammer put one nail in the center of each of the squares of the aluminum tape, put the smaller circular end of the safety pin under one of the nails to create your switch. Do not hammer them all the way in.

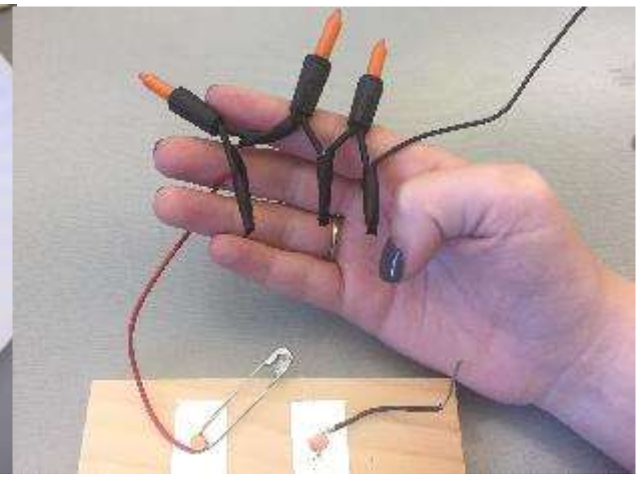
5.) On the same nail where you placed the safety pin, wrap the other end of the red wire onto the nail and hammer it all the way in so the safety pin and wire are secure.



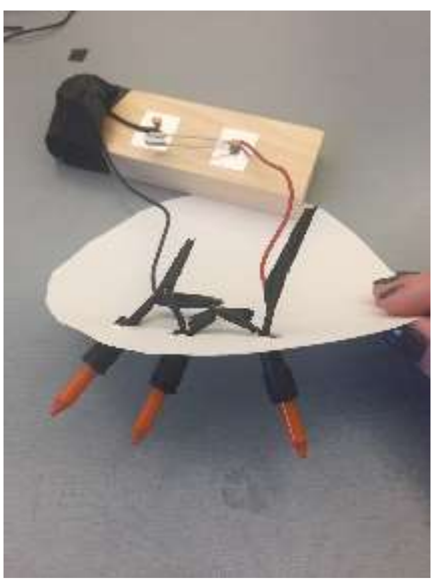
6.) Take the 2nd black wire not attached to the strand of lights and strip both sides, wrap one end around the 2nd nail and hammer nail all the way in. You should now have one nail with the red wire and safety pin secured and one nail with the unattached black wire.

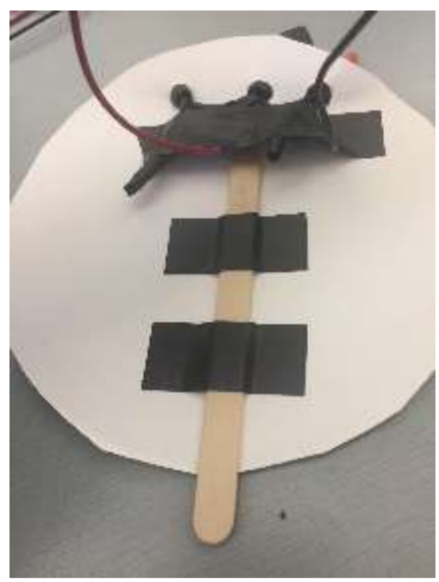
7.) Take your paper plate and cut out the flat part of the plate so you are left with the smaller circle, punch 3 holes in it to poke the lights through.



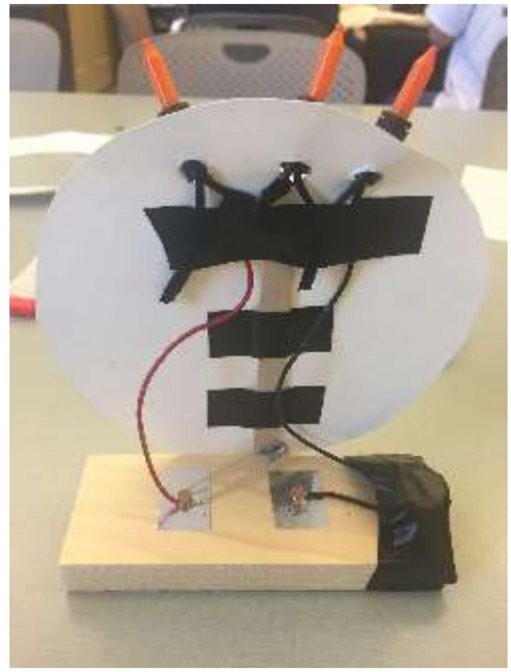


8.) Secure the lights with electrical tape to the back of the plate and then attach the popsicle stick to the back of the plate as well for support.





9.) Rubber cement the plate to the side of the wooden block so that the plate stands up and the wires and circuit are hidden.



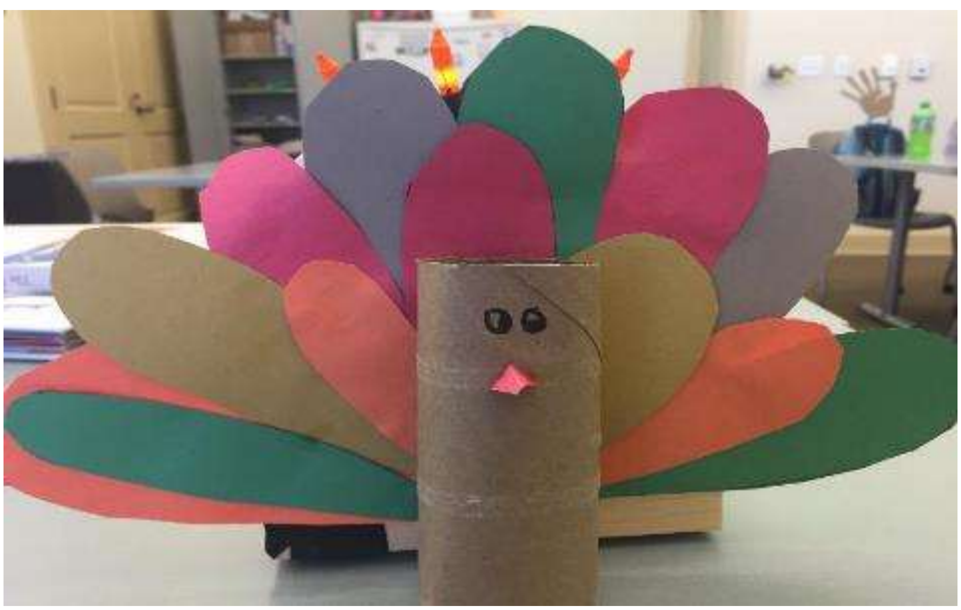
10.) Place the black wire that is attached to the nail under your 4 batteries that you have stacked up. Place the other black wire that is attached to the lights on top of the stack of batteries and secure with electrical tape.

11.) At this stage of you touch the other end of the safety pin to the other nail it should complete your circuit and turn the lights on. If this does not happen check that your wires are tightly wound and all connections are stable.

12.) After trouble shooting and confirming that your circuit is stable and working you may begin decorating your turkey. Using several different colors of construction paper cut out feather-like shapes (narrow ovals will work).

13.) Attach the feathers to the front, blank side of the plate and arrange them in a fan like pattern around the lights and the top of the plate.

14.) Attach the toilet paper roll in the center of the plate and lined up with the bottom to be the "body' of the turkey. Cut out a little triangle out of construction paper to make it's beak and draw on the eyes to complete your project.



Rikki Ann and Yue

November 15, 2016

Holiday Themed Electricity Project

Star Light Star Bright

Materials

- 1 paper plate
- 1 sheet of white paper (4x4 in.)
- 5 M5 Mini LED bulbs
- 1 block of wood (1¼ x 2 in.)
- 2 copper nails
- 1 metal clothes pin
- 4 3V coin batteries
- 2 black wires
- 1 red wire
- Electrical tape
- Silver conductor tape

Tools

- Scissors
- Hammer
- A wire stripper
-

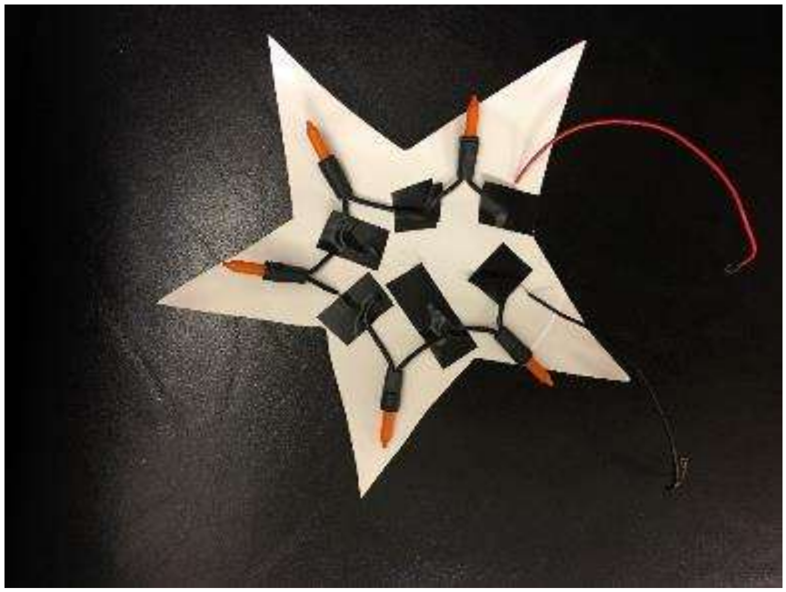
Directions:

The Star

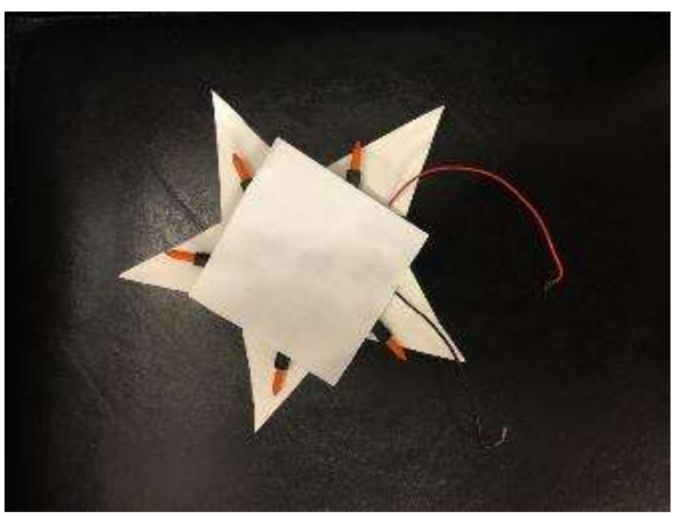
1. Take the wire stripper and strip any and all wires necessary. It is helpful to have quite a bit of exposed wire!

2. Once all 5 bulb wires have been stripped, take the ends of each and twist them together in a star formation.

3. When you have your star formation, place the star on the white paper plate. With a pencil, outline the backdrop of the star and cut it out.
4. After cutting out your star, place the bulbs in each of the points and tape the exposed wires down to the paper star using electrical tape. Be sure not to tape or twist the last two wires of your star—leave it open-ended.



5. Attach the red wire to one open-ended bulb wire by twisting it in the same way you did to connect the other bulbs.
6. Attach one of the black wires to the other open end of your star (similarly to the red).
7. To cover the wires and tape, take the 4x4 piece of paper, decorate it to say "Happy Holidays", and tape it onto the middle of your star! You may have to adjust the size of your paper depending on how large or small your star is.

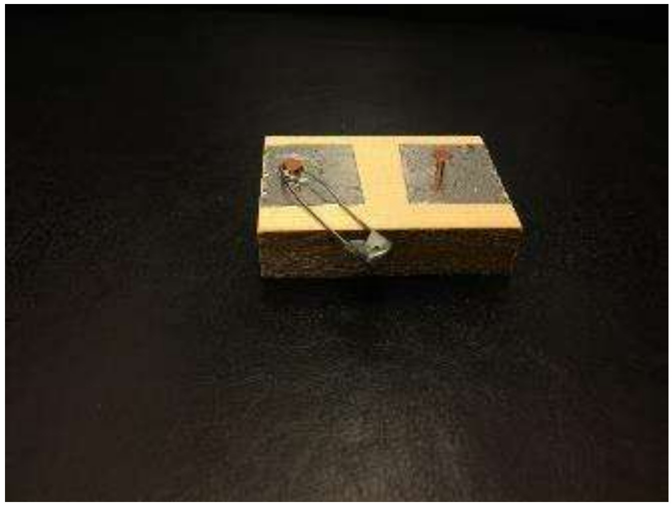


The Battery

1. Take the 4 3V coin batteries and stack them so that they are all facing the same direction.
2. Use the electrical tape to create a sort of blanket around the perimeter of the 4 batteries. This will help them stick together! Be sure the top and bottom of the battery stack are shown.

3. Tape the open end of the black wire that is attached to your star to one end of the battery. Take the second black wire and tape it to the other end of the battery.

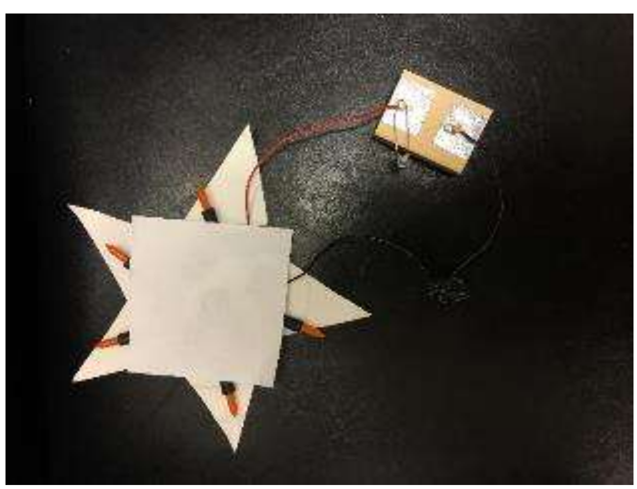
The Switch



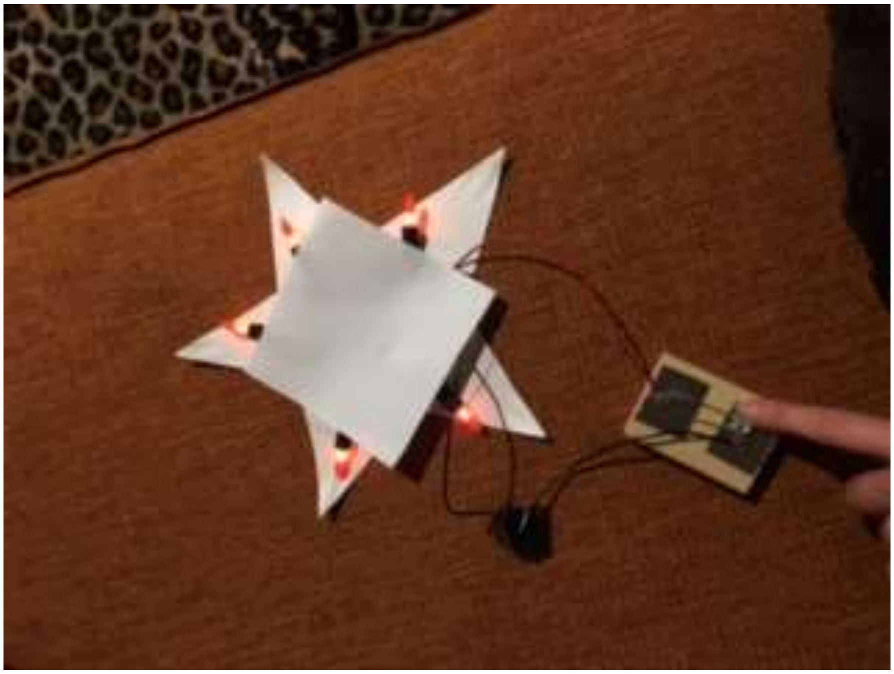
1. Take the wooden block. Cut two squares of silver conductor tape. Place them at opposite ends of the wooden block.
2. Loop one copper nail through the tiny circle at the end of the metal clothespin. Hammer the nail into the wood over the center of the conductor tape. Make sure you hammer it tightly into the wood block.
3. Hammer the other copper nail through the conductor tape on the opposite side of the block. Hammer it just enough so that it is firmly in the wood block, but also has a bit of space between the block and the head of the nail.

Light it up!

1. Take the open end of the black wire that is attached to the battery and wrap the wire around the taller nail. Be sure to wrap it all the way around, tightly!



2. Take the open end of the red wire and attach it to the nail and clothespin by wrapping it around as well.
3. To switch your star on and off, move the clothespin back and forth to touch the opposite copper nail. When they connect, the circuit is closed, and the star will light up!



Teachers Guide

<u>Title:</u> Star Light Star Bright

<u>Disciplinary Area</u>: STEM – Electrical Circuits

<u>Grade Level:</u> 4th Grade

<u>STEM Content Standards:</u>

- Science
  4-PS3-2 Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

- Technology and Engineering
  STL 12: Students will develop the abilities to use and maintain technological products and systems.

    D. Follow step-by-step directions to assemble a product.
    E. Select and safely use tools, products, and systems for specific tasks.

  STL 16: Students will develop an understanding of and be able to select and use energy and power technologies.

    C. Energy comes in different forms.

    D. Tools, machines, products, and systems use energy in order to do work.

- Mathematics
  MP.2 Reason abstractly and quantitatively. (4-ESS3-1)

  MP.4 Model with mathematics. (4-ESS3-1)

<u>Big Idea(s):</u>

- Principles of electric currents and switches
- Explore uses for electricity
- Following step-by-step instruction.

Essential Question:

With a partner, follow the detailed instruction and use the materials and tools provided to make your own holiday star.

Scenario: https://www.youtube.com/watch?v=3gAZTtCiQc8

Twinkle, twinkle, little star,

How I wonder what you are.

Up above the world so high,

Like a diamond in the sky.

When the blazing sun is gone,

When he nothing shines upon,

Then you show your little light,

Twinkle, twinkle, all the night.

Then the traveler in the dark,

Thanks you for your tiny spark,

He could not see which way to go,

If you did not twinkle so.

In the dark blue sky you keep,

And often through my curtains peep,

For you never shut your eye,

Till the sun is in the sky.

As your bright and tiny spark,

Lights the traveler in the dark.

Though I know not what you are,

Twinkle, twinkle, little star.

This is a popular English lullaby. The lyrics are from an early 19th century English poem by Jane Taylor. During 1761, Wolfgang Amadeus Mozart composed the melody. Today, we will follow the instructions to create a simple circuit and make our own star that will shine, just like the song!

Challenge:

- With a partner, follow the detailed instructions to make a shining star.
- You can only use the provided materials and tools.
- Please be creative when decorating your star! We will present and hang the stars once the project is finished.

Materials & Tools:

Materials	**Tools**
1 paper plate	Electrical tape
1 sheet of white paper (4*4 in)	Silver conductor tape
5 M5 Mini LED bulbs	Scissors
1 block of wood (1¼* 2 in)	Hammer
2 copper nails	Wire stripper
1 mental clothes pin	
4 3V coin batteries	Crayons/Colored marker (for decoration)
2 black wires	
1 red wire	

STEM Content:

1) An electric circuit interaction occurs when a source of electrical energy is connected in a closed path of conductors to an energy receiver. If the path is opened (the switch is off), then the electric circuit interaction will cease occurring.
    - Example of energy sources for electric circuits: battery, generator and solar cell.
    - Example of energy receivers for electric circuits: light bulb and motor.
2) Each device in an electric circuit is double-ended; each end must be directly connected in the circuit. If only one end of a device is connected in the circuit, then the device or circuit will not work.
3) Electric circuit interactions can be described in terms of *electrical energy*, and the law of energy conservation applies to all devices in the electric circuit.

Deliverables:

Students will be placed in groups of two to finish their work. Following the detailed instructions, students build the simple circuit using the materials and tools provided for the shining star. The light of the star must turn on when the switch is on and turn off when the switch is off.

Parameters or Constraints:

- Only use the provided materials and tools
- Finish in one class period
- Be creative when decorating and cutting out your star

Evaluation:

Group Members: ____

1. Followed the instructions and finished the work on time.	________________/20
2. Only used the tools and materials provided. The star shines when the switch is on.	___________________/40
3. Creative decorations	___________________/20
4. Effective Teamwork	____________________/20
Total	___________________/100

Christmas Tree Electricity Craft

By: Sarah Newhouse and Mary Engledowl

"Oh Christmas Tree, O Christmas Tree! How brightly shine your branches!"

Merry Christmas!

We will be making a Christmas Tree with working lights. You will create a working circuit with a switch to be able to turn the lights on and off.

<u>You will need:</u>

- 1 Paper plate
- Green paint
- Cardstock Paper
- Cotton balls
- 1 Paper clip
- 2 Brads
- 4 Lights
- 4 Batteries
- Glue
- Electrical Tape
- Scotch Tape
- Small piece of foam board or cardboard

<u>You will need these Tools too</u>:

- Hole punch
- Scissors
- Wire Strippers
- Ruler
- Paint brush
- Pencil/pen

<u>Optional Craft Items:</u>

- Glitter
- Buttons
- Pipe Cleaners
- Markers

Follow these Steps to make your light-up tree!!!

1. Measure the diameter of the Paper plate. Then, Mark the center of the plate with your pencil.

2. Using the center mark you will cut a ¼ piece out of your paper plate.

3. Paint the bottom side of the paper plate

4. Wrap and overlap the edges of the paper plate to create a cone shape and lightly tape.

5. Mark where you would like to put your lights on your tree. Fold your plate lightly in half where your marks are. Use the hole punch to make a hole where your lights will go through.

6. Once you have your holes, reshape your paper plate into the cone again, overlap the edges to make a nice tree shape, and glue the edges together.

7. Now you can decorate your tree how you wish! Use markers, buttons, paper, pipe cleaners or any other craft materials you can find to decorate your tree. Have fun with this!

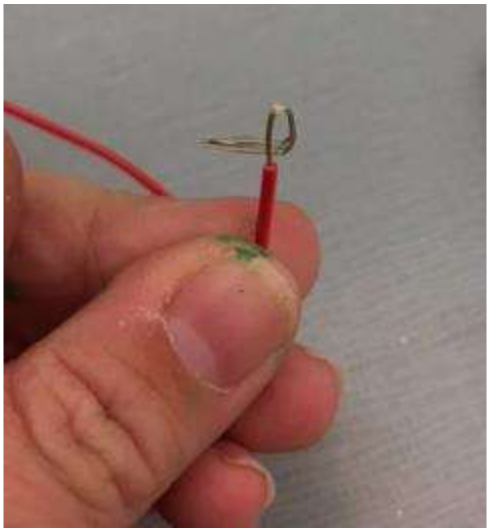
8. Once your tree is decorated, cut a small piece of the tip of your cone off so you have room for a top light to go through. (See the pictures below)

Let your tree dry. While you wait, let's begin making our switch and circuit for the lights.

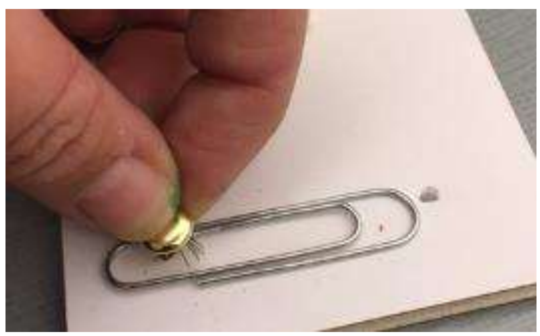
9. You will need to strip your lights' wires and also the extra wire on the ends (Only enough to twist the wires together and make a good connection: Approximately an inch.)

10. Connect your 4 lights with extra wire connecting the lights together by twisting the bare wire together and taping them together with electrical tape. (See images below)

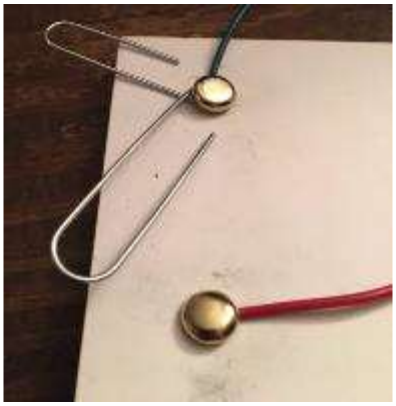
11. Make a small loop on both ends of the exposed wires in your light circuit. Then put one of the “legs” of a brad through one wire loop. Repeat with the second brad and the other wire loop.

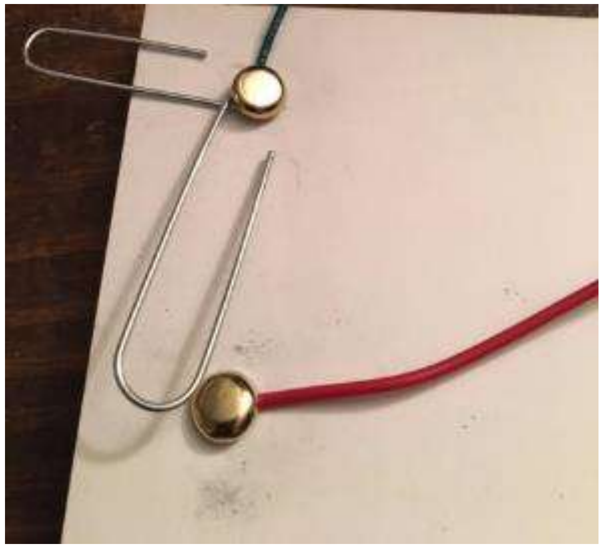


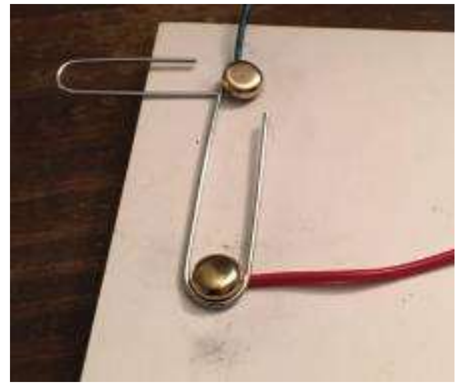
12. Using the foam/ cardboard piece as a base for your switch, put the brads with the wires connected to them, into the foam board the length of your paperclip apart from each other.



13. Twist the paperclip pieces until they form an “l” shape around the brad on the left. Make sure the paperclip goes under the brad and makes contact with the wire. The larger end of the paperclip should not go around the brad yet!



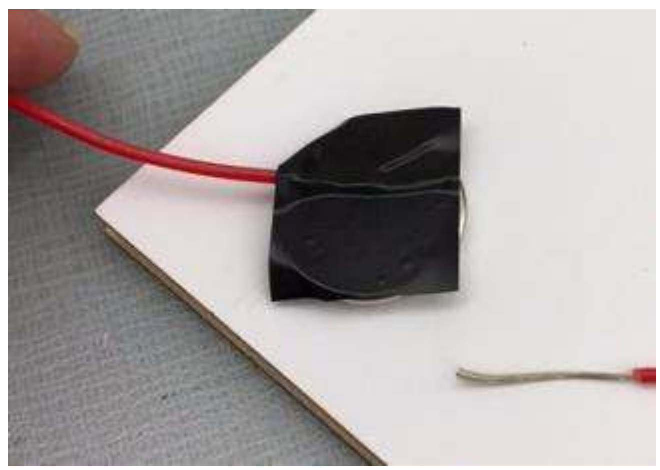




When the paperclip is not touching the brad, your light circuit is not complete and so the switch is "off," as seen in this picture.

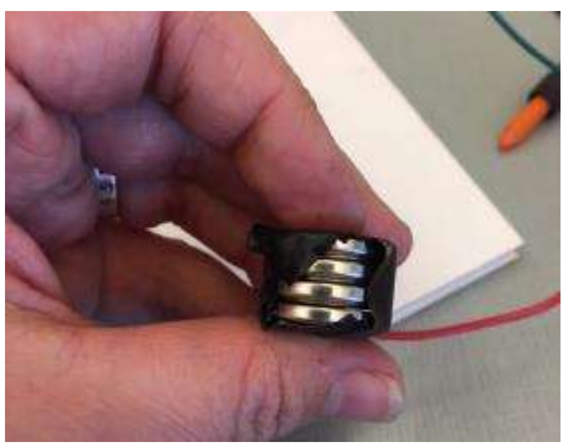
When the paperclip touches or goes around the brad, the circuit is closed, making the lights work! (See picture above!)

14. With one of your batteries, identify the positive and the negative side (positive has "+" and negative has "-". Pick one side and tape one of the wires from your lights to the battery using electrical tape.

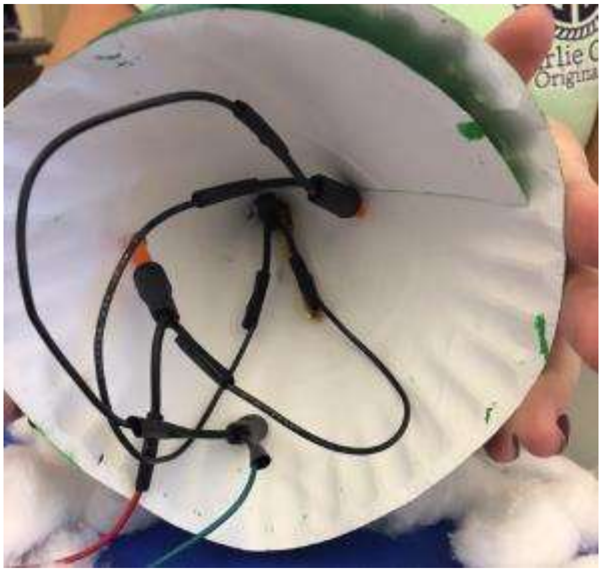



15. You will then continue to add the 3 other batteries. For the batteries to power your lights correctly, you must put the positive against negative or negative against positive to conduct power. On the very last battery, you will tape the other side of your wire of lights to it.

16. Tape all the batteries together.

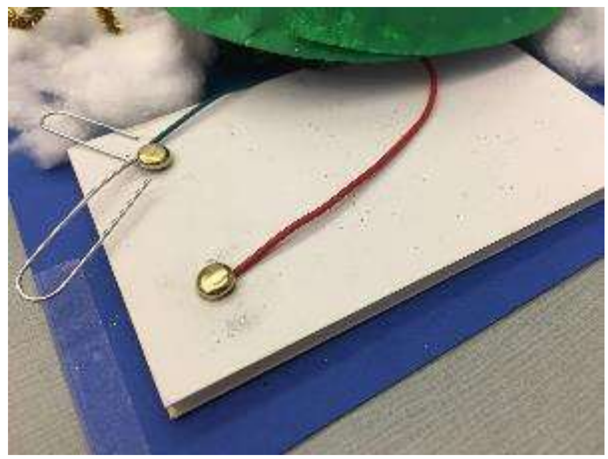


17. Test your switch to make sure all of your bulbs light up correctly! Yay lights!!



18. Turn off the switch so you don't burn out the lights! Pull the lights through the holes, making sure that one light is through the top. Push the wires up into the tree so they are hidden!

19. Use scotch tape to tape the switch plate in one corner of the piece of cardstock.



20. Put the tree in the middle of the cardstock. Do not glue the tree down! Glue cotton balls around the tree and add any other embellishments you want around the tree! Turn on your switch and marvel at your genius! Pretty lights!!!

Sara Grace Inman

Helen Musial

Holiday Themed Electricity Assignment

Title: Twinkling Turkey

Discipline unit: STEM

Big ideas: Students will learn about the different parts of circuits and how to put them together to create a product (by following technical procedural steps)

Materials/ resources:

- Construction paper
- Scissors
- Glue stick
- Pen
- Wire cutters/ stripper
- 4 lithium 3V batteries
- 2 wires
- 3 orange Christmas lights
- Masking tape
- Electrical tape
- Metal backing tape

Content information

Electrical circuits

- Electrical current: the flow of charge
- When the switch is connected, electrons will flow from the positive end to the negative end
- The battery supplies a force that pushes the electrons through this electrical circuit

Twinkling Turkey Technical Procedural Instructions

1. Trace hand on brown piece of construction paper
2. Cut out
3. Choose how you are going to decorate the turkey using colored construction paper/ crayons/ markers
4. Measure the width and length of the palm of your hand. Record measurement for later use
5. Get out 4 lithium 3 V batteries, 2 wires (different colors), 3 orange Christmas lights, electric tape, and metal backing tape
6. Cut a inch and a half long by half inch wide piece of metal backing tape, and attach to a white piece of paper
    a. Cut in half
    b. Connect halves with electrical tape

7. Get black wire and cut to length that matches measurements of palm
8. Strip half inch of wire on both sides
9. Connect one end of wire to left side of switch with metal backing tape

10. Get 3 orange Christmas lights and strip half inch from each end of wire
    a. Twist the three of these together so they are all connected

11. Take far left light and connect to the right side of the switch using metal backing tape

12. Take red wire and cut to appropriate length
13. Strip half inch of wire on both sides
14. Twist and tape together the far right side Christmas light with red wire

15. Attach red wire (open end) to the positive side of one battery
16. Attach black wire (open end) to negative side of one battery
17. Stack the 2 remaining batteries (positive ends to negative ends) between the two used batteries.
18. Tape them all together using electrical tape

19. Test your circuit

20. When you find that it is successful, weave lights between fingers and attach to turkey back using masking tape (make sure the circuit is not visible from the turkey's front)
21. Pinch switch to make turkey turn on

Katie Jones and Morgan Kazanovicz

Title: Help Light the Way for Santa's Sleigh!

Big Ideas:

Understanding simple circuits

Understanding how a switch works to complete a circuit

Follow step by step procedures to complete a experiment

Scenario: Last Christmas Santa and his reindeer got in some serious trouble. As you now know, they ran over someone's grandma! Now, the elf patrol is forcing Santa to take better precautions this Christmas Eve. Santa's sleigh is now required to have working headlights. It is your job to help him rewire his sleigh to meet protocol.

Challenge: After being introduced to basic circuits and switches by watching a short video, students will follow the step by step guide to create a sleigh with headlights for Santa. The students will be able to decorate the sleigh as they choose and will test their sleigh's circuit to make sure it works.

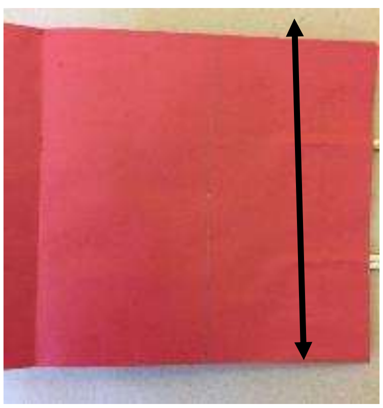
Materials: (per pair)	**Tools:**
10" x 8" Gift Bag With Handle (1)	Scissors
Electrical Tape (4 inches)	Wire Cutters
Aluminum Tape (4 inches)	Wire Strippers
Lithium 3 Volt Batteries (4)	Ruler
Christmas Lights (2)	Single Hole Punch

Electrical Wire (15 inches)	Hot Glue Gun and Hot Glue Sticks
Paper Clips (2)	
Metal Paper Fastener (1)	
Miscellaneous Christmas Decorations for sleigh such as: pipe cleaners, garland, markers, stickers etc.	

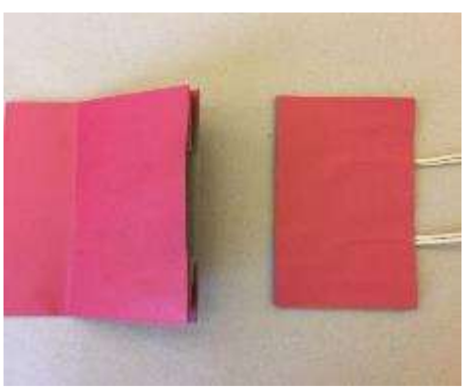
STEP-BY-STEP CONSTRUCTION

1. Measure 4 inches from the middle fold.

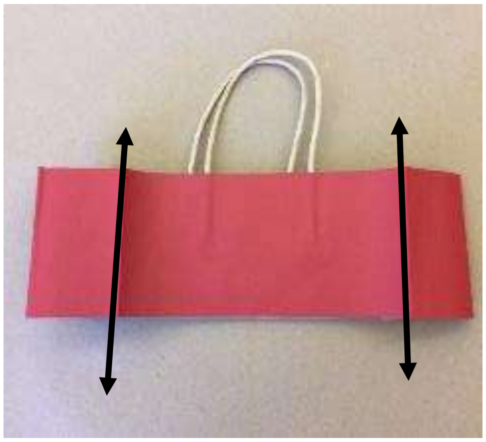
2. Draw a line at your 4-inch mark, parallel to the fold.



3. Cut along the line**.**

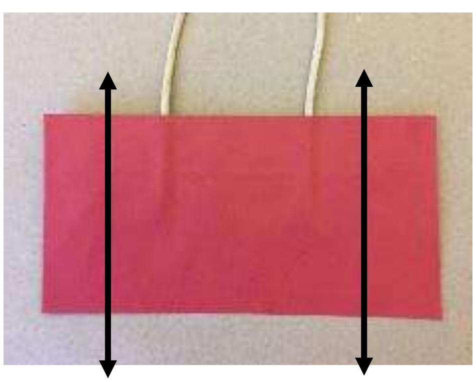


4. Take the handle portion of the bag and cut along the two front folds.

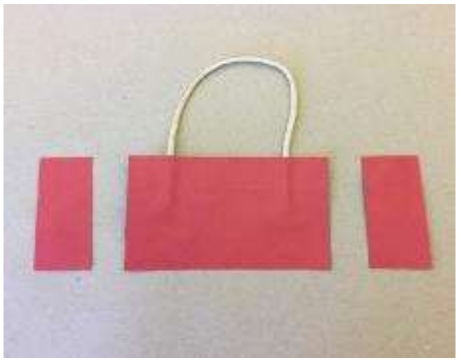


5. Measure 1 inch from the handle on both sides.

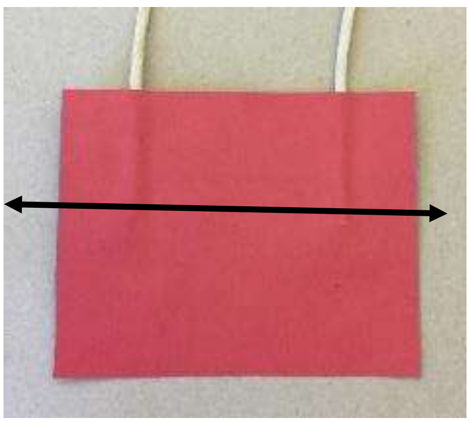
6. Draw a line at each of your 1 inch marks, parallel from the sides.



7. Cut along the two lines**.**

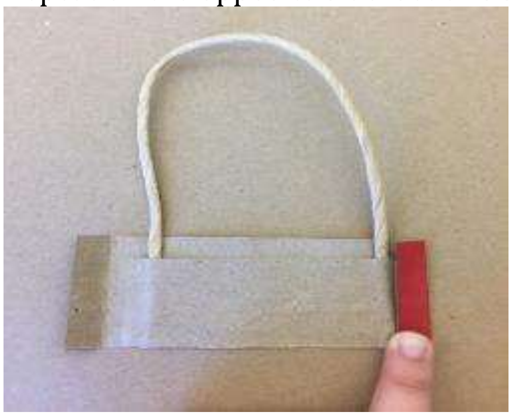


8. Using the bottom of the handles as a guide, draw a line parallel with the top of the sack.

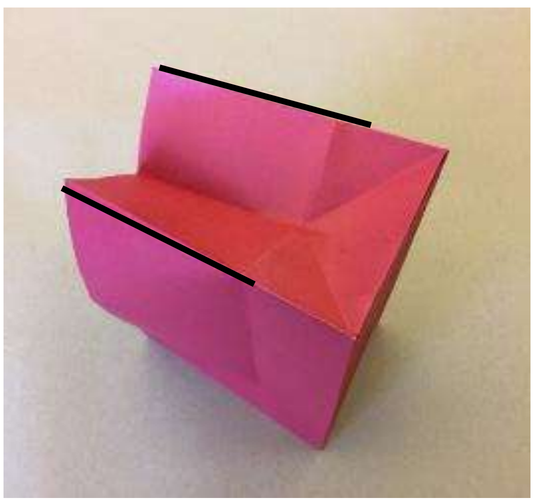


9. Cut along this line. Your handle section should now be split into 4 pieces.

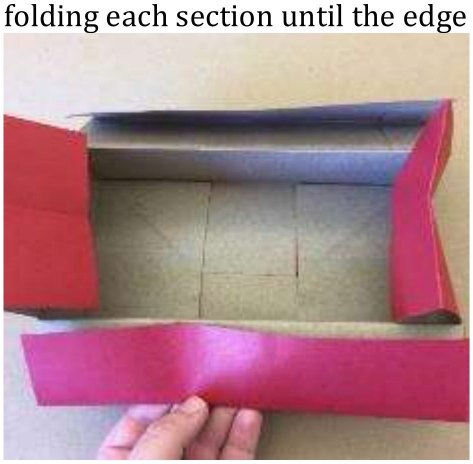
10. Using the handle section, fold over the side edge until it meets the edge of the handle. Repeat on the opposite side. Set this section aside.



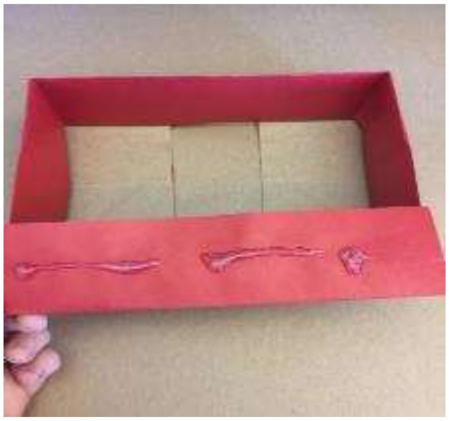
11. Taking the bottom section of the sack, cut down the 4 side folds until you reach the middle fold.



12. Fold each of the 4 cut sections in half, towards the inside of the sack. You should be folding each section until the edge meets the middle fold, not the bottom of the sack.



13. Using the hot glue gun, add glue to a long folded section. Fold this section inward again to glue the side down. Repeat this step with the remaining 3 sides.



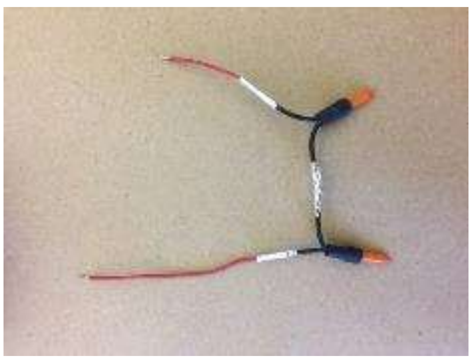
14. Using the hole punch, punch 2 holes in one of the narrow sides of your sleigh. These holes will be where you will place the headlights.

15. Use the wire strippers to strip a ½ inch of plastic off the four Christmas light ends.

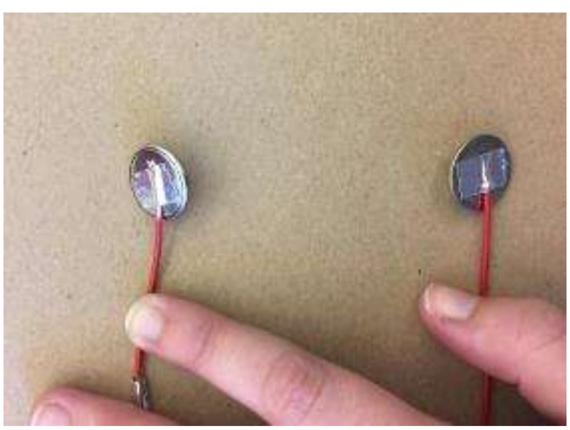
16. Connect the two Christmas lights together with a piece of aluminum tape. Make sure the exposed wires touch.

17. Cut two sections of wire to at least 2 inches long. Strip each end of these wires.

18. Connect a wire to each exposed end of the Christmas lights using the same method used in step 16.

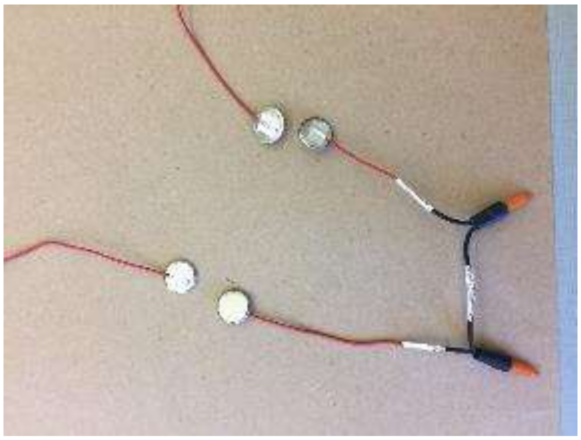


19. Use the aluminum tape to attach the two remaining ends of the red wires to one battery each. Remember that one wire should be attached to the positive end of a battery and one should be attached to a negative end.

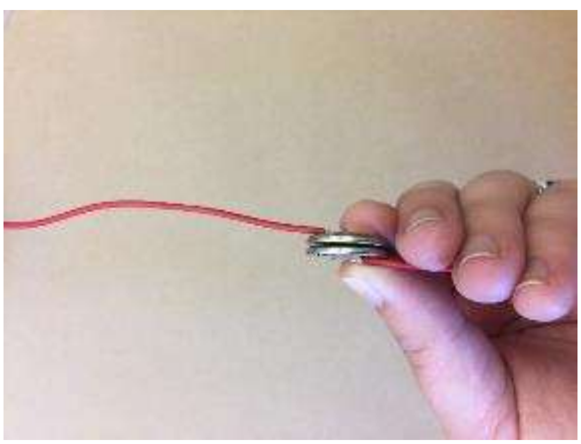


20. Cut the remaining section of red wire into two equal pieces. Strip a single end off both wires.

21. Using the two wires from step 20, repeat step 19 to attach a battery to each wire.



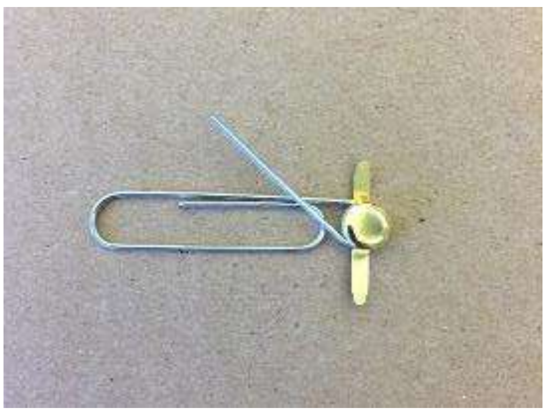
22. Press a battery from step 19 to a battery from step 21. Repeat with the remaining two batteries. Remember to connect the batteries positive to negative.



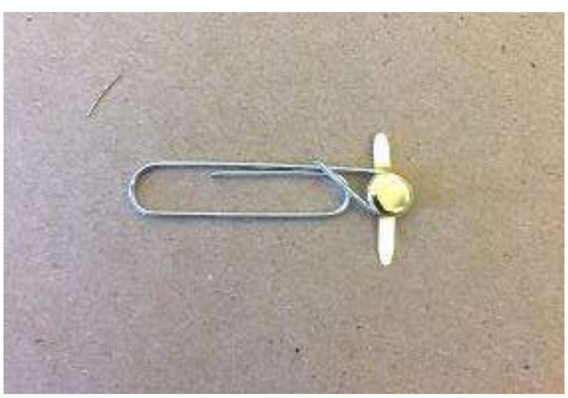
23. Use electrical tape to secure each pair of batteries.

24. Attach your incomplete circuit to the sleigh by adding hot glue to the Christmas lights and placing the lights into the prepared holes. Use electrical tape to secure the wires to the sides of the sleigh.

24. Bend one paper clip around the metal paper fastener to create one end of your switch.



25. Use the wire cutters to cut the tail end off of the paper clip.



26. Glue this portion of your switch to the back inside of the sleigh.

27. Strip the right wire and use aluminum tape to attach the wire to the cold portion of your switch.

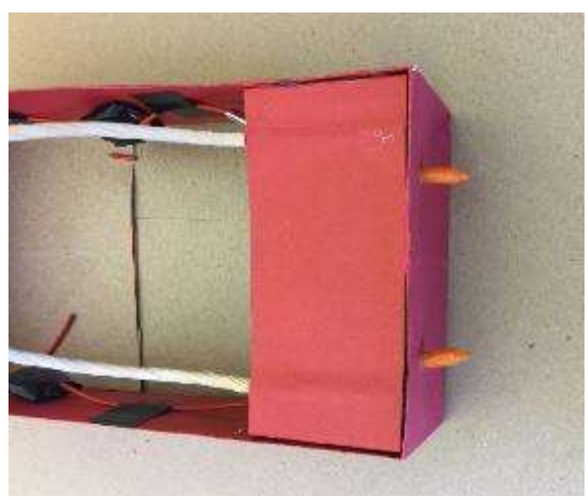
28. Use the wire cutter to cut a small portion off of the second paper clip. Bend this section into a hook.

29. Cut and strip the remaining red wire so that the exposed section can touch the switch.

30. Use the aluminum tape to connect the exposed wire to the small metal hook you made in step 28.

31. Test your switch and cover the exposed aluminum tape with electrical tape.

32. Glue the prepared handle section from step 10 over the headlight portion of your sleigh.



33. DECORATE!

Sierra Logan
Brooke Mabeus

Electricity Circuit Angel

Materials:

- 1 Styrofoam Cone
- 1 Styrofoam Ball
- 1 Set of Google Eyes
- Colored Construction Paper
- Bag of Doll Hair
- 3 Diols
- Glitter Paper
- Wing Template

Other Material Options:

- Tissue Paper
- Glue
- Glitter

Tools:

- Spoon
- Scissors
- Hot Glue Gun (for younger students, teacher use only)
- Electrical Tape
- 4 Batteries (3 Volt)
- 4 Christmas Lights
- Paper Clip
- Wire Strippers

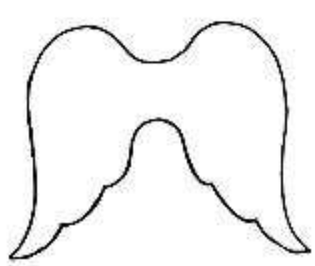
****Safety Precautions****
Will go over safety instructions about how to use a hot glue gun with older students. Younger students will need the teachers help before using the hot glue gun.

Step-by-step Instructions:

Step 1: Using your spoon, carve out the inside of the Styrofoam Cone.

Step 2: Fold Doilies in half and layer them together. Have your teacher hot glue them on the cone.

Step 3: Cut out wings with construction paper or glitter paper using the wing template. Using your teachers help, hot glue them to the back of the cone.



Step 4: Using the hot glue gun and your teachers help, glue the googly eyes and hair to the Styrofoam ball.

Step 5: Using the hot glue gun, glue the head onto the cone.

Step 6: Strip the wires to the Christmas lights. Then wrap the wires from each light around each other, leaving one end open. Then using electrical tape, cover the wires.

Step 7: Gather your 4 batteries and tape them together, leaving the two round ends uncovered. All of the batteries need to face the same direction when stacked like shown.



Step 8: Tape one end of the untapped wires to one round end of the batteries. Wrap the other end around one end of the paper clip and tape it.

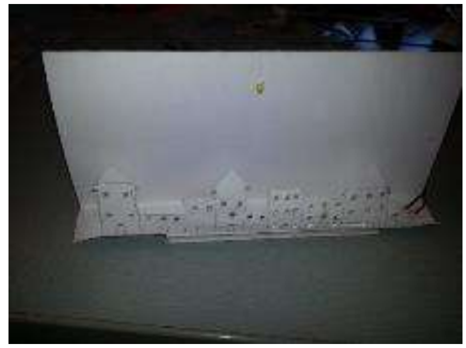

Step 9: Push the bulbs of the lights through the cone from the inside so just the tip is showing through. The end of the batteries that does not have anything on it should be facing down.

<u>Step 10:</u> Open one end of the paper clip a little bit and poke it through the bottom of the cone so when you set the angel down, it will touch the other end of the batteries.


<u>Step 11:</u> Set your angel down and watch it light up! ☺


Backlit City

David Parkes



Step 1:

Using a standard sheet of paper and ruler, mark the points at which the paper will be folded.

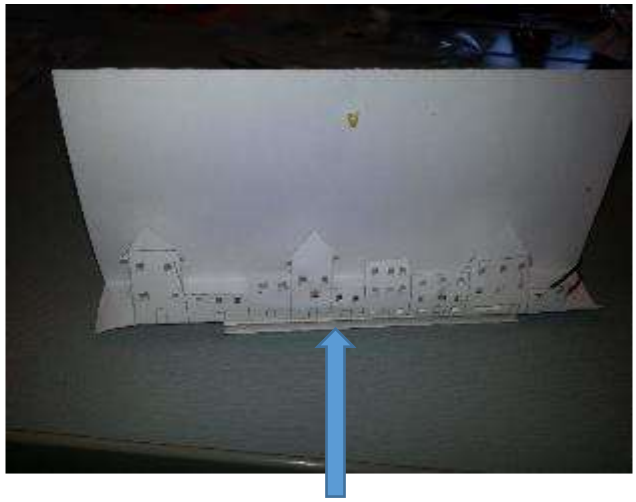
These point should be made at 2”, 3”, 6”, and 9” on the edges of the paper.

After point are marked fold paper and tape the bottom of your scene together as shown in picture.

The middle peak is the back drop and the front fold that is about 1” shorter than the peak is the front scene. You will cut out your scene. It could be a town, Christmas tree, presents, whatever you want within reason.

Step 2:

Cut out your scene using scissors. It could be helpful to draw it first.



Feel free to color your scene however you like and also the backdrop.

For instance I could have drawn a mountain scene in the distance on my back drop.

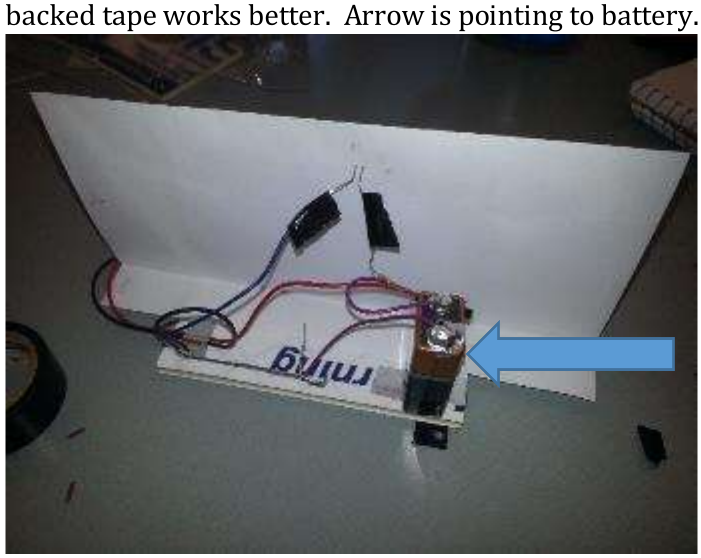
Step3:

Tape your scene down to a piece of card board or foam board. This will make for a good base to mount the electrical hardware on. The arrow shows the foam board I used

Step 4:

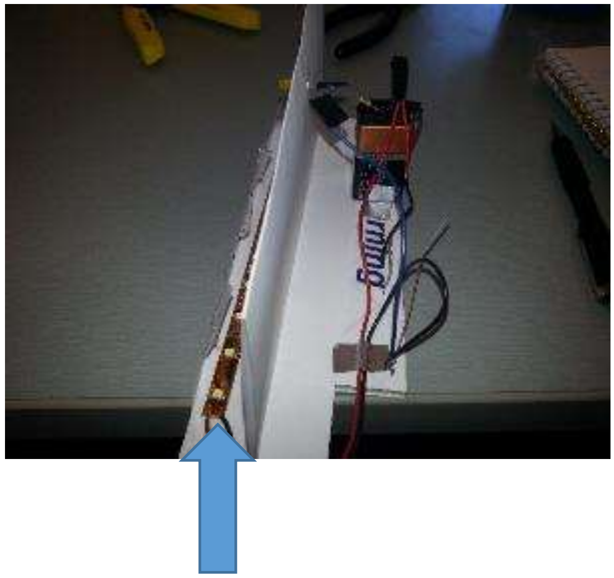
<u>THE POWER</u>

Tape a 9 volt battery down to your base using electrical tape or foil backed tape. The foil backed tape works better. Arrow is pointing to battery.



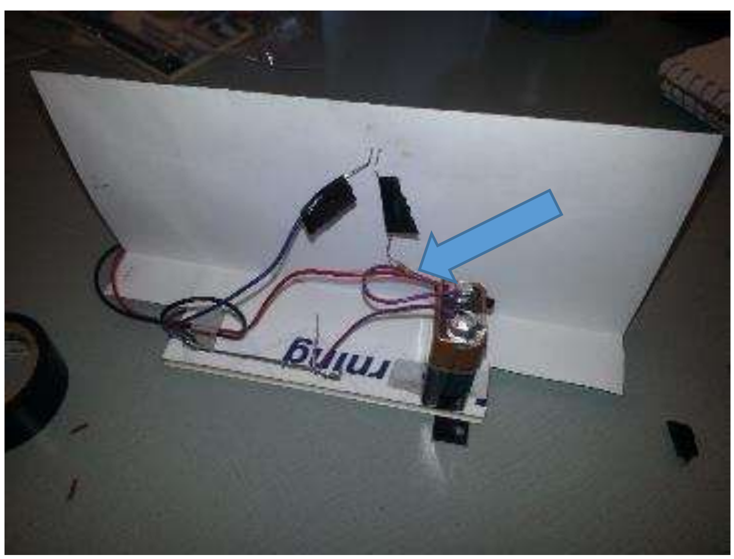
Step5:

Peel the back of the light emitting diode (LED) strip and sick the strip behind your front scene. The arrow shows where it should be located.



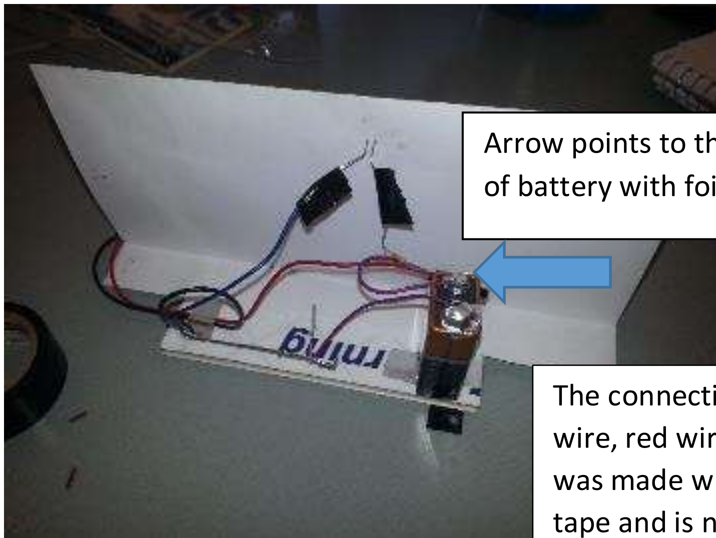
Step 6:

Poke a led through the front of the back drop this will be a star. Using electrical tape attach one side of the resistor to the long leg of the LED that was just pushed through the paper. The arrow show the resistor.



Step 7:

Run a wire from the positive side of the LED strip to the other end of the resistor as well as a wire from the positive side of the battery. Use foil backed tape to connect the positive wire to the positive side of battery and electrical tape to make connection of the two wires and resistor.



Step 8:

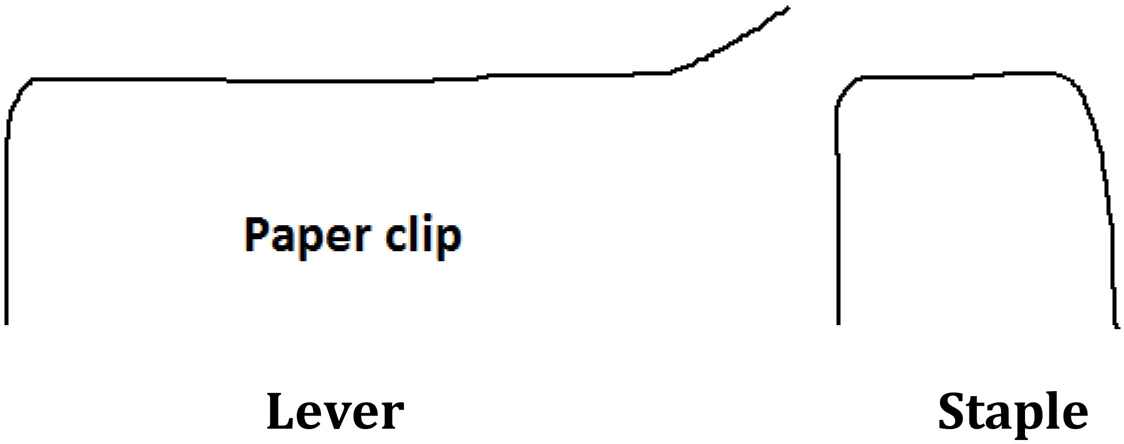
Connect a wire from the short leg of the single light that was poked through the backdrop using electrical tape. Connect a wire to the negative side of the LED strip and twist it together with the wire that was just attached to the single LED.

Step 9:

<u>Making the Switch</u>

Bend and shape a paper clip to make these two parts they will make the switch required.

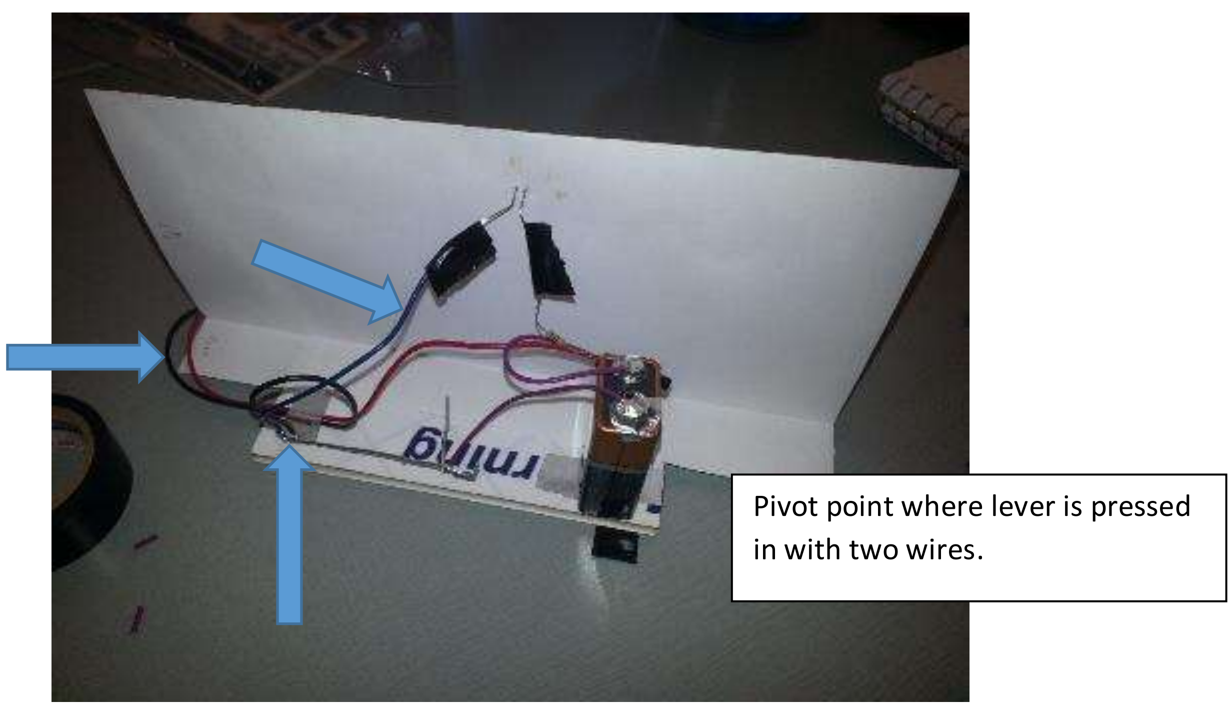
The height of the bend should be close to the same height as the staple shape, as shown. (Next page)



Note: A switch is a place in a circuit where the transfer of electrons can be stopped simply by opening the circuit like shown above. A closed switch would have the lever actually touching the staple so that electrons can flow through the circuit. The switch we are making has a lever that pivots allowing the connection to be made or broken at the staple.

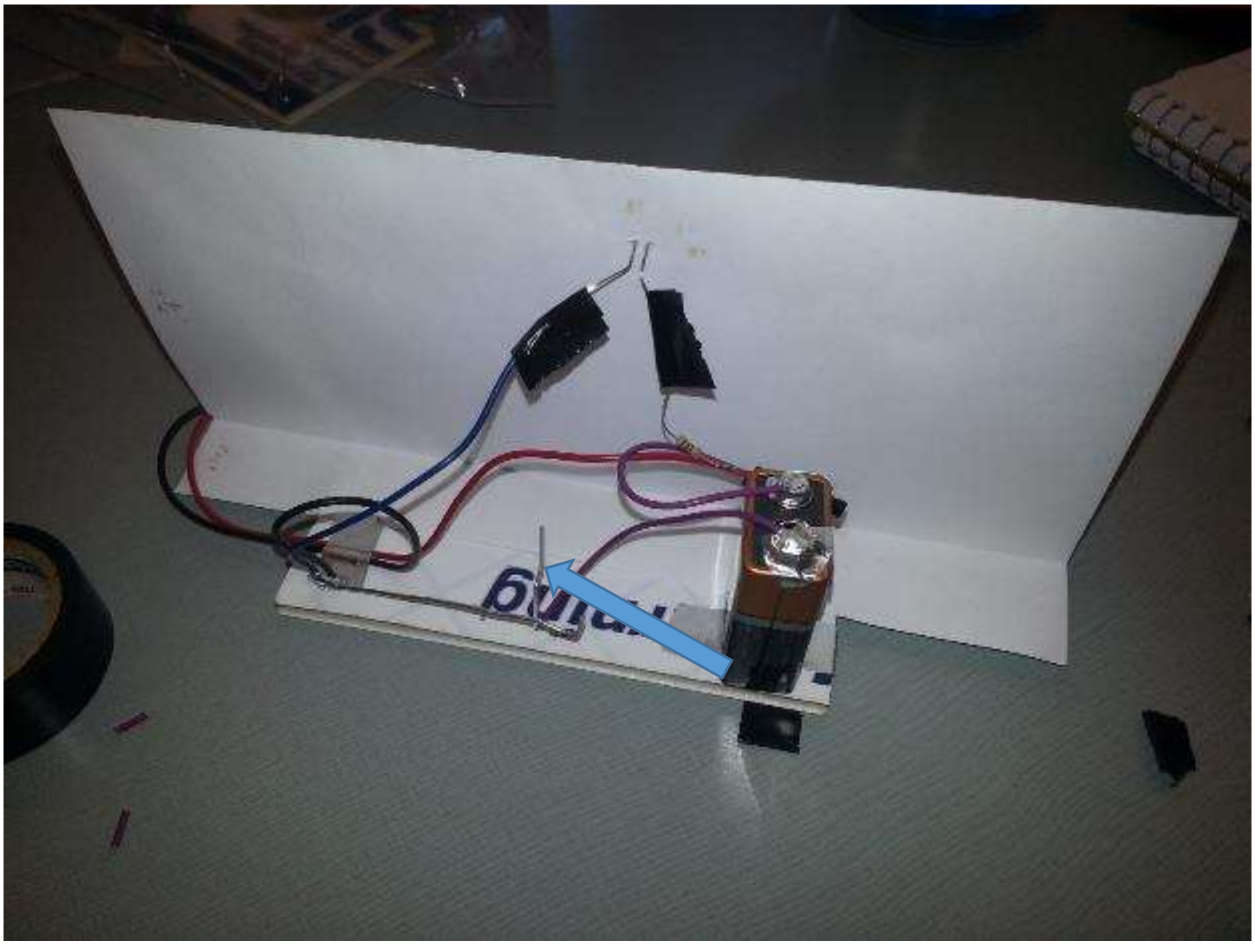
Step 10:

Poke the short leg of the lever into the base and then remove it. Form the two negative wires to a point and insert them into the hole made by the lever. Then press the lever into the hole with the wires



Step 11:

Press staple in perpendicular to lever and close enough so that the end of the lever can sit on top of staple. Then remove the staple. Connect a wire to the negative terminal on the battery using foil backed tape and insert the other end of the wire into one of the holes made by the staple. Then pressed the staple into the same holes with the wire. This will make for a good connection.



To open the circuit pivot the lever off of the staple. To close the circuit pivot the lever to touch the staple.

Trouble shooting:

If lights are not working check the connections made. If the wires are not touching the current of electrons cannot flow through the circuit. Electrical tape is an insulator if the wires are not touching in the connection made with electrical tape the current ill stop.

Check Battery.

Lighting the Christmas Tree

Grade

4th grade

Big Idea

Electricity (electrons) must travel through a closed electrical current for a light bulb to ignite.

- Electrical Current- a flow of charge
- Electron flow from the anode(positive) to the cathode(negative)
- A switch is used to stop the flow of electricity with a break in the circuit. When the switch is closed, the circuit is complete--allowing the electricity to flow appropriately.

Standards

Science Standards:

4PS3-2 Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

Technology and Engineering:

STL 12: Students will develop the abilities to use and maintain technological products and systems.

D. Follow step-by-step directions to assemble a product.

E. Select and safely use tools, products, and systems for specific tasks.

STL 16: Students will develop an understanding of and be able to select and use energy and power technologies.

C. Energy comes in different forms

D. Tools, machines, products, and systems use energy to do work.

Mathematics:

MP.2 Reason abstractly and quantitatively (4-ESS3-1)

MP.4 Model with mathematics (4-ESS3-1)

Materials

PER GROUP

To construct the circuit	To construct the tree	Decorations Ideas **(Optional)**
Wire cutters/stripper	Scissors	Markers
Aluminum Tape	Scotch tape	Glitter
1 inch strip of electrical tape	(1/2) Toilet paper roll	Glue
(1) 6 inch Red copper wire	(1) Christmas tree cutout; listed below	Construction Paper
(1) 2 inch Black copper wire	(1) 3 inch x 4 inch Foam board	Jewels
(2) Coin Lithium Batteries	Gallon Zip-lock bag	Pom Pom balls
(2) ½ inch nails		Tinsel
(1) Standard paper clip		*Whatever materials you have available*
(1) Christmas light bulb		

Preparation

Organize the materials into bags for each group of the students. The decoration materials for the finished Christmas tree can be rationed to each group or out for students to grab as needed.

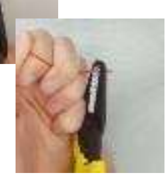
Procedures

1.) Build the Circuit

a. Using very thin strips of electrical tape, tape your batteries together with the negative side of the first battery touching the positive side of the second battery. Leave plenty of the battery's face uncovered by the tape. Set aside.

b. Cut the red wire into two sections: a 2 inch section, a 4 inch section.

c. Strip ½ inch off each end of each red wires



   1. To strip, place wire (½ inch from the end) in the Wire Stripper on the smallest groove. Squeeze handles shut and pull off the end of the wire coating.

d. Strip both ends of the black wire (½ inch from the end). Set aside.

e. Strip both ends of the light bulb wires (½ inch from the end). Set aside.

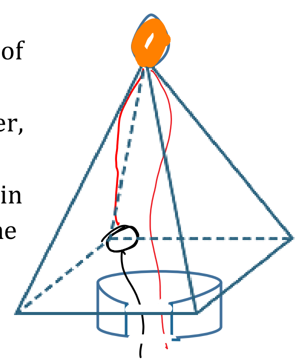
f. Using your aluminum tape, attach the 4 inch red wire to one nail, and the black wire to the other nail.
   a. Be sure not to have any wire exposed.
   2. Be sure to have the wire directly on the nail before you tape them together.

g. Attach the other end of the 4 inch red wire to the light bulb with your aluminum tape.

h. Attach the 2 inch red wire to the other wire on the light bulb with the aluminum tape.
i. Moving to the black wire, tape the free end to the negative side of the battery. Be sure to firmly secure the open wire on the battery.
j. On the positive side of the battery, tape down the open end of the 2 inch red wire with aluminum tape. Again, be sure to have the wire firmly taped to the negative side of the battery.
k. Touch both nails to your paper clip to test your circuit. Your light should come on!
   1. If your light does not come on, go back and squeeze all taped together sections to ensure a good connection.

2.) Build the Tree

a. Cut one line through the toilet paper roll, so that it can be opened wider. Set aside.
b. Cut out the Christmas Tree cutout.
c. Fold in half, and cut out the white hole in the center of the square. Unfold.



d. Next, tape 3 of the triangles on the Tree Cutout together, leaving one triangle free.
e. Pull the light bulb on your circuit up through the hole in the bottom of the tree cutout and up to the top of the tree. The light should poke past the tip of the tree.
f. Tape up the last triangle of the tree, closing the tree (it should be a 3D pyramid now).
g. Tape around the light bulb and paper securely so that the pyramid is completely closed and the light bulb is secure.

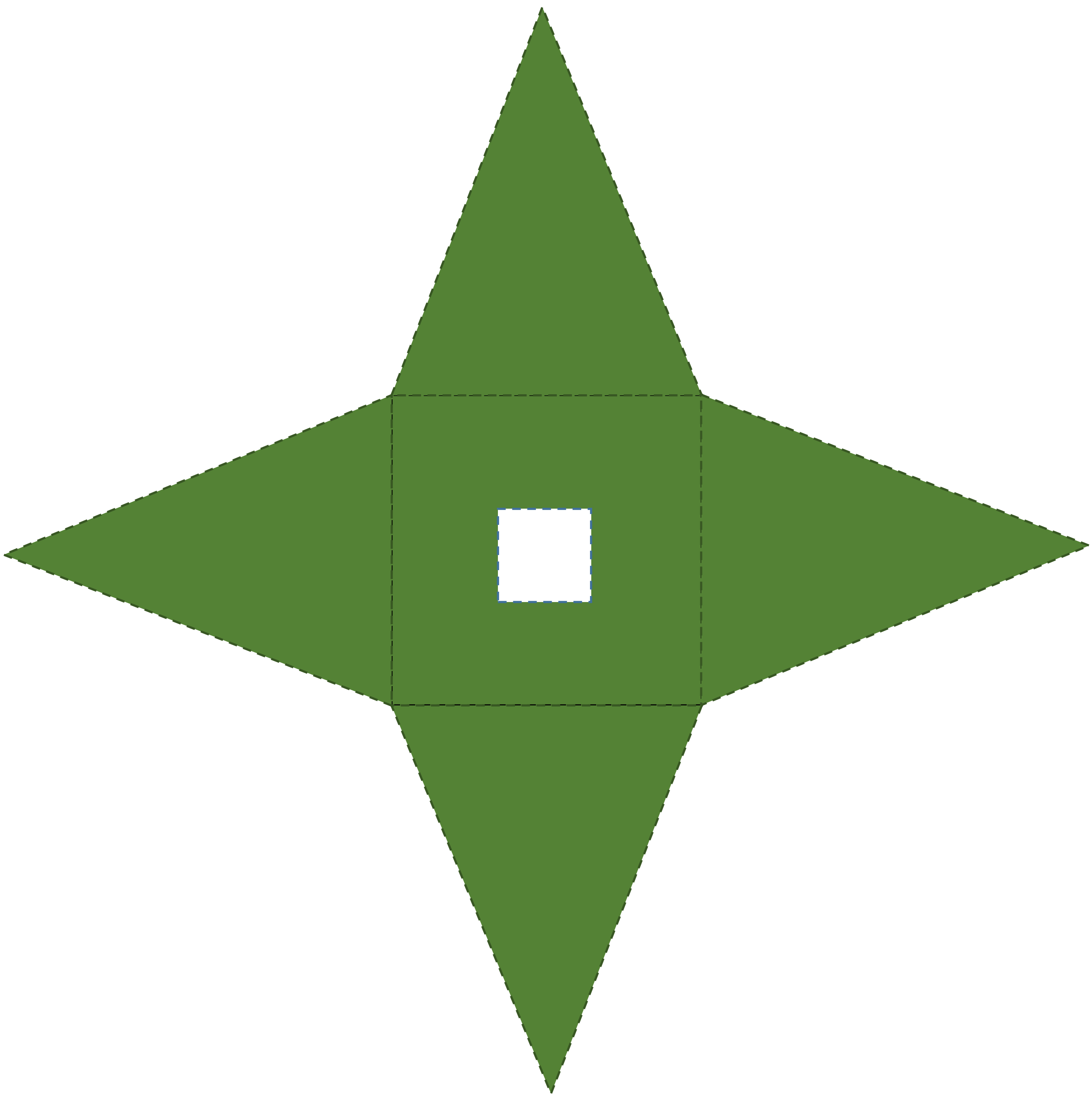
h. Place your tree on top of the toilet paper roll and tape together. Be sure the toilet paper roll is widened so that there is room for you to work inside the tree.
i. Be sure to have the nail end of the wires hanging through the tree, past the toilet paper roll.

3.) Build the Switch

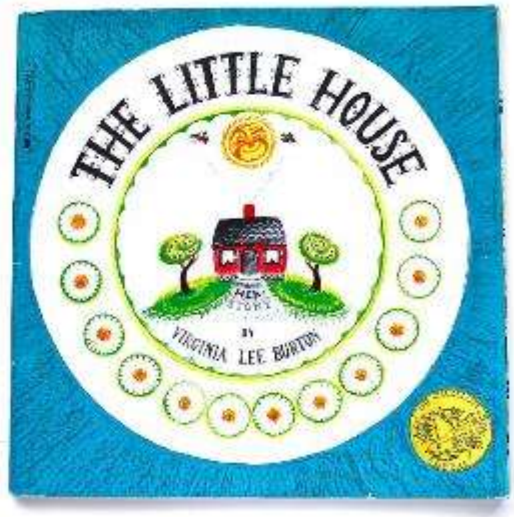
a. Place your nails through the foam board so that they fit just inside the toilet paper roll. The tree should be standing straight on the foam board, secured by the nails.
b. Tape the toilet paper roll to the foam board, for extra support.

c. Slip the paper clip around one of the nails.
d. Test your switch by pushing the paper clip against the other nail; if the paper clip is touching both nails, then the light should come on!
e. You are finished, now decorate your tree! (optional)

CHRISTMAS TREE CUTOUT



Narrative Curriculum



The Little House Narrative Curriculum Challenge

Lily Alexander

Constructing a Bridge

Title: Help Little House!

Disciplinary Area: STEM

Grade Level: 1st- 2nd

Literacy Connection: *The Little House* by Virginia Lee Burton

STEM Content Standards:

Science:

Next Generation Science Standards: PS1.A Structure of Matter

Matter exists as different substances that have observable different properties. Different properties are suited to different purposes. Objects can be built up from smaller parts.

Technology and Engineering:

Standard 9: Students will develop an understanding of engineering design.

-Benchmark A: The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.

-Benchmark B: Expressing ideas to others verbally and through sketches and models is an important part of the design process.

Standard 11: Students will develop the abilities to apply the design process.

-Benchmark A: Brainstorm people's needs and wants and pick some problems that can be solved through the design process.

-Benchmark B: Build or construct an object using the design process.

-Benchmark C: Investigate how things are made and how they can be improved

Math:

AR.Math.Content.1.G.A.1

-Distinguish between defining attributes (e.g., triangles are closed and three sided) versus non-defining attributes (e.g., color, orientation, overall size); build and draw shapes to possess defining attributes

AR.Math.Content.1.G.A.2

-Compose two-dimensional shapes (e.g., rectangles, squares, trapezoids, triangles, half-circles, and quarter-circles) or three-dimensional shapes (e.g., cubes, right rectangular prisms, right circular cones, and right circular cylinders) to create a composite shape

Big Ideas:

- Correct use of the Design Loop/Design Process
- Using creativity to successfully build a structure
- Understanding that different objects can aid or hinder in the construction of a structure and affect how much weight can be held
- Basic understanding of weight and shapes
- Teamwork

Essential Question:

How can you design a bridge that holds a large amount of weight (2 pounds), so that the Little House can get back to the countryside?

Scenario:

Oh no! The Little House can't get back to the countryside without crossing a rackety old bridge. Unfortunately the Little House is too heavy for the old bridge and she needs our help to build a new bridge that will support her weight. Since the truck that is carrying the Little House is so heavy too, the bridge needs to be extra sturdy. Help the Little House be happy again, and the team that creates the bridge that can hold the most weight wins!

Challenge:

After reading The Little House together as a class, the students will be challenged to construct a bridge that will hold the weight of the truck and the Little House using the materials provided. They will each work with a partner (2 students per group) and complete worksheets before to brainstorm ideas and better their understanding of what is asked of them.

Tools, Materials, and Resources:

Each set of partners will receive the following materials:

- 8 Popsicle Sticks
- 3 Toilet Paper Rolls
- Tape
- Scissors
- Ruler
- 2 Notecards
- 3 Straws
- String

- 1 Paper Cup
- 2 weights that represent the Little House and the truck carrying her

Content Information:

After reading the book as a class we will discuss what we know about weight, two and three-dimensional shapes as well as what we think makes a structure sturdy and reliable. They will expand this knowledge through the worksheets/design sheets given to them before they start constructing. Ultimately we will answer the following questions:

What are Two-Dimensional Shapes?

-A shape that has no thickness, it sits flat. Ex: squares, circles, triangles.

What are Three-Dimensional Shapes?

-A shape that has height, width, and depth, like any object in the real world. Ex: cylinders, prisms, cones.

What is weight?

-It is the amount of how heavy an object is. Ex: Sally weighed 73 pounds, or I drank 8 ounces of water.

Deliverables:

The students will need to deliver to me a bridge-like structure that they creatively built with the provided materials and show me that they understood what was asked of them. The bridge will need to be able to at least hold the two weights given to them, and the group whose bridge can hold the most weight overall will win a prize. The students will also turn into me their design process as well as the worksheet that expands their knowledge on the math skills applied.

Parameters or Constraints:

The boundaries for the students consists of the limited materials provided, they are allotted 50 min to complete this activity, the bridge must hold the weight of the Little House and the truck, and they must demonstrate and apply their knowledge of shapes and weight, as well as the design process.

Evaluation:

I will evaluate the students with a rubric that addresses all the areas in which the students need to show learning and understanding. I will also assess their use of teamwork by having them complete a partner evaluation so that one student is not left doing all the work or providing ideas.

"Little House" Rubric

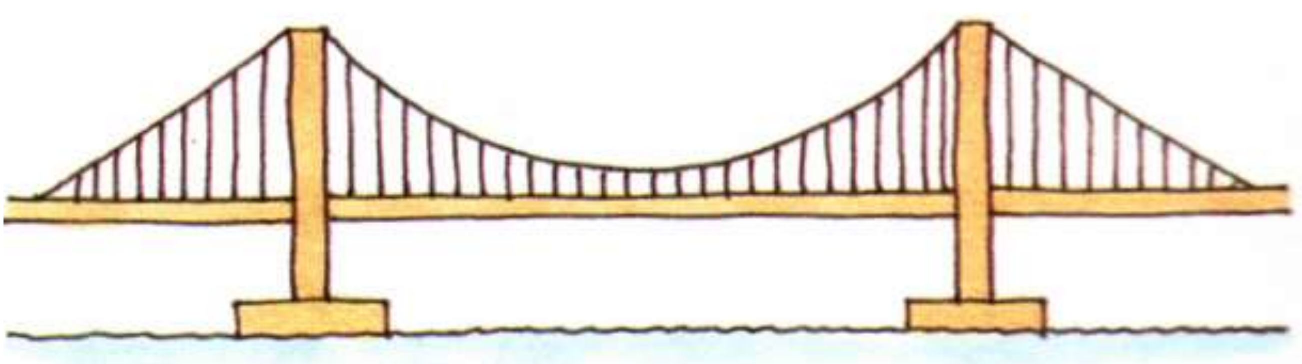
Group Members: _________________

Name of Your Bridge: _______________

Criteria of Your Bridge:

1. The bridge is capable of holding the Little House and the truck. __/15
2. You and your group member only used the materials given. __/10
3. You and your partner's design worksheets are turned in. __/15
4. You and your partner's shapes worksheets are turned in. __/15
5. The bridge is creative and unique. __/10
6. Your bridge follows the design process you established. __/10
    i. With revisions allowed and encouraged
7. Teamwork was used to create the bridge. __/10
8. You and your partner showed an understanding of weights and shapes. __/15

Total: __/100



Partner Evaluation

Your Name: _______________

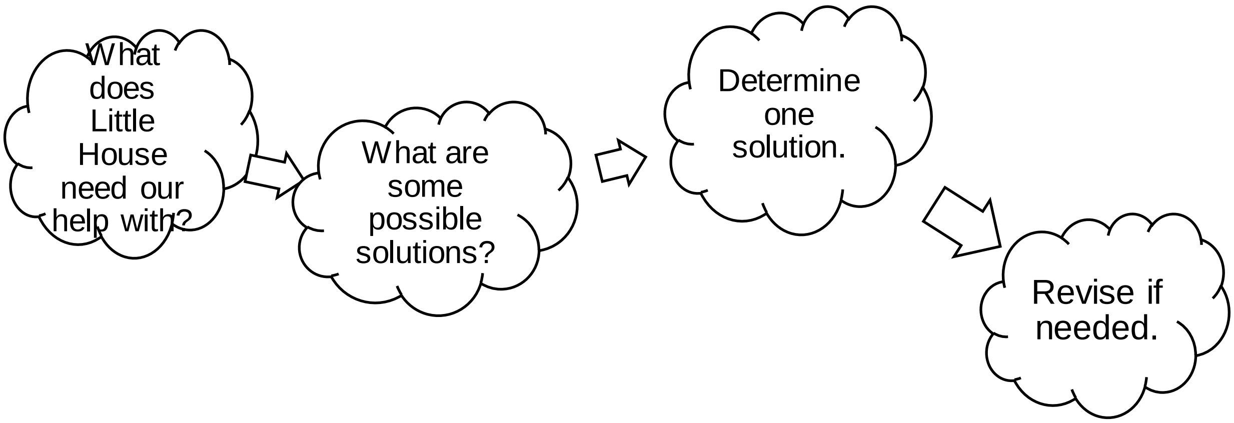
Partner's Name: _____________

Circle "Yes" or "No" for the following questions:

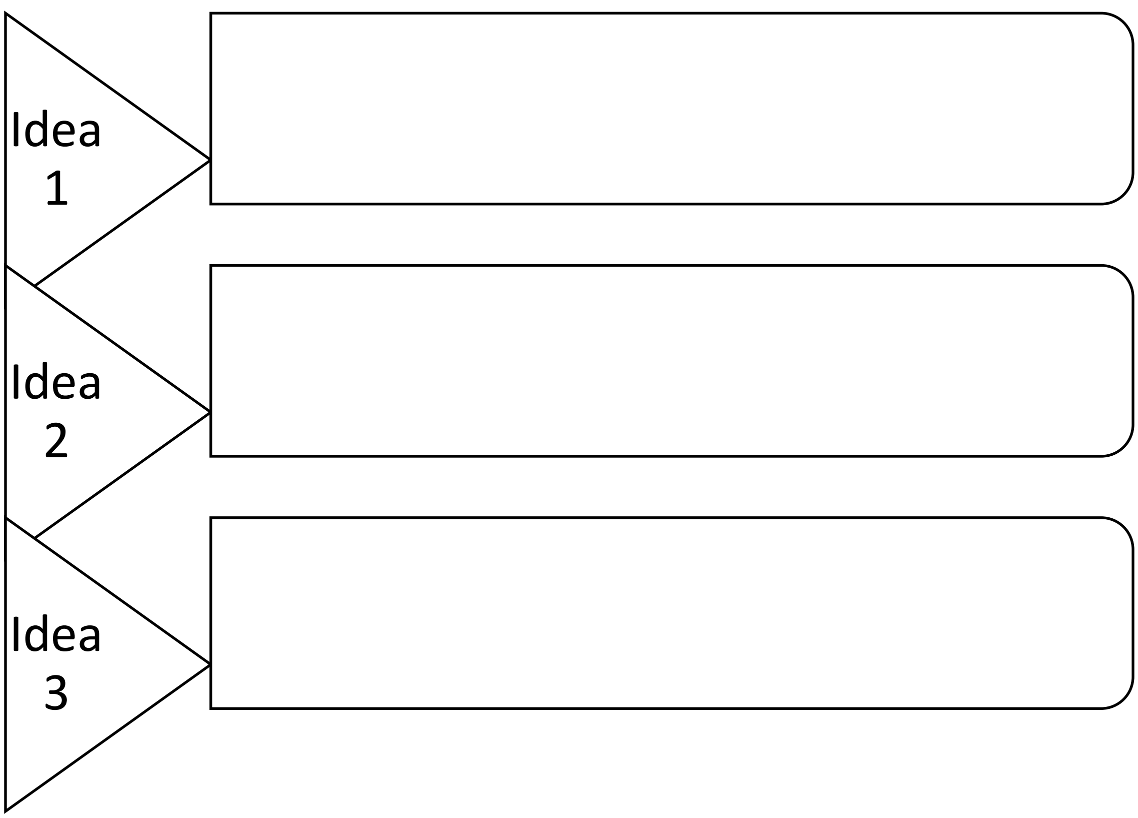
1. Was your partner kind and respectful? Yes/No
2. Did your partner offer ideas? Yes/No
3. Did your partner help clean up? Yes/No
4. Was your partner a team player? Yes/No
5. Did you and your partner understand the project? Yes/No

Design Your Bridge!

Below brainstorm some ideas and travel through the design process to help Little House!



Ideas for our bridge:



Weight and Shapes

1. Out of the provided materials below, which ones are two-dimensional?

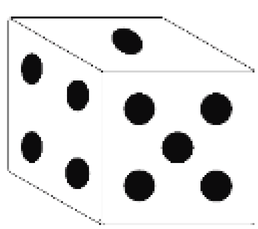


2. Out of the provided materials below, which ones are three-dimensional?



3. What is the difference between a three-dimensional object and a two-dimensional object?

4. What other shapes do you see in this three-dimensional object?



5. How would you define weight?

Student Copy

Help the Little House!

Situation:

The Little House is very sad because all around her the beautiful countryside has disappeared. She's crowded by all the hustle and bustle of the city and dreams of one day living out in the open air again. To her surprise a very nice lady is trying to help her! She's arranged a strong truck to pack her up and lead her out into the open fields. The only problem is that the old bridge cannot hold the weight of the Little House and the truck combined. Can you help the Little House by building a bridge that will support her and the truck?

Challenge:

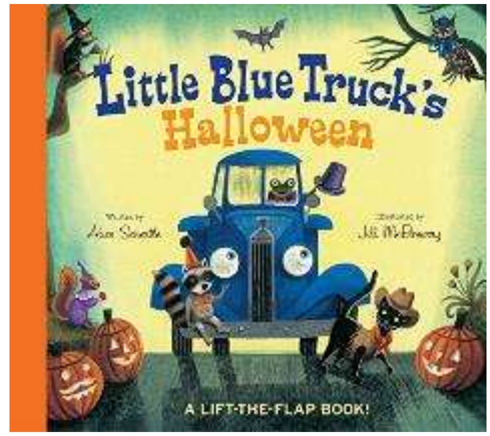
Before you begin brainstorming, test your knowledge on weight and shapes and how they will affect what you build. Complete the "Weight and Shapes" worksheet. Then before you begin building, brainstorm ideas that you think will make a sturdy, stable bridge. You will use the design process to help you pick out the best materials to build your bridge. Write or draw your ideas on the "Design Your Bridge!" worksheet. Your bridge must be able to hold the two weights labeled as "Little House" and "Truck." The group whose bridge holds the most weight will get to pick a prize out of the prize box.

Materials:

- 8 Popsicle Sticks
- 3 Toilet Paper Rolls
- Tape
- Scissors
- Ruler
- 2 Notecards
- 3 Straws
- String
- 1 Paper Cup
- 2 weights that represent the Little House and the truck (a total of 2 pounds)

You will have 50 minutes to complete this activity with a partner. Be sure to work as a team. Each team will share their creation with the class.

Teaching Instructions
Grade Level: 2nd
Disciplinary Area: STEM
Unit: Addition and Subtraction
Literacy: Little Blue Truck's Halloween by Alice Schertle
Content Standards:



Science/Technology
Next Generation Science Standards: K- 2-ETS.1-1: Engineering Design, Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new and improved object or tool.

Engineering
Standard 11: Students will develop the abilities to apply the design process.

Math
AR.Math.Content.K.OA.A.1: Represent addition and subtraction using objects, fingers, mental images, drawings, sounds (e.g., claps), acting out situations, verbal explanations, *expressions* (e.g., 2+3), or *equations* (e.g., 2+3 =).

Big Ideas:

- Proper use of the design loop
- Adding single digit numbers
- Constructing their own moving vehicle

Essential Question: How could you design a car to travel to each of your friends to see their Halloween costumes?

Scenario: The little blue truck is traveling through town for Halloween and on the way sees his friends in their costumes. The little blue truck wants to figure out at the end of the trip how long he traveled all together.

Challenge: Using the materials provided, follow the design loop and design a truck to travel so in the end the amount of distance traveled can be added up.

Materials:
- Students individually
    - Tooth picks
    - Fruit loops
    - Toilet paper rolls
    - Marshmallows

- Tape
- Crayons

Content Information

- Lesson Context: Students have been learning how to add numbers together to find the sum of a problem. The literacy component will introduce the problem for the lesson, while the design/engineering problem will introduce student to the design loop and basic addition. After the lesson is complete the students will be able to recall the lesson as a basic visual aid learning tool.
- Read Little Blue Truck's Halloween
- Divide students into pairs
- Have students follow the design loop to brainstorm, build their trucks, and solve the problem by measuring the distance the truck traveled between his friends.
- Students will receive a worksheet to solve the math problem they are given, which will tie in with the book
- Closure: Have students take turns if they want to, sharing their findings and the truck that they designed

Teacher Instructions

1. Read the book at the beginning of the class
2. Pass out worksheet and materials to students
3. Divide students into groups of 2
4. Give them 20 minutes to work on constructing their truck and 20 minutes to work on the worksheet
5. At the end of the time have the students that want to present come to the front of the class and summarize their findings and the building of their truck
6. Have each student turn in their worksheet for grading

Name:___________________

Little Blue Trucks Adventure

Little Blue Truck is traveling all over town to a Halloween party. Each step of the way he runs into one of his friends who decide to tag along with him. At the very end of the trip Little Blue wants to know how far he has traveled all together with his friends. He knows the distances between each friend but is having trouble figuring out the total amount!

1. Little Blue leaves his house and travels to the duck = 2 miles
2. From the duck to the sheep = 4 miles
3. From the sheep to the cow = 3 miles
4. From the cow to the pig = 7 miles
5. From the pig to the hen = 5 miles
6. From the hen to the horse = 1 mile
7. From the horse to the party = 6 miles

__+__+__+__+__+__+__=__

Work Space if Needed:

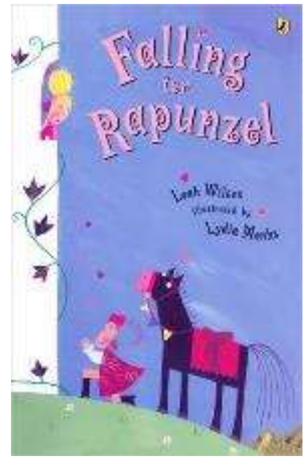
Evaluation:

Grading Rubric

Student is able to follow the Design Loop to brainstorm ideas, build, and complete project	___/25
Students complete the building of their car	___/25
Student works effectively with partner	___/10
Demonstrates the understanding of adding numbers	___/20
Student completed handouts given	___/20
Total Points:	**___/100**

NARRATIVE CURRICULUM DEVELOPMENT ASSIGNMENT

Teacher Instructions:



Grade Level: 2nd or 3rd
Disciplinary Area: STEM
Unit: Gravity
Literacy: *Falling for Rapunzel*, by Leah Wilcox

Content Standards:

Science
Next Generation Science Standards: PS2.A Forces and Motion

- Each force acts on one particular object and has both strength and direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion

Arkansas Science Frameworks: PS.5.3.3

- Determine the mass of solids

Technology
Standards for Technological Literacy: Standard 1. Students will develop an understanding of the characteristics and scope of technology.

- D. Tools, materials, and skills are used to make things and carry out tasks.

Engineering
Standards for Technological Literacy: Standard 9. Students will develop an understanding of engineering design.

- C. The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.

Standards for Technological Literacy: Standard 11. Students will develop the abilities to apply the design process.

- F. Test and evaluate the solutions for the design process.
- G. Improve the design solutions.

Math
Arkansas Mathematics Framework: AR.Math.Content.2.MD.A.1

- Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes

<u>Big Ideas</u>:

- Understanding the concept of gravity
- Understanding the concept of force
- Understanding the concept of mass/weight
- Use of the design process

Essential Question: How can you create a parachute that will support different weights to help Rapunzel toss items out of her tower?

Scenario: Rapunzel is worried the Prince will come to her tower again and ask for strange items from her. She does not want to hurt the Prince by hitting him in the head with items, so Rapunzel needs your help. Help Rapunzel build a parachute that will gently bring down the items the Prince has asked for.

Challenge: Work with groups of three to design and build a parachute. Your parachute should be able to gently release light (1 gram), average (5 grams), and heavy (10 grams) items from 3 foot high tower. Use a scale to determine the weight of the items being dropped (1 gm, 5 gm, and 10 gm) and measure the height of the tower in which you drop the items from. After creating, experimenting, and improving your design, present your ideas to the class. Journal about your experimental process and what you can observe about gravity.

Materials:
- String/Twine (up to 1 yd.)
- Cloth (pre-cut)
- Paper
- Tape
- Straws (up to 5)
- Paper Clips

Tools:
- Scissors
- Ruler
- Triple beam balance
- Paperclips (the "items" being dropped)

Resources:
- *Falling for Rapunzel* by Leah Wilcox
- Design Loop Worksheet
- Student Journals

Content Information:
What is force?

- A force is a push or a pull on an object that causes it to change direction

What is gravity?

- The pull on everything on or near the earth towards the center of the earth.

What is Newton's First Law?

- An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force.

How do you use a triple beam balance?

- To find out the weight of the object, slide the weight poises until the pointer is at zero again. Start with the two heavier weight poises and then use the lightest one to do the fine-tuning to weigh the desired object.

New vocabulary:
Descend: to go or pass from a higher to a lower place
Gravity: a force that tries to pull two objects toward each other
Force: a push or a pull on an object that causes it to change direction
Weight/Mass: the downward pull of gravity on an object
Triple beam balance: an instrument used to measure mass

Deliverables:
The students will need to have the following done:

- Design Loop Worksheet
- Journal Entry

Parameters:

- Design must slow down the descant
- Parachute must be dropped from 3 feet

Evaluation:
Students will be evaluated on their project following the parameters of the assignment, their understanding of gravity, and the completion of Design loop worksheet and journal entry.

Grading Rubric:
Completion of Parachute

- Both of the towers are completed correctly
- Parachutes follow the parameters given for the project

____ /25
Group Work

- All members participated
- Work distributed evenly

- Worked well with others when taking data from other groups

____ */20*

Understanding of Gravity and Force and Measurement

- Able to define gravity and force in their own words
- Understand how gravity and force are related

____ */15*

Understanding of measurement in mass and feet

- Able to use a triple beam balance
- Able to accurately measure in feet and grams

____ */15*

Completion of Handouts Provided

- All handouts are completed with name on it and turned in
- Journal entry is completed

____ /25

Total ___ / 100

PARACHUTE FOR RAPUNZEL

Rapunzel is worried the Prince will come to her tower again and ask for strange items from her. She does not want to hurt the Prince by hitting him with items, so Rapunzel needs your help. Help Rapunzel build a parachute that will gently bring down the items the Prince has asked for.

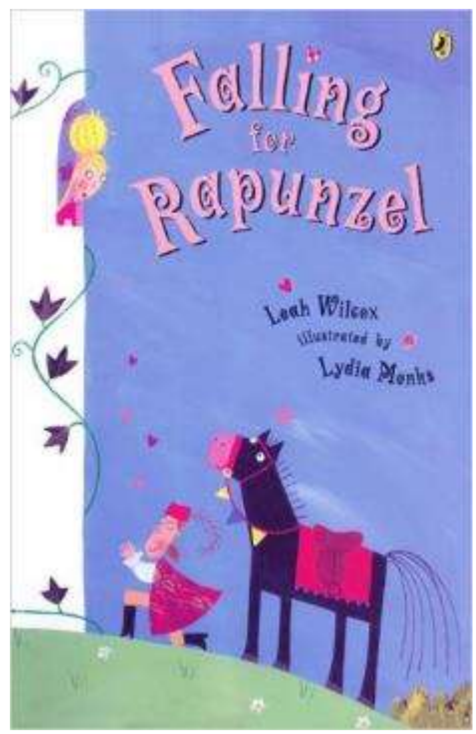
Essential Question: How can you create a parachute that will support different weights to help Rapunzel toss items out of her tower?

Challenge!!

Work with groups of three to design and build a parachute. Your parachute should be able to gently release light (1 gram), average (5 grams), and heavy (10 grams) items from 3-foot high tower. Use a scale to determine the weight of the items being dropped (1 gm, 5 gm, and 10 gm) and measure the height of the tower in which you drop the items from. After creating, experimenting, and improving your design, present your ideas to the class. Journal about your experimental process and what you can observe about gravity and force.

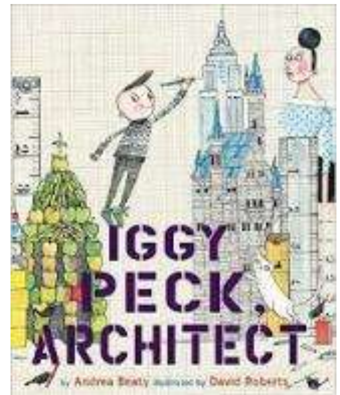
Materials:
- String/Twine (up to 1 yd.)
- Cloth (pre-cut)
- Paper
- Tape
- Straws (up to 5)
- Paper Clips

Tools:
- Scissors
- Ruler
- Triple beam balance
- Paperclips (the “items” being dropped)



Limitations:
- Parachute must be dropped from 3 feet.
- Parachute must slow down the descent of items

Turn in:
- Journal entry
- Design loop worksheet



Can I Build with Food

Grade Level: 2nd
Literacy: Iggy Peck Architect by Andrea Beaty

STEM Standards

<u>Science</u>
NS.1.2.4
Estimate and measure length and *temperature* using International System of Units (SI)

<u>Technology and Engineering</u>
Standard 2: Students will develop an understanding of the core concepts of technology.
In order to comprehend the core concepts of technology, students should learn that:
K-2 Benchmarks: Different materials are used in making things.

Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.
In order to recognize the changes in society caused by the use of technology, students need to learn that:
K-2 Benchmarks: The use of tools and machines can be helpful or harmful.

<u>Math</u>
AR.Math.Content.2.MD.A.1 Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes

Big Ideas:
- How can they measure how tall they can build a tower
- Using items like food, and other materials, can you build a structure
- Are the tools that you used helpful or harmful for your tower

Essential Question:
How can you build a tower from food?

Scenario:
Iggy has to build a tower for the town that holds a satellite on top for phone signals. Iggy has decided to build this tower out of food and make the satellite out of a marshmallow. You are going to help Iggy build this tower. Iggy needs to have the tallest tower that will stand without falling.

Challenge:
You will need to work as a team of 3 or 4. Using only the materials provided to you, you will have **20 min** to construct a tower out of spaghetti noodles, and the other items, that will

stand on a flat surface and hold a marshmallow on the top of it. The height of the tower will be measured from the bottom of the tower to the top of the marshmallow

Materials:

- 20 pcs uncooked spaghetti noodles
- 3 pcs uncooked lasagna noodles
- 10 raisins
- 1 large marshmallow

Tools:

- scissors
- 1 yd. tape
- 1 yd. string
- Ruler and Yard stick

Resource:

- Book- Iggy Peck Architect

Content:
Students need to know how to hold a ruler and interpret the increments to a measurement. If the class hasn't been taught how to measure. Assist them with the measuring.

Parameters:
The students will have only 20 minutes and the exact amount of materials to build their tower.

Evaluation:
Are the students able to create a structure that has a marshmallow as the topper. Can they use their ruler and give a measurement of the height of tower. They should be evaluated on if they gave a sketch of their design in the box, and did they record a measurement in the space provided? Did they give a response on how they could improve their tower?

Student Copy

Name___________________________

Can I Build With Food

Literacy: Iggy Peck Architect by Andrea Beaty

Essential Question: How can you build a tower from food?

Scenario:
Iggy has to build a tower for the town that holds a satellite on top for phone signals. Iggy has decided to build this tower out of food and make the satellite out of a marshmallow. You are going to help Iggy build this tower. Iggy needs to have the tallest tower that will stand without falling.

Challenge:
You will need to work as a team of 3 or 4. Using only the materials provided to you, you will have **20 min** to construct a tower out of spaghetti noodles, and the other items, that will stand on a flat surface and hold a marshmallow on the top of it. The height of the tower will be measured from the bottom of the tower to the top of the marshmallow.

Materials:

- 20 pcs uncooked spaghetti noodles
- 3 pc uncooked lasagna noodles
- 10 raisins
- 1 large marshmallow

Tools:
- scissors
- 1 yd. tape
- 1 yd. string
- ruler and yard stick

Sketches/Brainstorm

The height of our tower is ________ cm

Some improvements we could give to our tower is:

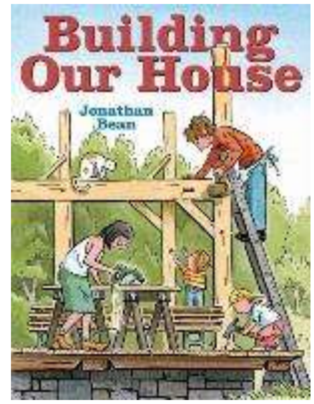
____

____

____

Teachers Guide:

Disciplinary Area: STEM
Grade Level: 2nd Grade
Literacy Connection: *Building Our House* by Jonathan Bean



STEM Standards:

Next Generation Science Standards:
2-PS1-2
Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

Arkansas Mathematics Standards
AR.Math.Content.2.MD.A.1
Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes

Technological Literacy Content Standards
Standard 20
Students will develop an understanding of and be able to select and use construction technologies

Benchmarks

A. People live, work and go to school in buildings, which are different types of: houses, apartments, office buildings, and schools.

B. The type of structure determines how the parts are put together

"Big Ideas":

- Some materials are better suited for different purposes
- Using creative thinking to solve problems
- Construction plays an important role in society
- Construction requires innovation
- The engineering design loop

Essential Question: What materials will you use to build a sturdy structure to withstand the high winds of the city?

Scenario: Your city has gotten funding to create a new building to attract more people to your town. The mayor has asked several construction companies to come up with a plan and design so that he can choose one to help the city flourish. You get to choose what type of building you think will bring the most people to the area. The only problem is that your city in known for being exceptionally windy. Many buildings that have been built in the past were blown down when the high-speed winds come through. So whatever you choose to build, it must be able to withstand the high winds!

Challenge: Using the engineering design loop model, build a building of the style of your choice that is sturdy enough to withstand high-speed winds that gust through the city.

Materials:
Cardboard Pieces
Cellophane Tape
Styrofoam
Toothpicks
Straws
Popsicle Sticks
Construction Paper
Glue Sticks

Deliverables: Student will present their design loop as well as the structure they created that they think will withstand the high winds (leaf blower).

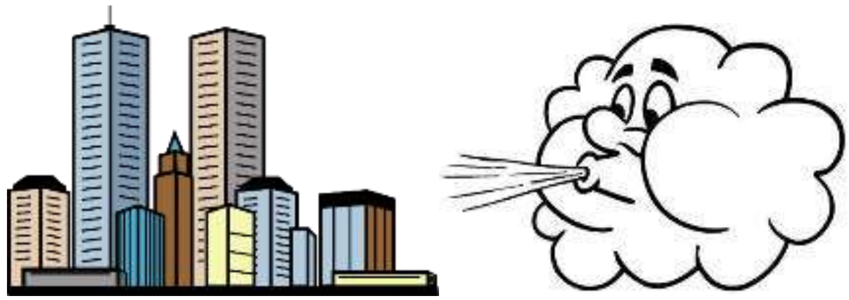
Parameters:
The structure must be able to stand on its own and still stay standing through the high winds (leaf blower)
Students will work in groups of two

Evaluation: Students will present their ideas to the class and tell the group why they decided on the materials that they chose. They will also defend why they built the structure the way they did. Students will then be evaluated on how well their final house (after going back and improving) stands up to the leaf blower.

Assessment:

Students used engineering design loop to create structure	____/15
Students effectively defended their structure and materials in front of the group	_____/15
Students constructed a building that could stand on its own	_____/10
Structure remained standing with the leaf blower	_____/5
All students equally participated in building the structure	_____/10

Student Guide



Scenario:

Your city has gotten funding to create a new building to attract more people to your town. The mayor has asked several construction companies to come up with a plan and design so that he can choose one to help the city flourish. You get to choose what type of building you think will bring the most people to the area. The only problem is that your city in known for being exceptionally windy. Many buildings that have been built in the past were blown down when the high-speed winds come through. So whatever you choose to build, it must be able to withstand the high winds!

Essential Question:

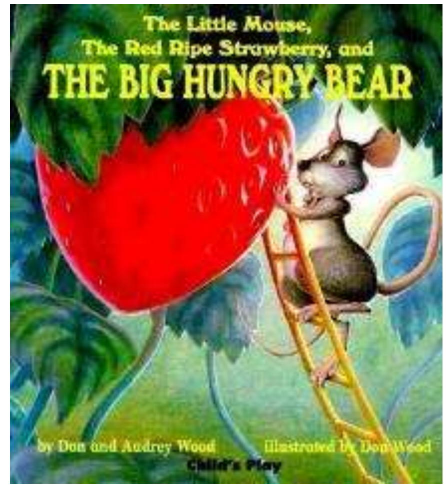
What materials will you use to build a sturdy structure to withstand the high winds of the city?

Challenge:

Using the engineering design loop, build a building of the style of your choice that is sturdy enough to withstand high-speed winds that gust through the city. After you build your structure we will test its stability using a leaf blower.

Materials:
Cardboard
Cellophane Tape
Styrofoam
Toothpicks
Straws
Popsicle Sticks
Construction Paper
Glue Sticks

Teacher Copy



Title: The little mouse and his stash of strawberries!
Grade Level: 2nd
Scenario: Oh no! The little mouse has picked a stash of strawberries and it's too much to eat. Since he can't hide, guard, or disguise the strawberry, we must build a strong cage to keep them safe!

Stem content standards:

- **Science:** NS.1.2.1 Communicate observations orally, in writing, and in graphic organizers: T-charts, pictographs, Venn diagrams, and bar graphs.
- **Math:** AR.Math.Content.2.MD.A.1 Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes
- **Technology and engineering:** Standard 9: Students will develop an understanding of engineering design. In order to comprehend engineering design, students should learn that: K-2 Benchmarks
    A. The engineering design process includes identifying a problem, looking for ide, developing solutions, and sharing solutions with others.
    B. Expressing ideas to others verbally and through sketches and models is an important part of the design process.

Big Ideas: The main idea will be for students to get to collaborate and investigate the best way to build the strongest cage with the materials provided. By reading the book, *The Little Mouse, The Red Ripe Strawberry, and The Big Hungry Bear*, and giving a fun scenario, I hope to get the students involved and excited about the project. They will use the design loop throughout this process to find the best design then test it and make revisions. The students should find the best design, Test it using things around the room, and then figure out how to improve their design up until the day we test them. The students should be creative and really think outside the box.

Essential Question: How can you build the strongest cage, which can hold the most weight, to keep the strawberries safe from the big hungry bear?

Challenge: The students will build a cage to protect the strawberries using only the materials listed below. We will test the strength of the cage by seeing how much weight it supports before it breaks.

Tools	Materials	Resources
• Scissors • Rulers	• 8 popsicle sticks • 2 pieces of card stock • 6 straws • Glue	• Any previous work from class.

Content Information: The students will need to know how to measure their materials and the strength of their materials. The students will have some background with building structures with these materials from previous lessons.

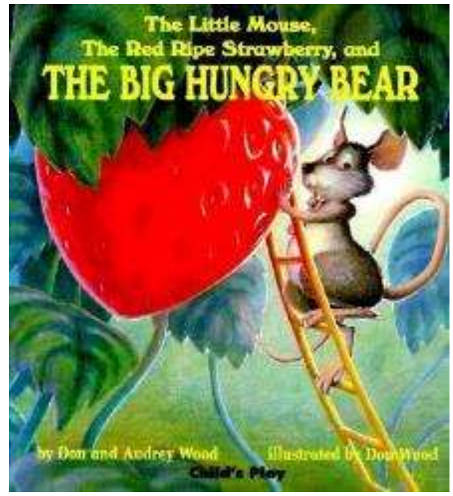
Deliverables: When the students are done they need to return their completed engineering design loops, clearly showing which design they chose and a statement of why they chose it. They also need to deliver the notes they took throughout the process (what worked well and what didn't) and their cage for testing.

Parameters or constraints: The students can only work with the materials listed above and the specific amount listed. The students will be given two classes to work on this and then we will test the cages during the third class.

Rubric:

Engineering Design loop Students fill out their complete design loop individually but while working with a group.	**1-5 points**
Group Collaboration The students work effectively with their groups and interact to come up with the best design possible.	**1-5 points**
Notes Students turn in notes to teacher describing what worked well throughout their experiment and what did not.	**1-5 points**
Strength of Cage Students cage should be able to hold at least three pounds and if not they need to write a paragraph backing up their design.	**1-5 points**

Student Version



The little mouse and his stash of strawberries!

Oh no! The little mouse has picked a stash of strawberries and it's too much to eat. Since he can't hide, guard, or disguise the strawberry, you must build a strong cage to keep them safe!

The main idea will be for you to collaborate and investigate the best way to build the strongest cage with the materials provided. By reading the book, *The Little Mouse, The Red Ripe Strawberry, and The Big Hungry Bear*, and giving a fun scenario, I hope to get you involved and excited about your project. You should find the best design, Test it using things around the room, and then figure out how to improve your design up until the day we test them. You should be creative and really think outside the box.
How can you build the strongest cage, which can hold the most weight, to keep the strawberries safe from the big hungry bear?

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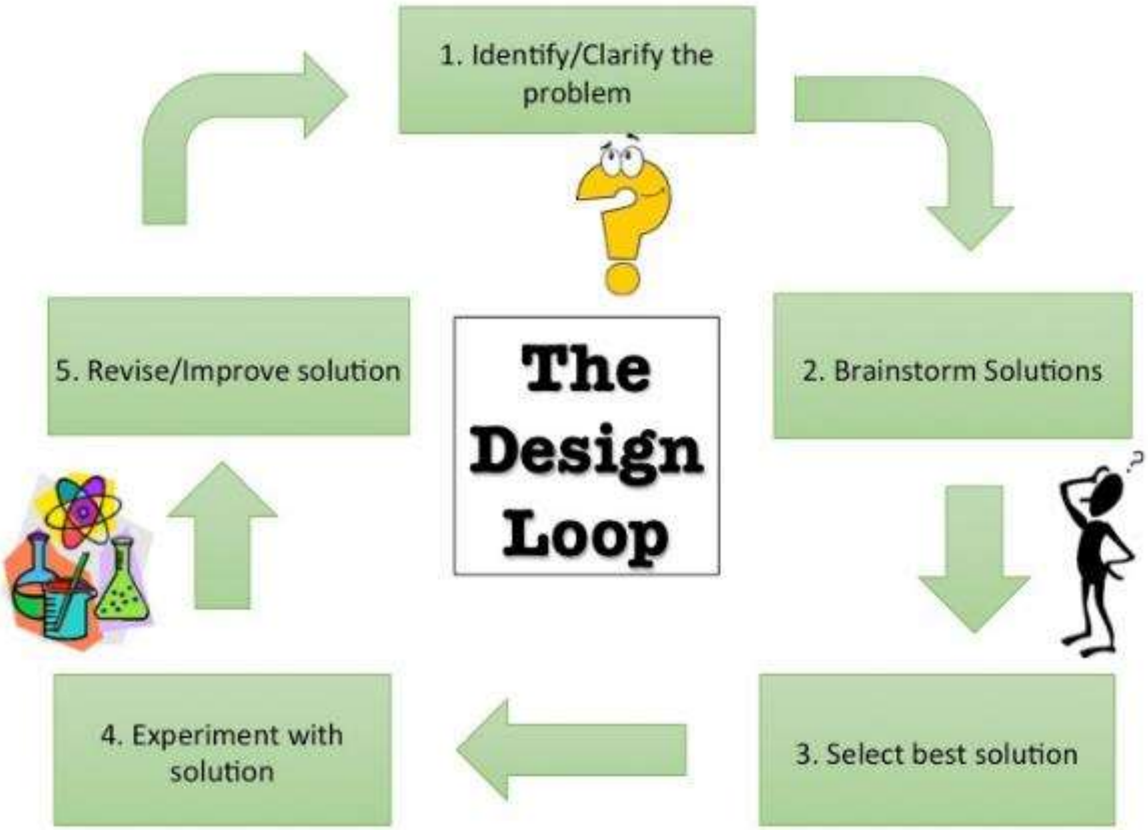
Tools	**Materials**	**Resources**
• Scissors • Rulers	• 8 popsicle sticks • 2 pieces of card stock • 6 straws • Glue	• Any previous work from class.

The students will need to know how to measure their materials and the strength of their materials. The students will have some background with building structures with these materials from previous lessons.

When you are done your group needs to return their completed engineering design loops, clearly showing which design your group chose and a statement of why you chose it. They also need to deliver the notes they took throughout the process (what worked well and what didn't) and their cage for testing.
The students can only work with the materials listed above and the specific amount listed. The students will be given two classes to work on this and then we will test the cages during the third class.

Rubric:

Engineering Design loop Students fill out their complete design loop individually but while working with a group.	**1-5 points**
Group Collaboration The students work effectively with their groups and interact to come up with the best design possible.	**1-5 points**
Notes Students turn in notes to teacher describing what worked well throughout their experiment and what did not.	**1-5 points**
Strength of Cage Students cage should be able to hold at least three pounds and if not they need to write a paragraph backing up their design.	**1-5 points**


1. Identify/Clarify the problem
The Design Loop
2. Brainstorm Solutions
3. Select best solution
4. Experiment with solution
5. Revise/Improve solution

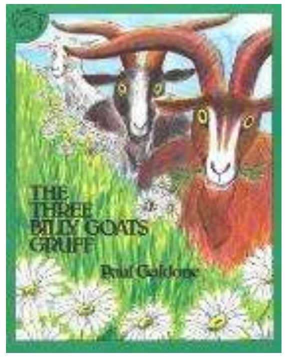
Design 1:

Design 2:

Final Design:

Eleanor Jahant
Dr. Daugherty
STEM 4033

STEM LESSON PLAN



The Three Billy Goats Gruff
By: Paul Galdone

Lesson Title: "Goat to Get Back!"
Grade Level: 1st Grade
Disciplinary Area: STEM
STEM Content Standards:

Science→

K-Ps2-*1 Plan and conduct an investigation to compare the effects of different strengths*

K-2-ETS1-1 *Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.*

Technology→

Standard 2: Students will develop an understanding of the core concepts of technology.

D. Different materials are used in making things.

Standard 8: Students will develop an understanding of the attributes of design.

A. Everyone can design solutions to a problem.

Standard 9: Students will develop an understanding of engineering design.

A. The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.

B. Expressing ideas to others verbally and through sketches and models is an important part of the design process.

Literacy→

CCSS.ELA-LITERACY.RF.1.4.A *Read grade-level text with purpose and understanding.*

Mathematics→

CCSS.MATH.CONTENT.1.OA.D.7 *Work with addition and subtraction equations*

Big Ideas:

- Problem solving & design
- Understanding the importance of stability & structure
- Understand how different bridges will hold different weights depending on how the bridge was built

Essential Question:

How can you build a bridge that supports the most weight?

Scenario:

Oh my, the bridge that the three billy goats crossed collapsed, and now they are stuck on the other side. The three goats need your help to design and build a bridge, so that they can return safely to the other side. Before the little goats and prance across the bridge you will need to test the bridge to see that it is safe for the goats to cross.

Challenge:

You will be placed into groups and will design a bridge. The goal is to build a bridge from the materials provided that can support as much weight as possible.

Tools, Materials, Resources:

Popsicle Sticks & Jumbo Popsicle Sticks
Toothpicks
Construction Paper
2 Styrofoam Blocks
Hot Glue Gun (teacher will help)
Wood Glue
Clay
Tape
Journals

Content Information:

- What is a bridge?
- What is weight?
- How does weight effect a bridge?
- Why do we use bridges?
- Who builds bridges?
- Why does it matter if the bridge can hold weight?

Deliverables:

Students will turn in:

- *Journal*
  - *The journal will contain what the problem is and different solutions to fix the problem, sketches of student's bridge design, and results of their bridge after being tested.*
  - *Questions for the Journal:*
    - *What are you supposed to be building?*
    - *What are different ways that you can build the bridge?*

- *Which way do you think will work best to support the weight of the three billy goats?*
- *Draw out a sketch of the design that you will think work best.*
- *Did you make any changes to your design while building?*
- *Which of the given materials did you use?*
- *What do you think is going to happen when the teacher adds weight to your bridge?*
- *After being tested did your bridge support the weight?*
- *If you could make any changes/improvements to your bridge what would they be and why?*
- *Why is it important to have a bridge that has a stable structure?*

o *Bridge that they built*

Parameters or Constraints:

Each student will be given a limited amount of materials to build their bridge (*10 Popsicle sticks, 5 jumbo Popsicle sticks, 10 toothpicks, 2 pieces of construction paper, 2 Styrofoam blocks, hot glue gun, wood glue, clay, and tape*).

Then length of the bridge can be no longer than 12 inches & the height of the bridge can be no longer than 12 inches, which is the length of a ruler. Students will be given an hour to create and design a solution to the problem.

Suggestions for the Teacher

The teacher will test the bridge by using 3 different weights that are measured in grams (pictured below). The 3 different weights will represent the 3 billy goats. The weights that will be used are 50 g, 100 g, and 150 g. The teacher will start out with the 50 g weight and then add the 100 g weight and then the 150 g weight to see if the bridge can support the three goats.

Evaluation:

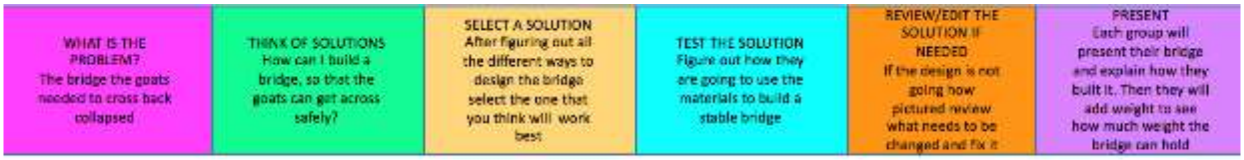
Students will present their final product to the class.
I will grade the students based on the rubric.

Rubric for Building a Bridge:

	20 Points	**15 Points**	**10 Points**
Solved the task: "Building a Bridge"	*Built a bridge*	*Attempted to build a bridge*	*Did not create anything that resembled a bridge*
Bridge Supported Weight	*Held more than one weight*	*Held one weight*	*Did not hold any weight*
Explain How They Built the Bridge	*Understand how they built their bridge*	*Sort of explain how they built their bridge*	*Cannot explain how they built their bridge*
Understand Importance of a Stable Bridge	*Know the importance of why a bridge needs to be stable*	*Try to understand why the bridge needs to be stable*	*Do not understand why a bridge needs to be able to hold weight*
Everyone in the Group Worked Together	*You were fully engaged and helping at all times*	*You occasionally gave input on ideas for building the bridge*	*You did not contribute anything*

Engineering Design Loop:

The teacher will walk through the design loop step by step. In between each step the teacher will pause giving children time to think about and write down what they plan on doing.

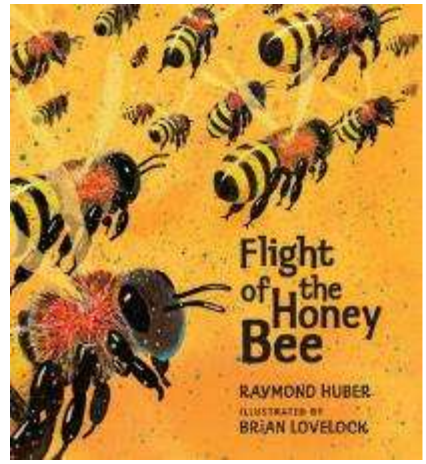


Worksheet relating to the engineering design loop attached for children.

THINK: Bridge Engineer Design loop

What is the problem?	What are some ways you could solve the problem?
What is the best way to solve the problem?	Sketch the solution…
How did the bridge hold up to the test?	What are ways you can improve your bridge?

Flight of the Honey Bee



Grade Level: 2

STEM Content Standards:

Science

Next Generation Science Standards
2-LS2-2: Interdependent Relationships in Ecosystems
Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.

Technology

Standards for Technological Literacy
Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

A. Asking questions and making observations helps a person figure out how things work.

Standard 15: Students will develop an understanding of and be able to select and use agricultural and related biotechnologies.

B. There are many different tools necessary to control and make up the parts of an ecosystem.

Math

Arkansas Mathematics Standards
AR.Math.Content.2.MD.A.1: Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.

Big Ideas:

- Understanding how bees aid in the pollination of plants
- Problem solving
- Understanding how to select agricultural biotechnologies
- Measurement of length
- Observations of multiple substances

Essential Question:

- Why is pollination essential?
- How do bees aid in the pollination of plants?
- What types of pollen are best transported by bees?

Scenario:

A local flower farmer has the option of planting three different flowers. Because the wind hardly blows, and it is too much work to pollinate by hand, she has chosen to buy bees to help pollinate her flowers. Out of the three different flowers she could plant, one produces a pollen most easily carried by bees. Which type of flower should she plant?

Challenge:

Using your knowledge about how bees carry pollen and the materials available, test the three flower pollens and help the farmer decide which type of flower she should plant this year.

Tools, Materials, and Resources:

- Straws
- Small paintbrushes
- 1/8 teaspoon
- Ruler
- Small bowls or cups
- Clear tape
- Black paper
- Pencil
- Magnifying glass
- Three types of paper flowers (one for every pair of students)
- Three types of 'pollen' powder (I used flour, cinnamon, and chili powder)

Content Information:

After reading the book, have a class discussion about how bees carry pollen from flower to flower. The book notes that bees are furry, even their eyeballs, and bees' fuzzy bodies are charged with static electricity during flight, which attracts pollen to their bodies.
Additional content needed:

- Can a student measure in inches using a ruler?
- Can a student observe differences in given powders?
- Can a student verbalize their thoughts after analyzing test results?
- Can students 'Travel along the Design Loop"?
    - 1. Identify the problem
    - 2. Brainstorm solutions
    - 3. Choose your solution
    - 4. Test your solution
    - 5. Evaluate your solution
    - 6. Present your solution

Deliverables:

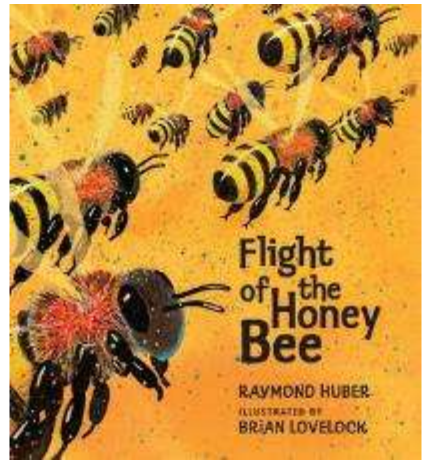
Using only the materials supplied, each student will work with a partner to observe and test the three types of pollen. The test results will be logged in individual design loop journals, which include tables for test results. Once a student pair decides which type of flower should be planted, they will deliver the paper flower representing their choice to the teacher. This paper flower will be 'planted' by the teacher who will tape the pair's flower on a space representing the flower grower's garden.

Parameters or Constraints:

- Partners will be pre-chosen by the teacher
- Students will be given 10 minutes to observe and brainstorm
- Students will be given thirty minutes to test their powders
- Students will only use the materials provided
- Each student pair will be given a paper flower representing each of the pollen choices
- Students will choose only one type of flower to deliver to the teacher
- Students will not mix the three types of powder together
- Students will not blow powders into other students' faces
- Students will tape results from finger and cotton swab tests in design loop journals
- Students will not dip a paintbrush or finger into a single sample of powder more than once without removing previous sample
- Students will be given two minutes to present their findings
- Students will present only one flower choice

Evaluation: Students will be evaluated in three ways during this project: 1) a rubric for the pollen test 2) completion of design loop journal 3) the selection and presentation of flower choice to the class

Student Copy: Flight of the Honey Bee



Essential Question:

- Why is pollination essential?
- How do bees aid in the pollination of plants?
- What types of pollen are best transported by bees?

Scenario:

A local flower farmer has the option of planting three different flowers. Because the wind hardly blows, and it is too much work to pollinate by hand, she has chosen to buy bees to help pollinate her flowers. Out of the three different flowers she could plant, only one produces pollen easily carried by bees. Which type of flower should she plant?

Challenge:

After reading *Flight of the Honey* Bee, use your knowledge about how bees carry pollen and the materials available, test the three flower pollens and help the farmer decide which type of flower she should plant this year to promote bee pollination.
Remember:

- Work with your partner
- Make detailed observations
- Test consistently
- Complete all sections of the Design Loop Journal

Parameters or Constraints:

- Students will work in pairs assigned by the teacher
- Students will be given 10 minutes to observe and brainstorm
- Students will use only the materials given to test their pollens
- Students will be given 30 minutes to test
- Pairs will be given 2 minutes to present their findings
- Students will not combine pollen samples

Materials: (for each pair)

- Three cups containing pollen samples
- Clear tape
- 1 sheet of black paper
- 2 straws
- 1 small paintbrush
- 2 Design Loop Journals

Tools: (for each pair)

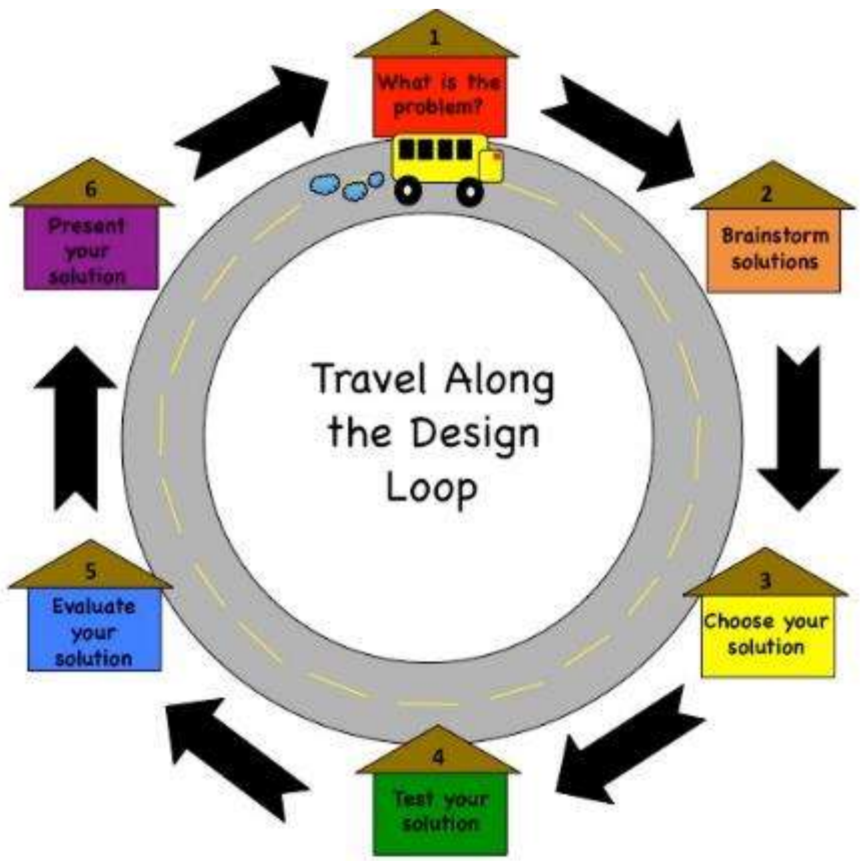
- 1/8 teaspoon
- Ruler

- Pencil
- Magnifying glass

To Turn In:

- Design Loop Journal
- Paper flower selection
- Presentation of pollen choice

Design Loop Journal: Pollination



Name: ____________Partner:__________

Date: ___/_____/____

Title: __________________________________

4. What is the problem?
   What do I need to do?

____

____

____

5. Brainstorm solutions –
   What do I already know?

____

____

____

What do I need to find out?

My Pollen Observations:

Flower A-

Drawings

Flower B-

Flower C-

6. Choose your solution:
   Which pollen do you choose? Why?

The steps I will use:

The tools and materials I will use:

____

____

____

4. Test your solution

Thinking About My Idea

Design Title: ____________________

How did you test your solution?

____

____

____

How do you know if your idea works?

____

____

____

Pollen	Air	Skin	Bee	Would be best moved by (Circle choice)
Flower A				Bee Wind You
Flower B				Bee Wind You
Flower C				Bee Wind You

5. Evaluate your solution

How would you change your idea?

What did you learn?

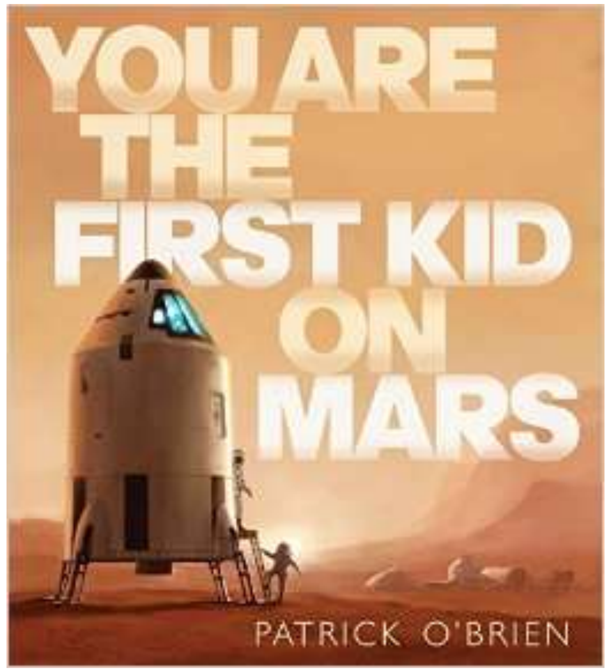
What did you like about this project?

What did you not like about this project?

Prepare to present your solution

How Did I Do?	Points	Teacher	Student
I understood the problem I was to solve	/5		
I learned things to help me test my ideas	/5		
I made drawings to show my ideas	/5		
I solved the problem in a way new to me	/5		
My project followed the rules	/5		
I used materials and tools correctly	/5		
I wrote my ideas in my design journal	/5		
I worked well with my partner	/5		
My classmates could hear and see my presentation	/5		
I used my time wisely	/5		
Total	/50		
Teacher Comments:			

Mars Launch System



Literacy Connection: *You Are the First Kid on Mars* by Patrick O'Brien

Grade Level: 4th

STEM Content Standards:

Science

Energy 4-PS3-4 Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*

Technology and Engineering

Standard 18: Students will develop an understanding of and be able to select and use transportation technologies
Benchmark D: The use of transportation allows people and goods to be moved from place to place.
Benchmark E: A transportation system may lose efficiency or fail if one part is missing or malfunctions or if a subsystem is not working.

Math

Measurement and Data: AR.Math.Content.4.MD.B.4

Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit. Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec; yd, ft, in; gal, qt, pt, c

Big Ideas:

- Properties of the Design Loop process
- Understanding transfer of energy
- How to convert measurements (inches to feet to miles)
- Being able to create a device that meets certain requirements
- Conservation of fuel (natural resources)

- Problems can be solved multiple ways

Content Information:

How can you create a successful design?

- By using the design loop. It could help clear your mind and facilitate the thinking process.

How can energy be transferred from one form to another?

- Energy: it is neither created nor destroyed, but rather changed from one form of energy to another
- Potential and Kinetic Energy

How do you convert inches to feet to miles?

- 12 in. = 1 ft.
- 5280 ft. = 1 mile

Possible Content:

- Weight: the amount or quantity of heaviness or mass; amount a thing weighs.

- Atmosphere: *Astronomy.* The gaseous envelope surrounding a heavenly body. *Chemistry.* Any gaseous envelope or medium.

The more fuel that is aboard the shuttle, the heavier the shuttle will be. The heavier the shuttle, the more fuel is needed for lift-off. See the dilemma?

Earth's atmospheric pressure: 101.325 kPa (kilopascal)
Mars' atmospheric pressure: 0.4-0.87 kPa
That means that Earth's atmospheric pressure is 126-253 times stronger than Mars'.
Air Pressure: What is it? https://youtu.be/axbFo-wsp4g

Pre-Lesson Activity:

Read *You Are the First Kid on Mars* as a class.

Discuss the differences between Mars and Earth, such as the differences in atmospheric pressure and weather.

Scenario:

You are about to become the first girls and boys to ever set foot on the Red Planet! However, NASA has run into a few problems just before the departure date. NASA needs your help investigating ways to take the least amount of fuel on the mission to Mars to decrease the weight of the shuttle. It is your task to develop a launch platform and lift-off device that launches a capsule with six astronauts into space on the surface of Mars without using fuel.

Essential Question:

Can your team create a device that launches the capsule high enough out of Mars' atmosphere?

Challenge:

After reviewing potential and kinetic energy, you will need to work as NASA's most diligent team of scientists and engineers to create a launch system with the greatest amount of thrust. Keep the weight and size of the device in mind.

Remember: the lift-off device must be able to transfer energy from itself to the capsule.

Parameters or Constraints:

- Complete engineering journal
- Use only material provided or recycled materials
- The device must somehow fit in a 10x12 box
- Students must be able to distinguish between an example of potential energy and kinetic energy within the device

- Students must be able to convert miles to feet to relate our version (measuring tape and the classroom) of Mars' atmosphere to envision the actual distance the Lander would need to be launched

Tools, Materials, and Resources:

- Recycled materials
- Balloons
- Rubber bands
- Dowel Rods
- Pencils
- Cardboard
- Plastic Cups
- Water bottles
- Toilet paper/paper towel rolls
- String
- Scissors
- Duct Tape
- Glue
- Provided "capsule"
- Cloth Tape Measure to hang from ceiling (I recommend taping pipe cleaners every 6 inches or each foot to more accurately tell how high the capsule was flown)

Content Information:

- Lesson on Energy: potential and kinetic.
    - Potential Energy: energy that is stored within an object. Ex- if you stretch a rubber band back
    - Kinetic Energy: energy in motion. Ex- when you release the rubber band and it flies through the air

- Quick discussion on elasticity and items we know to be elastic.
    - Elasticity: *Physics.* the property of a substance that enables it to change its length, volume, or shape in direct response to a force effecting such a change and to recover its original form upon the removal of the force.

    - Possible items to discuss: spring, bouncing ball, bowstring, bungee cord, trampoline, etc.

- Short lesson on how to convert from inches to feet to miles

Deliverables:

- Launching device
- Completed Design Journal
- Completed Worksheet

Evaluation:

- ➢ See rubric

Mission to Mars Design Journal:

Directions: Follow the Design Loop Process: Fill out the first three pages individually. Once you are assigned a Mission Team, collaborate and choose a solution. Test it out and evaluate.

1. What is the problem? What do I need to do?

____
____
____

2. Brainstorm Solutions:

What do I already know?

____
____
____

What do I need to find out?

What did I find out?

My First Ideas:

3. Choose Your Best Solution:

Our best idea is…

The steps we will use:

The tools and materials we will use:

____

____

____

4. Test your solution:

Design Title: ______________________________

How did you test your solution?

____

____

____

How do you know if your idea works?

5. Evaluate your solution:
How might you change your idea?

What did you learn?

What did you like about this project?

What did you not like about this project?

Prepare to present and defend your team's solution!

5 pts	10 pts	15 pts	20 pts
Students showed little understanding of concepts from lesson and were unable to launch the capsule at all	Students shows some understanding of concepts from the lesson and were able to launch the capsule	Students applied concepts from the lesson and created a launching device that launched the capsule at least 2 feet	Students effectively applied concepts from the lesson and created a launching device that launched the capsule further than 2 feet
Student completed one or two aspects of the design journal	Student completed some aspects of the design journal	Student completed most aspects of the design journal	Student completed every aspect of the design journal
Student was unable to identify either of the possible energy points on the device	Student was able to identify one of the possible energy points on the device	Student was either able to identify BOTH points of kinetic and potential energy on the device and/or identify one and give a real-life example of one	Student was able to identify points of kinetic and potential energy on the device and give real-life examples
Student was unable to convert inches to feet nor feet to miles. Did not show understanding of scale.	Student was able to convert either inches to feet or feet to miles. Somewhat showed understanding of scale.	Student was able to convert either inches to feet or feet to miles. Showed understanding of scale.	Student was able to convert inches to feet to miles. Showed understanding of scale.
Students did not collaborate as a team. Communication was lacking and conflicts were not resolved.	Students worked together, but did not share work equally. Conflicts were not resolved.	Students worked equally as a cohesive group, may have shown some signs of conflict without resolution	Students worked equally as a cohesive group and communicated well with each other

Student Copy

You are about to become the first girls and boys to ever set foot on the Red Planet! However, NASA has run into a few problems just before the departure date. NASA needs your help investigating ways to take the least amount of fuel on the mission to Mars to decrease the weight of the shuttle. It is your task to develop a launch platform and lift-off device that launches a capsule with six astronauts into space on the surface of Mars without using fuel.

Your challenge:
After reviewing potential and kinetic energy, you will need to work as NASA's most diligent team of scientists and engineers to create a launch system with the greatest amount of thrust. Keep the weight and size of the device in mind.

Remember: the lift-off device must be able to transfer energy from itself to the capsule.

Materials:

- Recycled materials
- Balloons
- Rubber bands
- Dowel rods
- Pencils
- Cardboard
- Plastic cups
- Water bottles
- Toilet paper/ paper towel rolls
- String
- Scissors
- Duct tape
- Glue
- Provided capsule

Parameters:

- Complete engineering journal
- Use only material provided or recycled materials
- The device must fit in 10x12 box

1. How many feet was your capsule thrusted in our classroom?

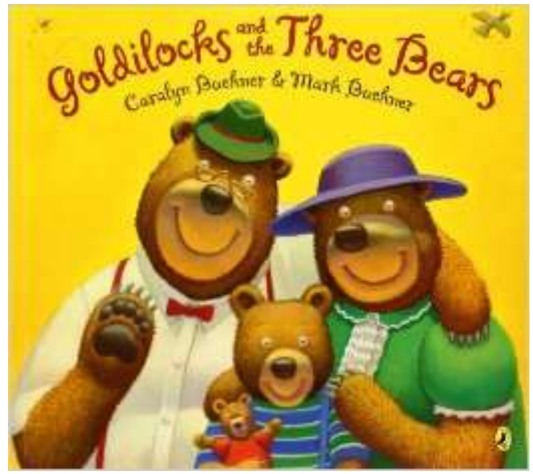
2. How many miles was your capsule thrusted on Mars?

3. Describe at which point the device is storing potential energy.

4. Describe at which point the potential energy has transferred to kinetic energy.


1 What is the problem? Observe/Analyze the situation.
2 Brainstorm! Discuss ideas and prior knowledge.
3 Decide on a solution and make a plan!
4 Create!
5 Test the solution!
6 Evaluate and improve!
7 Share your solution!
The Design Loop

Goldilocks and the Three Bears Latch Challenge



Teacher Instructions
Grade: 1st Grade
Disciplinary Area: STEM
Unit: Engineering Problems
Literacy: *Goldilocks and the Three Bears,* by Caralyn Buehner

Content Standards:

<u>Science</u>

Arkansas K-4 Science Standards

- 1-ETS1-1: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

<u>Technology</u>

Standards for Technological Literacy Content Standards and Benchmarks K-5

- Standard 11: Students will develop abilities to apply the design process. B. Build or construct an object using the design process.

<u>Engineering</u>

Standards for Technological Literacy Content Standards and Benchmarks K-5

- Standard 9: Students will develop an understanding of engineering design.
  A. The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.

Mathematics

Arkansas Mathematics Frameworks

- 1.OA.A.1: Use addition and subtraction within 20 to solve word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions

(e.g., by using objects, drawings, and equations with a symbol for the unknown number to represent the problem)

Big Idea:

- Basic understanding of problem solving.
- Understanding of how to use the design process.
- Student will make use of the engineering design process.

Essential Question:

How can you design a door latch that will keep Goldilocks from entering the Three Little Bears' home?

Scenario:

You have just read *Goldilocks and the Three Bears.* After discovering Goldilocks in their home, the Three Bears decide that maybe next time, they should lock the front door! Help them create the perfect latch to keep strangers out.

Challenge:

In groups of two, design a latch from any of the provided materials, as needed. (Not all materials are required to be used.) You must be able to demonstrate how the latch works. Once you complete your design, we will test the sturdiness to see if it will keep the door shut.

Tools, Materials, and Resources:

Construction paper
Tape, Scissors
Paperclips (2 per pair)
Clothes pins (1 per pair)
Pipe cleaners (2 per pair)
Popsicle sticks (3 per pair)
Straws (2 per pair)
Bottle caps (1 per pair)

Content Information:

Students must know what a **latch** is in order to grasp the concept of the project.

- A **latch** is a device that is used to fasten a door or a window.
- It is a type of bar that fits into a slot or a notch that is lifted from either side by a lever or a string.

Deliverables:

1. Completed design loop
2. Completed latch and presentation of design

Parameter:

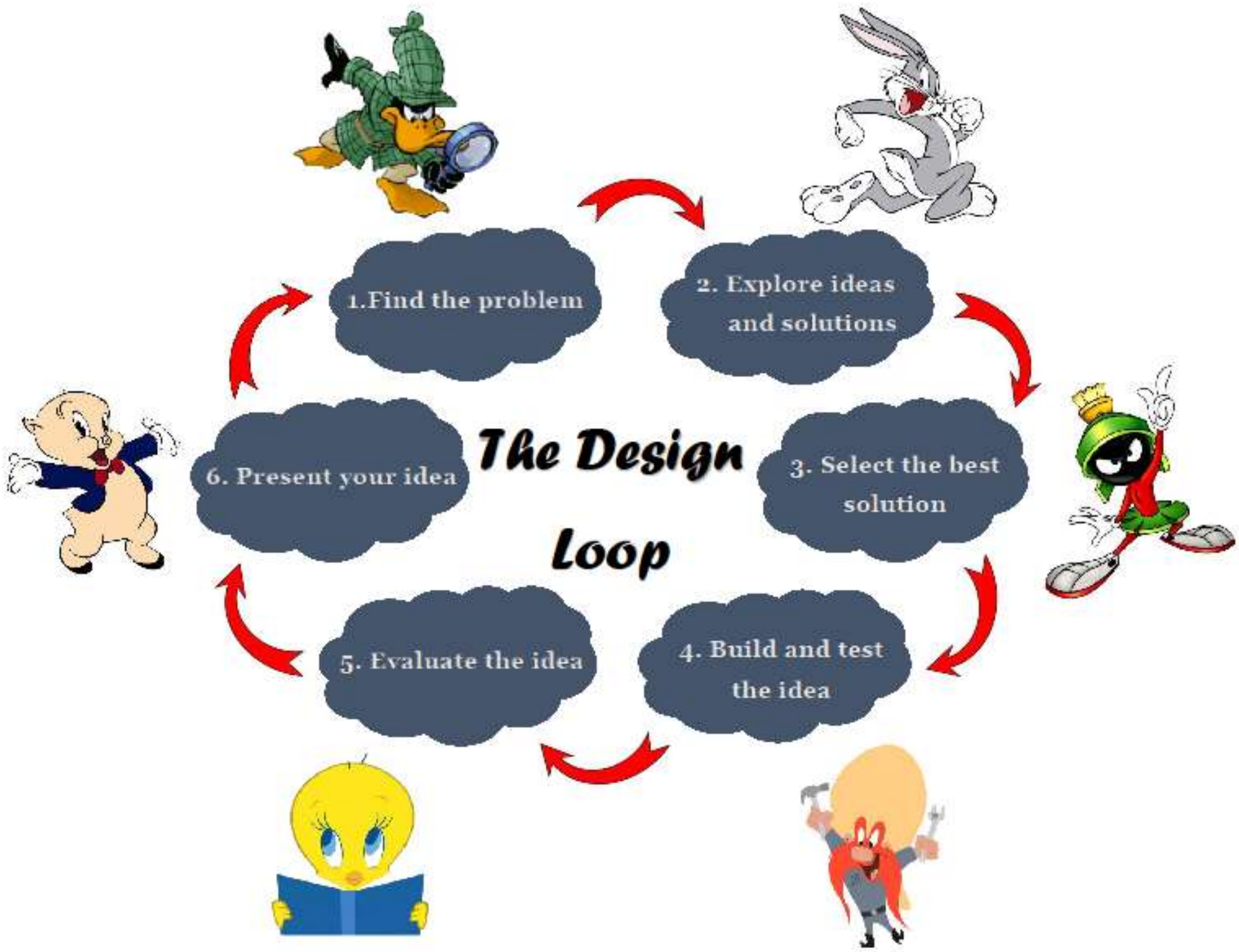
Students will have 30 minutes to complete the activity.
Students are not required to use all of the given materials.

Evaluation:

Students will be evaluated by testing out the latches to ensure the sturdiness, along with the provided rubric. The activity is worth 25 points.

Team Design Sheet

Directions: Use the design loop to help you think of different ways to make your latch. Draw two different designs in the areas provided.



Design 1
Design 2
Design 3

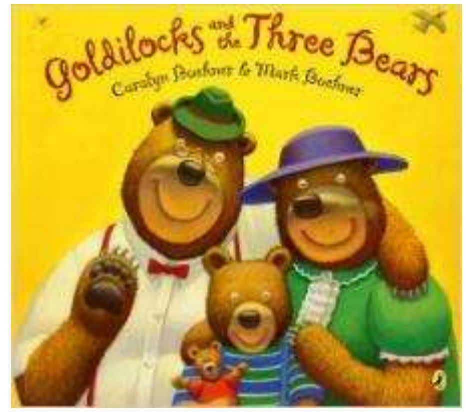
Name: ____

Grading Rubric

	Excellent (5 Points)	Good (3 Points)	Poor (1 Points)	**Total (25 Points)**
Group Collaboration	Worked well with group member, and allowed ideas to be heard.	Worked well with group members, but not all ideas were given a chance.	Did not work as a group.	
Completion of Engineering Design	Completed fully the Engineering Design sheet.	Somewhat completed the Engineering Design sheet.	Did not complete the Engineering Design sheet	
Proper Use of Design Process	Use the Design Process to create final structure.	Varied from the Design Process to create final structure.	Did not use the Design Process when creating structure.	
Understanding of Structure	Demonstrated understanding of why their final structure worked, or did not work.	Demonstrated some understanding of why their final structure did or did not work.	Showed no understanding of why their final structure did or did not work.	
Presentation	Presented a completed final structure.	Presented a somewhat complete final structure.	Presented no final structure.	

Total Points: _____/ 25

Goldilocks and the Three Bears Latch Challenge



After discovering Goldilocks in their home, the Three Bears decide that maybe next time, they should lock the front door! Help them create the perfect latch to keep strangers out.

Challenge:

In groups of two, design a latch from any of the provided materials, as needed. (Not all materials have to be used.) You must be able to show how the latch works. Once you complete your design, we will test to see if it will keep the door from opening.

Tools, Materials, and Resources:

Construction paper
Tape, Scissors
Paperclips (2 per pair)
Clothes pins (1 per pair)
Pipe cleaners (2 per pair)
Popsicle sticks (3 per pair)
Straws (2 per pair)
Bottle caps (1 per pair)

Turn in:

- Completed design loop and worksheet, signed by both members
- Final project

Let's Trap a Wild Thing!
Grade: 2
Teacher Guide

Standards:

- **Arkansas Science Standards**
  - 2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- **Standards for Technological Literacy**
  - Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
    - A. Asking questions and making observations helps a person to figure out how things work.
    - B. All products and systems are subject to failure. Many products and systems, however, can be fixed.
  - Standard 8: Students will develop an understanding of the attributes of design.
    - A. Everyone can design solutions to a problem.
    - B. Design is a creative process.
- **Arkansas Math Standards**
  - AR.Math.Content.2.OA.B.2
    - Fluently add and subtract within 20 using mental strategies.

Big Idea:

- Students will be able to sketch their ideas in their design journal.
- Students will be able to identify problems in their design and develop a solution based on their observations.
- Students will be able to add and subtract using mental strategies.

Essential Question:

How can you use the materials provided to help Max create a trap to keep his crown safe?

Scenario:

One of the Wild Things has decided that he deserves to be the King of all the Wild Things. Max heard that the Wild Things were gathering an army to take the crown. In order to keep his crown safe, Max needs help creating a trap! However, Max does not want to hurt the Wild Things.

Challenge:
Using only the materials provided, students need to design and build a Wild Thing trap. The trap must be large enough to trap the toy Wild Thing without causing harm. Your team has 10 Wild Thing dollars to purchase materials. It is up to the team to use the money wisely. A pencil, scissors, and tape will be given to each team for "free".

To test the traps, the students will place their traps on a flat surface. The teacher could use a toy car or a "walking" wind-up toy to test the traps.

Tools, Materials, and Resources:
Student:
- Student design challenge journal
- The supplies listed below.
- Teammate evaluation form
- Student checklist

Item	Cost
36 inches of string	3 Wild Thing dollars
2 index cards	1 Wild Thing dollar
1 toilet paper roll	3 Wild Thing dollars
2 rubber bands	2 Wild Thing dollars
5 straws	2 Wild Thing dollars
1 plastic spoon	2 Wild Thing dollar
1 paper plate	1 Wild Thing dollar
4 wooden dowels	2 Wild Thing dollars
1 plastic cup	1 Wild Thing dollar
5 pipe cleaners	1 Wild Thing dollar
5 toothpicks	1 Wild Thing dollar

A pencil, scissors, and 24 inches of tape will be provided to each team at no cost.

Teacher:
- *Where the Wild Things Are* by Maurice Sendak
- Design loop displayed in classroom

Content Information:

Deliverables:

At the end of the design challenge, students will need to submit these items to the teacher:

- Wild Thing trap
- Team member evaluation- every student will need to complete an evaluation for every member of their team.
- Design challenge journal- every member of the team will need to submit his or her own design challenge journal.
- Student Checklist

Constraints:

Every design team will have 10 Wild Thing dollars to purchase supplies. Scissors, a pencil, and 24 inches of tape will be given to each team at no cost. The trap must successfully trap the toy car or wind-up toy.

Evaluation:

- Rubric
- Teammate evaluation
- Design challenge journal

Let's Trap a Wild Thing!
Student Guide

One of the Wild Things wants to take the crown from Max. Max needs help making a trap to trap the Wild Thing. Can you help Max keep his crown safe?

Materials:
Each team will be given 10 Wild Thing Dollars to spend on supplies.

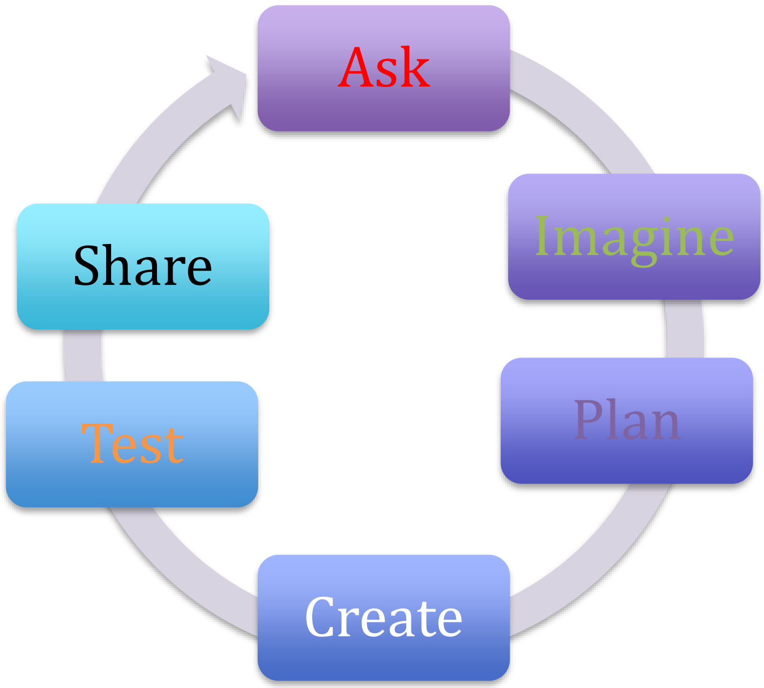
Item	**Cost**
36 inches of string	3 Wild Thing dollars
2 index cards	1 Wild Thing dollar
1 toilet paper roll	3 Wild Thing dollars
2 rubber bands	2 Wild Thing dollars
5 straws	2 Wild Thing dollars
1 plastic spoon	2 Wild Thing dollar
1 paper plate	1 Wild Thing dollar
4 wooden dowels	2 Wild Thing dollars
1 plastic cup	1 Wild Thing dollar
5 pipe cleaners	1 Wild Thing dollar
5 toothpicks	1 Wild Thing dollar

*Your team will be given scissors, tape, and a pencil "at no cost".

After completing the design challenge, you will need to turn in:
- Wild Thing trap (one per team)
- Team member evaluation
- Design challenge journal
- Student Checklist

Design Challenge Journal

Designer's Name____



What is the problem?

How can I solve it?

Draw some ideas!

What is the best idea?

What steps will I use?
What materials will I need?

Did your idea work?
Can you make your idea better?

How will you share with others?

Student Checklist

I understood the problem.	
I made drawings to show my ideas.	
I used my time wisely.	
My project met the constraints.	
I used materials and tools correctly.	
I wrote my ideas in my design challenge journal.	
I worked well with my group.	
My project was neat and attractive.	

Let’s Trap a Wild Thing Rubric

Student’s Name________________________________

	Points Possible	Points Awarded
Student understood what was expected.	10	
Student worked well with his or her teammates.	20	
The group’s design met the requirements.	20	
Is the final product an original idea?	10	
Is the student’s design challenge journal complete?	20	
Did the Wild Thing trap work?	20	

What did you do to help complete the design challenge?

Teammate Evaluation

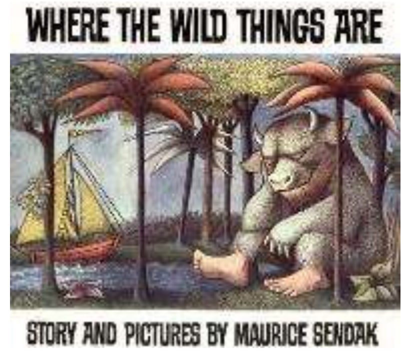
Your Name____

Group Member's Name____

Statement	Yes	No
Contributed idea to the project.		
Listened to and respected others in the group.		
Did his/her fair share of the work.		
Helped gather materials.		

What did this group member do to help complete the design challenge?

Comments:



Title: Let's Build a Boat!

Grade Level: 1st

STEM Content Standards:

Science Standard:

1-ETS1-2 Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

Benchmark: ETS1.C: Optimizing the Design Solution because there is always more than one possible solution to a problem, it is useful to compare and test designs. (1-ETS1-3)

Math Standard:

AR.Math.Content.1.MD.A.2 Express the length of an object as a whole number of length units, by laying multiple copies of a shorter object (the length unit) end to end; understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps

Technology literacy standards:

Standard 9: Students will develop an understanding of engineering design.
In order to comprehend engineering design, students should learn that:
K·2 Benchmarks
A. The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.
B. Expressing ideas to others verbally and through sketches and models is an important part of the design process.

Big Ideas:

- Design Loop
- Understanding how different materials and shapes can create stronger or weaker structures
- Measuring lengths using nonstandard methods

Essential Questions: How can you create a boat that will sail, and support the most weight with the given materials?

Scenario: The Wild Things have been located on an island in the middle of the Ocean. We are going to go find them, and explore their land. However, we have a problem. We first need to build some boats that will carry us across the ocean to them.

Challenge: In your group you will create a boat from the given materials. This boat must be able to sail, and to hold as much weight as possible. After building your group's boat you will compare it to other group's boats, write down the differences and similarities, and then measure them using the big pink erasers. After this is done we will put the boats to the test and sit them in water, and add pink erasers till it will no longer float. The boat with the most erasers will win!

Tools, Materials, Resources:

Tools:	Materials:	Resources**:**
• Glue • Tape • Scissors • Bowl of water • Pink Erasers	• Sheet of Aluminum foil • 10 Popsicle sticks • 1 Sponge • 1 Juice box • 2 Foam sheets • 4 Rubber bands • 2 Construction paper	• *Where The Wild Things Are* book • Design Loop

Content Information:

Content Information: After reading Where the Wild Things Are students will build a boat using different materials. They will do this by using the design loop, which is a problem solving method that has the student's brainstorm, build, and test their creations. The students will test their boats by putting them in a bowl of water, and adding one pink eraser at a time until it is no longer floating. The boat that holds the most erasers will win. The students will also learn ways to measure without using rulers they will instead use markers, erasers, etc.

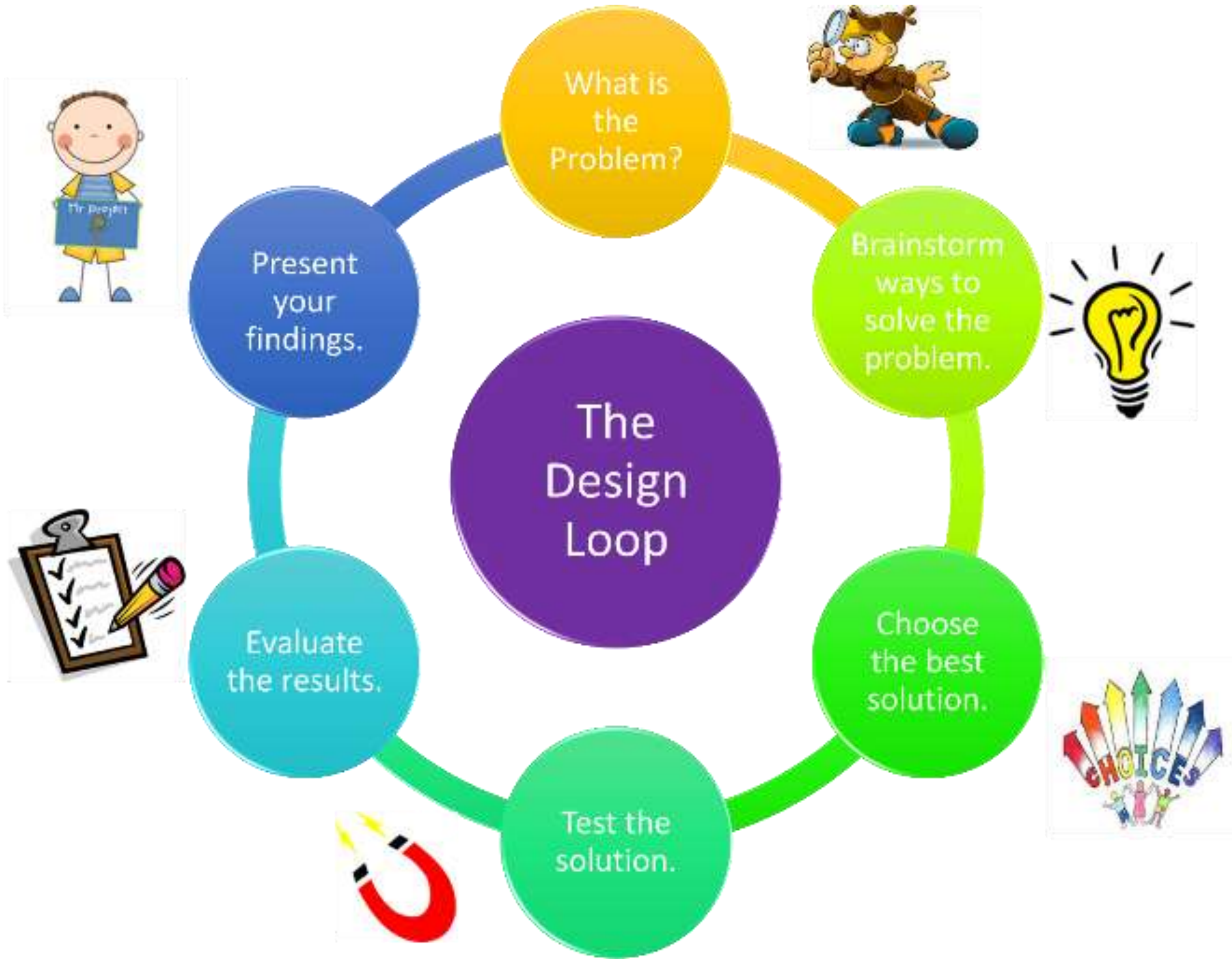
Deliverables:

- Design Loop
- Journal showing comparisons, and measurements
- Boats.

Parameters or Constraints:

- You will only be able to use the materials provided
- You will only have 30 minutes to build your boat
- You have to have the first part of the design loop done before you can start building.

Evaluation: I will evaluate if the boat sails, how much weight it will hold, their design loop, and their journals.

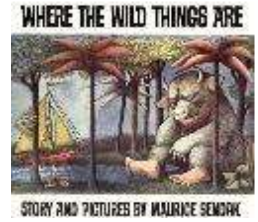

The Design Loop
What is the Problem?
Brainstorm ways to solve the problem.
Choose the best solution.
Test the solution.
Evaluate the results.
Present your findings.

Journal for boat comparison

For this part of the activity you will compare your boat to two other boats. You will just write what is the same and different. You will then get some pink erasers, and lay them end to end along the side of each boat to find the length.

How is it different?	How is it the same?	How many erasers long?	How many erasers until it sank?
Boat 1:			
Boat 2:			

How many erasers did your group's boat hold until it sank? ___________



Student Version

Let’s Build A Boat!

Essential Questions: How can you create a boat that will sail, and support the most weight with the given materials?

Scenario: The Wild Things have been located on an island in the middle of the Ocean. We are going to go find them, and explore their land. However, we have a problem. We first need to build some boats that will carry us across the ocean to them.

Challenge: In your group you will create a boat from the given materials. This boat must be able to sail, and to hold as much weight as possible. After building your group’s boat you will compare it to other group’s boats, write down the differences and similarities, and then measure them using the big pink erasers. After this is done we will put the boats to the test and sit them in water, and add pink erasers till it will no longer float. The boat with the most erasers will win!

Tools, Materials, Resources:

Tools:	Materials:	Resources:
• Glue • Tape • Scissors • Bowl of water • Pink Erasers	• Sheet of Aluminum foil • 10 Popsicle sticks • 1 Sponge • 1 Juice box • 2 Foam sheets • 4 Rubber bands • 2 Construction paper	• *Where The Wild Things Are* book • Design Loop

Deliverables:

- Design Loop
- Journal showing comparisons, and measurements
- Boats.

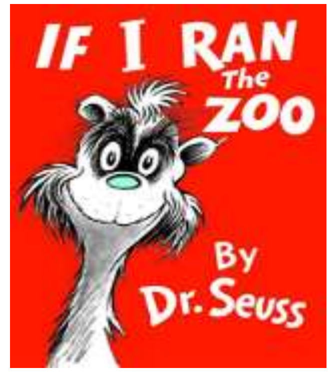
Parameters or Constraints:

- You will only be able to use the materials provided
- You will only have 30 minutes to build your boat
- You have to have the first part of the design loop done before you can start building.

Evaluation: I will evaluate if the boat sails, how much weight it will hold, your design loop, and your journal.

If I Ran the Zoo

Teacher Copy



Grade: 3

Unit: Forces and Structures

STEM Content Standards

Technology

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Science:

3-PS2-1 Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

Math:

AR.Math.Content.3.MD.C.5 Recognize area as an attribute of plane figures and understand concepts of area measurement:

Big Ideas:

- Understand how to think creatively
- Use the design loop to problem solve
- Understand that by using the same materials in different ways, some can hold more weight than others
- Different structures can hold more weight than others

Essential Question:

Using the materials provided, can you build a zoo cage that can hold the most weight without collapsing?

Scenario:

Cages are very important to keep animals and humans safe. Recently, a little boy fell in a Gorillas cage at a zoo. The little boy was not hurt but the Gorilla did not survive. A roof on the gorilla's enclosure would have kept it and the little boy more safe. These roofs need to be able to hold weight on top so it does not fall on the animals in the cage. After reading *If I Ran the Zoo*, can you build a cage out of the materials provided that will hold the animal and not collapse when weight is put on it?

Challenge:

You must work with a partner to create a cage that is strong enough to hold weight on top of it and not collapse. Your cage must hold your zoo animal you create.

You need to complete each step of the design loop worksheet and write down your findings.

You may only use the materials provided, but you do not have to use them all.

Be creative and have fun!

Present your cage to the class and explain what you did to create it. What ideas did you have in the beginning that did not work? What did you change? How did you fix the problems?

Materials and Tools: Per Group

- 5 straws
- 2 Cardboard Pieces(4"x5")
- Regular Clay
- Tissue Paper
- Glue
- Scissors
- Weights(textbooks)
- Plastic zoo animal

Content Information:

What is a structure?

- A structure is something that has been built to hold together

What is a force?

- A force is strength or energy that happens due to physical action or movement

Deliverables:

- Completion of Design Loop worksheet
- Completion of the results worksheet
- Presentation of final design, results, and reasoning for the way you arranged the cage.

Parameters or Constraints:

- Use only the materials provided
- The cage you build must hold the plastic zoo animal inside
- You may cut the straws but you will only get 5 for this challenge

Evaluation:

Students will be evaluated using a rubric on the work they did on their worksheets to see if they answered all of the questions, understanding of concepts, if they met the parameters, and on their final presentation and creativity.

Student Copy

Essential Question:

Using the materials provided, can you build a zoo cage that can hold the most weight without collapsing?

Scenario:

Cages are very important to keep animals and humans safe. Recently, a little boy fell in a Gorillas cage at a zoo. The little boy was not hurt but the Gorilla did not survive. A roof on the gorilla's enclosure would have kept it and the little boy safer. These roofs need to be able to hold weight on top so it does not fall on the animals in the cage. After reading *If I Ran the Zoo*, can you build a cage out of the materials provided that will hold the animal and not collapse when weight is put on it?

Challenge:

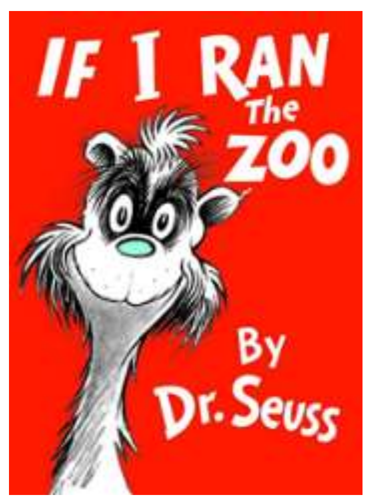
You must work with a partner to create a cage that is strong enough to hold weight on top of it and not collapse. The weight is going to create force on your cage, and it must be able to withstand this force. Your cage must hold your zoo animal you create.

You need to complete each step of the design loop worksheet and write down your findings.

You may only use the materials provided, but you do not have to use them all.

Present your cage to the class and explain what you did to create it. What ideas did you have in the beginning that did not work? What did you change? How did you fix the problems?

Be creative and have fun!



Tools: Per Group

- ❖ 5 straws
- ❖ 2 Cardboard Pieces(4"x5")
- ❖ Clay
- ❖ Glue
- ❖ Scissors
- ❖ Weights(textbooks)
- ❖ Plastic zoo animal

Content Information:

What is a structure?

- ❖ A structure is something that has been built to hold together (your cage is your structure)

What is a force?

- ❖ A force is strength or energy that happens due to physical action or movement

Student Lab Sheet: Zoo Cage Challenge

Name: ___________________________________

What is the problem?

____

____

____

Possible Solutions: star the one you are going to pick

How many books was your structure able to hold? ________________________________

How could you re-design your cage to make it better? (Sketch it)

Evaluation

Grading Rubric

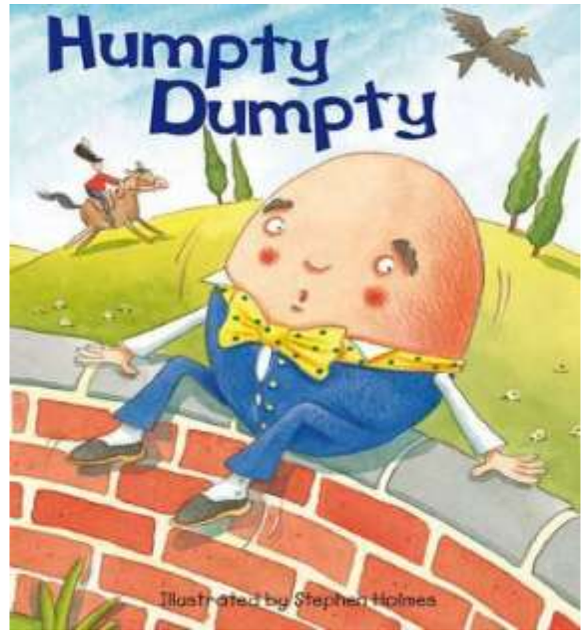
Student is able to follow design loop to build and complete project (0-25pts):______

Student is able to cooperatively work with group members (0-25pts):_______

Student demonstrates knowledge of shape and structure (0-25pts):________

Student completed all questions on lab sheet (0-25pts):_______

Humpty Dumpty Protective Clothing Challenge



Title: Help Humpty Dumpty Make a Safe Landing
Book: Humpty Dumpty, Illustrated by Stephen Holmes

Disciplinary Area: STEM

Grade Level: Kindergarten

STEM Content Standards:

Arkansas Science Standards
Standard 2: Living Systems:LS.2.K.5 Characteristics, Structure, and Function
Students shall demonstrate and apply knowledge of living systems using appropriate safety procedures, equipment, and technology.
Structure and Function: Name and describe the five senses.

Standards for Technological Literacy
Standard 8: Design, Students will develop an understanding of the attributes of design. In order to comprehend the attributes of design, students should learn that:
A. Everyone can design solutions to a problem.
B. Design is a creative process.

Arkansas Mathematics Standards
AR.Math.Content.K.G.A.2 Geometry: Identify and describe shapes (squares, circles, triangles, rectangles, hexagons, cubes, cones, cylinders, and spheres).
Correctly name shapes regardless of their orientations or overall size.
Note: Orientation refers to the way the shape is turned (upside down, sideways).

Big Ideas:

- Proper use of design process
- Understand attributes of design process
- Accurately name and describe the five senses
- Creatively design solutions to a problem
- Accurately name and describe shapes

Essential Question:
How could you help Humpty Dumpty stay intact when he falls off of the wall?

Scenario: Humpty Dumpty was enjoying a picnic while sitting on top of the king's wall. All of a sudden, the king's horses started charging toward Humpty Dumpty. Terrified, Humpty Dumpty lost his balance and fell off of the brick wall. He fell off the wall and onto the ground below.

Open Discussion:
Imagine that we are sitting on the wall with Humpty Dumpty. Use your senses, and describe to me what you see, hear, smell, taste, and touch.

What are the five senses?
How do we use our senses?
Why does Humpty Dumpty need protection?
How can we use what we saw to help Humpty Dumpty?

Challenge: Using the provided materials, and following the design loop, design protective clothing to help Humpty Dumpty land safely when he falls off the wall.

Tools, Materials, and Resources:
Teacher:
Humpty Dumpty Book, constructed wall
Students: (Pair up)
Egg (Humpty Dumpty),
Pencils, tape, construction paper, glue
Cloth, paper cups, cotton balls, paper towel and toilet paper rolls

Content Information:

- Common shapes will be discussed while reading the book.
- The picnic content sheet, and shape party will reinforce students understanding of shapes.
- Ask students, "What other items (shapes) might be in the picnic basket?"(Watermelon, ice cream cone, etc.)
- Students will describe what takes place in the story by using their senses.
- Students will use what they learned from the story to design protective clothing for Humpty Dumpty.
- Students will learn that everyone can design a solution to a problem.
- Students will use the design loop to reach their very best solution.
- Students will learn that design is creative.
- Students will value protection.

Deliverables:
Teacher will engage while reading the book, and what is occurring on each page. Have students use the pictures to describe what they see, hear, feel, taste and smell.
Students will gain a clear understanding of how to identify and describe shapes from the book, and completing the Shape Party worksheet and the Picnic Basic Contents sheet.
Students will learn how to work together in a team, and how to use the engineering design loop to develop their solution.

Parameters or Constraints:
Protective clothing must keep Humpty Dumpty intact when pushed off the wall.
Humpty Dumpty must not crack!
Students must work well in a pair.

Student must use the engineering design loop.
Students must only use 4 of the materials provided.
Students must complete the challenge in 17 minutes.

Evaluation:
Students will go through the engineering loop design process by: clarifying the problem, imagining possible solution (using the protective clothing design worksheet) and creating their best idea. Students will test their solution, and make improvements, if necessary. Students will present their product, and be evaluated on their participation, performance, shape and sense accuracy, team-work, proper use of the design loop, and their product. Students will need to be able to defend their ideas, and justify their reasoning after their solution has been tested.

Checklist is the form of assessment.

Humpty Dumpty's Picnic Basket Contents

Describe the shape of each item as a class. Draw the shape

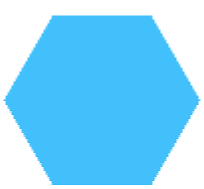
Napkin

Paper plate

Pizza

Kit-Kat

Hexagon



(Square, circle, triangle, rectangle, hexagon)

Cube

Cone

Coke

Soccer ball

(cube, cone, cylinder, sphere)

Protective Clothing Design

Brainstorm: Sketch your protective clothing design, and draw all of the materials used.

Idea 1

Idea 2

Idea 3

Circle the best design with your partner!

Design Activity Guide: Help Humpty Dumpty Make a Safe Landing

Humpty Dumpty will be pushed off the wall! Design protective clothing, so that he makes a safe landing without cracking his shell. You may use 4 of the materials provided. You have 17 minutes to construct a safe landing Humpty Dumpty, go!

Materials:

- Egg(Humpty Dumpty),
- Pencils, tape, construction paper, glue
- Cloth, paper cups, cotton balls, paper towel and toilet paper rolls

Humpty Dumpty Protective Clothing Challenge

Assessment Checklist

Student's Name:

Proper use of Design Loop (20 pts)

Good team-work (20 pts)

Creative design (20 pts)

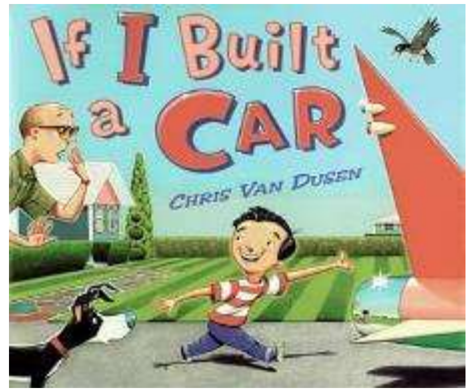
Listened to directions (20 pts)

Followed the parameters (20 pts)

Total:

Ask team-member if their partner deserves 5 extra bonus points for doing a good job.

If I Built a Car by Chris Van Dusen
Teachers Guide



Grade Level: 3rd Grade

Unit: Structures and Models

STEM Standards:

Next Generation Science Standards

PS3.C Motion and Stability: Forces and Interactions

- When objects collide, contact forces transfer energy, which results in a change in the objects motion.

PS2.A Forces and motion:

- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion.

Common Core Mathematics Standards:

Measuring & Data

- Represent and interpret data: generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch.
- Express the length of an object as a whole number of length units, by laying multiple copies of a shorter object (the length unit) end to end; understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps.

Standards of Technological Literacy

Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation and experimentation in problem solving.

A. Asking questions and making observations helps a person to figure out how things work.
B. All products and systems are subject to failure. Many products and systems, however, can be fixed.

Standard 11: Students will develop the abilities to apply the design process.

A. Brainstorm people's needs and wants and pick some problems that can be solved through the design process.
B. Build or construct an object using the design process.

C. Investigate how things are made and how they can be improved.

Big Ideas:

- Engineering design process
- Role of brain storming to problem solve
- Applied creative thinking for innovation
- Understanding the importance of measurements when constructing
- Understanding the concept of motion, force, and energy
- Ability to work with peers
- Understanding the value of money

Essential Question: How can you design a car that will allow Jack and his friends to safely travel down three different ramps?

Scenario: Oh no! Jack thinks his dad's car is boring and plain. He has imagined a safe and unique car that he wants to build but Jack can't construct the car without you! It is up to you to help Jack build a unique car that will safely carry two or more passengers down a hill.

Instructions: The instructor or a student needs to read out loud the book *If I built a Car*. After reading the book, the children will be divided into groups of four and then they need to construct a car by using the design loop provided. To avoid wasting materials, the students will need to come up with an idea, present it to the teacher, and then buy the materials using a credit/debit money system. Once the students have built their cars and made any necessary changes, they will then test out them out on three different size ramps. The students will measure their car's distant traveled and record it. The students will then add more marshmallows to their cars so that they can see the effects of weight. The group of students whose car traveled the longest or held the most marshmallows wins the contest.

Parameters: The car must:

- Be completed within the assigned hour
- Be able to safely roll the two or more passengers down a ramp
- Be designed using the engineering design loop
- Be made only using the materials provided
- Be documented by each group member
- Roll down three different ramps
- Have an open top and passengers cannot be taped or held down by any materials.

Materials & Resources: (groups of 4)

(2) small cups	(2) cardboard pieces	(1) empty soda bottle	
(4) sheets of paper	(7) popsicle sticks	(2) straws	24"duct tape
(4) buttons	(4) bottle caps	(6) pipe cleaners	other recyclables

*Each group may have a pair of scissors and (x) amount of marshmallows. A hand drill and saw may also be used during the creating process. The students will need to buy the materials using a credit/debit system. *

Content Information:
Students will need to know how to measure and estimate an objects length in order to create a stable cart that will propel forward. The value of money would also need to be discussed so that the students will be able to determine what materials they can and cannot afford. The teacher will need to discuss Newton's first law of physics. This will allow the students to understand the reasons why the car starts and stops moving. They will need to be able to understand the effects of friction and other forces that will work against the car while it's in motion.

Newton's First Law: An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force.

Friction: The resistance that one surface or object encounters while moving over another.

Car Construction

Scenario: Oh no! Jack thinks his dad's car is boring and plain. He has imagined a safe and unique car that he wants to build but Jack can't construct the car without you! It is up to you to help Jack build a unique car that will safely carry two passengers down a hill.

Challenge: Construct a car, using the materials provided, that will allow multiple passengers to safely travel down three ramps.

Deliverables: At the end of this challenge, each group will need to turn in the car that they constructed. Each group member will turn in his or her notes/documentation of the design loop process and the peer evaluation form.

Parameters: The car must:

- Be completed within the assigned hour
- Be able to safely roll the two or more passengers down a ramp
- Be designed using the engineering design loop
- Be made only using the materials provided
- Be documented by each group member
- Roll down three different ramps
- Have an open top and passengers cannot be taped or held down by any materials.

Materials:

(2) small cups	(2) cardboard pieces	(1) empty soda bottle	
(4) sheets of paper	(7) popsicle sticks	(2) straws	other recyclables
(4) buttons	(4) bottle caps	(6) pipe cleaners	24"duct tape

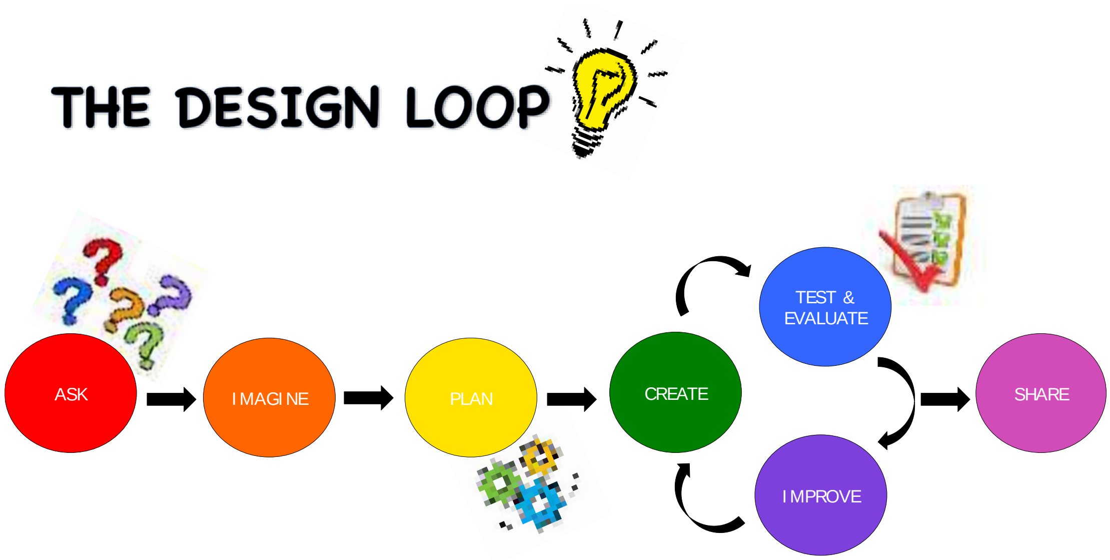
* Each group may have a pair of scissors and (x) amount of marshmallows. A hand drill and saw may also be used during the creating process. The students will need to buy the materials using a credit/debit system. *

Test:

1. Test out the solution on the lowest ramp and make any adjustments needed.
2. After finalizing the solution, the group will need to present their cars to the class and discuss the process of building the car.
3. Then we will put each car to the test. The students will test their cars out on all three ramps and will record their results.
4. After the first round of testing, the students will add marshmallows to their cars to see what effect the weight has on the cars. The students will need to record their findings.

5. Lastly, each group member will need to write 3-4 sentence discussing why or why not their model was successful and what improvements they would make if they were to repeat the assignment.

Documentation: Each team must create Jack's car by using the design loop. Remember to document every step your team makes while completing the assignment.



My problem is:

My goal is:

My model will look like:

Or this…

Or this…

The materials I need are:

The best solution is:

My group member's duties are:

My results are:

The adjustments needed:

The final results are:

Peer Evaluation

Name: ________________________

Group Number ______________

Rate your group members 1-5
1 = did not participate and 5 = took the lead/extremely helpful

Group Members Name	Brain Storming (1-5)	Creating Model (1-5)	Collecting Data/Testing/ Presenting (1-5)

Why or why didn't your model work? What could you change?

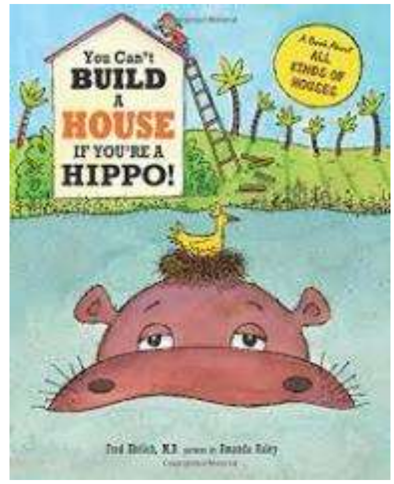
Teacher Evaluation:

Student's name ______________________

Group Number: ___________

Car was submitted on time	/10
The car successfully carried the passengers down the ramps	/25
The car demonstrated uniqueness and creativity	/10
The student's clearly presented their car to the class	/15
The group demonstrated their understanding of the design loop process	/20
Documentation of the design loop and peer evaluation	/20
Total	/100

Additional comments:



Title:
"You CAN build a house!"

Grade Level:
Grade 2

STEM Content Standards:

Arkansas Science Standards
2-ETS1-2: develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem

Standards for technological literacy
Standard 11: Students will develop abilities to apply the design process
(K-2): K-2 Benchmarks

A. Brainstorm people's needs and wants and pick some problems that can be solved through the design process.
B. Build or construct an object using the design process.

Investigate how things are made and how they can be improved

Arkansas mathematics standards
AR.Math.Content.2.G.A.1

- Recognize and draw shapes having specified *attributes* (e.g., number of angles, number of sides, or a given number of equal faces)
- Identify triangles, quadrilaterals, pentagons, hexagons, and cubes

Big Ideas:
Major concept delivered through design brief: Students will work to create a shelter for a selected animal, using materials found in nature.

Essential Question:
What kind of shelter can you make out of materials found only in nature that will protect this animal?

Scenario:
A baby animal has gotten stranded and a storm is quickly approaching. You have found the animal and want to help make it a shelter. However, you can only use materials that are found in nature.

Challenge:
Build a shelter for this animal using materials that are found in nature that can withstand a heavy rain within a time limit of 30 minutes. Write a paragraph rationale for your design and present it to your classmates.

Tools, Materials, and Resources:
Students will go outside the classroom and collect materials that they can use to build their shelter. We will also allow them to use scissors and a limited amount of tape to hold together pieces.

Content information:

1. Discuss drawing out sketches and what should be included in the sketch and how this will help you build your model.
2. After talking about the sketches, tie this into the design loop
3. Pass out assignment sheet to kids
4. Brainstorm as a class possible materials that could be used for project
5. After talking about materials, talk about how pieces are assembled (angles, amount of sides) and what would work best for building a sustainable shelter
6. Have students pair up and read over assignment sheet and ask any questions
7. Go outside to collect materials
8. Come inside and start design loop
9. Present models to class along with the rationale (during this time, teacher will fill out rubrics)
10. Test models by creating a "storm" with water

Deliverables:
Students will deliver their completed shelter as well as notes on why they have chosen this design (a rationale).

Parameters or constraints:
Students will have to use only materials that they can find outside (we will allow scissors and tape to be used) and also build their design in 30 minutes due to the fast approaching storm.

Also, we will test their shelters by pouring water over it and seeing if a model of the animal stays dry and the shelter does not get destroyed.

There will be no size limits on the shelter.

Evaluation:
Students will be evaluated on their rationale for design and presentation to classmates of their shelter. They must have a reason behind their design and have followed the guidelines (used appropriate materials) as well as the time constraints. A scale/ rubric will be created for these forms of evaluation. Students will also fill out a group evaluation (as individuals).

You CAN build it!

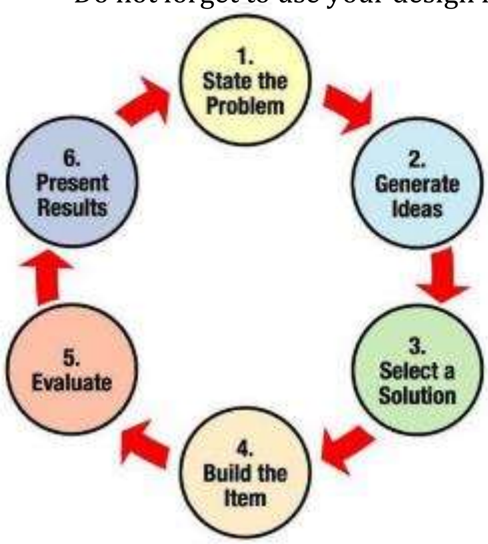
What's the problem?
You've come across a baby animal named Harriet that has been stranded! A big storm is coming and you need to help Harriet build a shelter to keep her safe.

YOUR challenge is. . .
Build a shelter to keep Harriet safe using only materials found in nature in 30 minutes before the storm arrives. Go outside and find your materials (tape and scissors will be provided). Write a 3-sentence rationale for why you have built this structure and how it is going to keep Harriet safe. Present your design to the class. After your shelter is completed watch to see if it can withstand the rain.

Resources
- What you find in nature (outside)
- Scissors
- Tape

Directions
1. Brainstorm ideas for your shelter based off the animal that you have selected
2. Go outside as a class and collect resources from nature
3. Sketch your design with materials you have collected
4. Build your model
5. Write your rationale (see challenge for instructions)
6. Present to class
7. See if it keeps Harriet dry during the storm (we will simulate a storm!)
8. Fill out your group evaluation

Do not forget to use your design loop!



You CAN build it Rubric

Science standards

________ (5 points) Sketch or drawing created prior to building that shows how the structure will work and solve the problem

________ (3 points) Sketch or drawing created prior to building but does NOT show how the structure will work or solve the problem

________ (0 points) No sketch has been created

Technological literacy standards

________ (5 points) Students followed design loop and built an attempt at solving the problem

________ (3 points) Students somewhat followed design loop, but may have skipped some steps

________ (0 points) Students did not follow design loop guidelines/ have an attempt at creating an actual solution to the problem

Math standards

________ (5 points) Students discussed parts of their design using vocabulary such as "angles, sides, shapes"

________ (3 points) students discussed physical attributes of their design, but not using math vocabulary

________ (0 points) Students did not discuss physical attributes of their design

_______/ 15 points

Narrative Curriculum Assignment

Title: Mystery Box

Grade Level: Second Grade

STEM Content Standards:

Mathematics

Measurement & Data-Measure & estimate lengths in standard units/represent & interpret data

AR.Math.Content.2.MD.A.4

Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit

AR.Math.Content.2.MD.D.9

Generating data from multiple measurements of the same object

AR.Math.Content.2.MD.D.10

Draw a picture graph and bar graph, with single-unit scale, to represent a data set with up to four categories

Science

Physical Science

2-PS1-1: Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

Patterns could include the similar properties that different materials share

2-PS1-2: Analyze data obtained from testing different materials to determine which materials have the properties that are suited for an intended purpose.

Technology

Standard 8: Students will develop an understanding of the attributes of design.
In order to comprehend the attributes of design, students should learn that:
K·2 Benchmarks
A. Everyone can design solutions to a problem.
B. Design is a creative process.

Standard 9: Students will develop an understanding of engineering design.
In order to comprehend engineering design, students should learn that:
K·2 Benchmarks

A. The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.
B. Expressing ideas to others verbally and through sketches and models is an important part of the design process.

Big Ideas: Students will be able to build a series of paper airplane models that can be tested to collect data, and interpret those results. The second part (plane catcher design) is to engage students in thinking of new methods that could be used to improve the lives of others.

Essential Question: What materials would help create the ultimate paper airplane by allowing it to fly the farthest and smoothest? What would be the best design in creating the prefect plane catcher in order to safely recover a paper airplane without causing any damage to the plane?

Scenario: A stranger handed you a box, like in *The Boy and The Airplane*, except it contained two brown paper bags. One of the bags contained a large sheet of butcher paper, foil, wax paper, some tape, one toilet paper roll, glue, scissors, paperclips, and three coins. The first bag contained a note stating can you design the ultimate paper airplane that can fly past five floor title? In the second paper bag contained pop stickle sticks, glue, small square of bubble wrap, foil, tape, scissors, string, paper, and dowel. This bag states that paper airplanes like to fly very high and can get stuck on top of high places. Can you design a plane catcher to prevent your paper airplane from being permanently stuck without hurting the design of your paper airplane?

Content:

Mathematics

- Understanding measurement- calculating the distance of the flight with using correct length of measurement
    - Students can throw both airplanes at the same time and determine the measurement or test each plane individually. Regardless, of how the test is conducted the students will have the ability to use measuring tools or counting titles to determine the distance of flight.
- Estimating measurement
    - Given the cabinet is 5 cubes high each cube is 6” tall, how tall is the cabinet for the plane catcher? Students will have the ability to solve word problems within this project. Students will be capable to apply this knowledge in other aspects outside this assignment as well.
- Record data to help determine which design allows the plane to fly the farthest

- Students will be able to draw, either a bar or line graph, and interoperate the results. The students will have a strong foundation in illustrating data and being able to interpret the information using appropriate mathematical vocabulary.

Physical Science

- Understanding materials of different textures can change outcome or results
- Using data to determine which method in constructing a paper airplane was either effective or ineffective based on the type of materials used in the design.

Technology

- Understanding the core concepts of technology by using the correct unit of measurement to record distance, using multiple versions of materials to test what will cause the plane to fly the farthest. Using the design loop as a system to complete the project to find the proper end results, through a method of planning.
- Students will discover that each individual will be able to design and create a method that seems effective based on prior knowledge reasoning skills
- Students will be able to improve designs through trial and error, observations, and asking/sharing results, methods, ideas with classmates
- Using the design loop students will be able to conduct and construct logical models for this challenge.

Challenge: Building the ultimate paper airplane & a plane catcher

Students will be in pairs (or groups of three) to follow the design loop in order to create the ultimate paper airplane. Each student will design their own paper airplanes, and test, each plane it five times. After recording the data, which is measuring the distance traveled, students will determine which plane was the most successful and why (this will be conducted with teammate(s)). After discussion the groups will renovate the idea to find the perfect method to having their paper airplane travel a greater distance. The new modified paper airplane will be tested three times, and students will combine all data together to differentiate the result to class (and present their paper airplanes).

Student Version:

After reading part of *The Boy and The Airplane*, students be placed in pairs and will be given a box with selective materials to design their own paper airplanes, by using the design loop. Each student will be given a STEM journal to record each step of the design loop process along with, all data collection and reflect each day. Student will distinguish the problem, which is can you construct the ultimate paper airplane to travel past five floor titles? The parameters will be through the materials allowed to be used within the design process. Students will explore the situation by observing the materials and prior knowledge in which could allow the paper airplane to travel a great distance. Together students will brainstorm options, for each student must make two models-ideally wanting students to have each paper airplane created with all different materials. Therefore, students will sketch and write down ideas. Through these sketches and written description students will execute planning out the idea and design the models. All models will be tested and recorded. The results will help students determine which design is more effective to combine together to make the ultimate paper airplane. All students will gather in the best testing area to have each group test their model and data will be collected. After the experiment students will gather and collaborate their discoveries. Students will also be executing this step each day to share thoughts, ideas, or problems they might be having can need other insights. The next week will start the process of creating a device that will be the most effective plane catcher, by not damaging the final paper airplane model. Prior to starting the project students will listen to more parts of the story; *The Boy and The Airplane*. Afterwards students will follow the same design loop to construct a device using selective materials to help grab their paper airplane from the top of a cabinet. Students will also need to solve a word problem- the cabinet is 5 cubes high each cube is 6" tall, how tall would the plane catcher need to be to reach the cabinet? Students will be using the same STEM journal to record each day and take a-ways. Students will be encouraged to present findings (and models) at the end of each day to show that students are still working as a class whole even if assigned to a specific partner.

Day 1: Students will gather for read-aloud activity *The Boy and The Airplane* by Mark Pett. The book will only be read up to the part the boy is flying his toy airplane. Students will record in writing journals on what they predict will occur in the picture book. The students will pair up to begin the STEM challenge. The challenge will be given oral and written within their STEM journal. Together as a team the students will distinguish the problem, establish parameters, and explore situation within the three pages of journal. This section will be completed in their own thoughts and ideas. This day is to generate a grasp of what the project is as a whole rather than just focusing on making a plane. Class discussion will need to be conducted to enhance what causes a variety of reactions to paper airplanes-can begin with read aloud.

Day 2: Students will meet with their teammate to think about ideas that were discussed from the day before (poster will be displayed). The materials will be distributive to each group for examining. In journals students will brainstorm options about how the materials can be used to make an effect paper airplane; drawings will be placed in this section. Students will share and pair ideas before planning ideas, small goal is to see if students will each use different materials to farther observe which the best is. Students will be creating two paper airplanes and will have initials marked on each design. After students will display their design in the designated area for projects. Students will gather for group discussion on takes during this section of the design loop. What parts did they enjoy? Reason? Did certain parts help conduct a better idea for a paper airplane? Why do you think so? What were some ideas on making a paper airplane? Why did you use those materials? Was it based on yesterday's discussion-explain, etc. *Note: need to have students determine which type of graph (line plot or bar graph) they are most comfortable with. Go over examples for each type to help the students decide.

Day 3: Students will group with their teammate and discuss where would be the most effect location to test their paper airplane (keeping in mind that will be the location for the whole day). Students will also need to explore what would be the best way to measure the planes distance; mark so many units of measurement, or other ways? (The students may need a discussion-refresher or lesson in measurement based on AR standard if it has not been addressed yet). Today, the students will predict the distance of their paper airplane and explain their reasoning. The students will be testing only *one* paper airplane each (5 test per plane) and record results in journal. After each test students need to make a note of what happen; was if a perfect take off, did the paper airplane fly into any objects, any loops made by paper airplane, etc. After each partner is finished they will share results side-by-side to narrow down paper airplane designs. Based on today's results, students will make a prediction on what will happen with the second airplane. Class will gather for a discussion on take-a ways; what was challenging, did location work well, what type of units of measurement works best-why is that, etc.

Day 4: Repeating same process as above; location, unit of measurement decided, etc. The date from this day should be next to the date from the day before, but in a different color. After the data is collected share side-by-side to determine which two planes flew the best. Using their notes from previous days, they will write renovated ideas, their ideas must come from what they wrote down (not what other teams did). Drawings are required and labels of materials. [Assessment area-are students using their journals as evidence to support their new ideas?] This is strictly renovating idea day. The students will write in journals about expectations of new idea. Then all students will gather to discuss take-away moments; mainly what did their data show and some ideas on how to make the ultimate airplane ideas.

Day 5: The teams will be designing their group idea from the previous day. All students will meet in the hall to conduct final experiment. There will be markers to indicate starting points and will be using floor as unit of measurement (one square title is one square foot). Each group will fly their paper airplane twice (one per group mate). While the process occurs the teacher will be recording results. After each group has finishes all students will gather to share results (or airplane) and express if expectations were met. The students will be engaged in take-away; what materials were used on the winning paper airplane, why was the winning paper airplane able to travel the farthest, etc. [Reflection aspect-assessment area]. After discussions students will place all paper airplane back on project area. Students will draw graph in journal and express their feelings or thoughts about the results (winner and their own team paper airplane).

Day 6: Students will gather to discuss what was their predictions were for the remaining parts of the book. Beginning reading the story up to the boy trying all the ideas (right before he plants the seed). Ask students to make predictions together, and to write them in their writing journal. Prior to leaving the gathered area present the next part of the project; the plane catcher-all the team planes are stuck on a high cabinet. Students will be designing an invention that will help bring their team paper airplane down from high places. The students will be practicing word problems on deciding how tall the plane will be place upon. Along with, using the design loop to construct a design that will be effective and not damage their plane. Using their STEM journals to distinguish problem, recognizing the parameters, and exploring the situation. This part will be conducted collaboratively within team.

Day 7: Students will gather to share what they wrote down from previous day to help others prior to starting the next steps of the design loop. The student will be given the materials and begin to brainstorm options on how to create the best plane catcher. Students will be recording their personal idea and decided idea; drawings with labeled materials should be present. Students will begin on constructing idea. The model should not be completed on this day-if so, begin asking high thinking questions or even test idea. The students should have word problem completed, needs to have evidence to support reasoning (pictures, words, etc.). Have students gather for class discussion on take-away moments; what are some challenges within this area, what were some ways in solving the word problem, how do you know if you are right, is there another way to solve it, etc.

Day 8: Students will continue to work on making model. May roll into another day depends on class progression. Depending on how far class is in the process will determine the take-away discussion questions. *Ideally want students 90% done with model making. Have each group test idea and make modifications on day 8 or 9.

Day 9: Students will be completing last minute touches. While models are drying have students gather. What were some of the challenges making this model compared to the paper airplane, which one seemed more engaging-why, do you think the boy used any of the models that are created to get the plane down, etc. After take-away discussion finish the book completely, and ask more high thinking questions; was his idea a bad idea, what is another way the boy (man) could have retrieved his plane, why do you think he gave away his plane? Who gave the boy the plane in the beginning?

Day 10: Last day of project, students will be experimenting their model on their own group's paper airplane. Record results. Have class discuss what would they find out about their experiment, what were some different ideas that were not used in your team design, etc. [Reflections] After experiment have student display project in the project area for all to view. Have students self-evaluate and peer evaluate within STEM journal. [Assessment area]. Gear students to wondering how this activity is applied in a real-world aspect, could be conducted together or writing assignment then share ideas. Some ideas to think about, why would it be important to understand how paper airplanes reach based on the materials to construct them, what can the "plane catcher" be used in a more realistic way- could it be a help tool to certain people, why do you think these ideas, how did you discover these ideas, etc.

Tools, Materials, & Resources:

Paper airplane

- Large sheet of butcher paper
- Foil
- Wax paper
- Tape
- 1 Toilet paper roll
- Glue
- Scissors
- Brown paper bag
- Paper clips
- 3 Coins

Plane catcher

- Pop stickle sticks
- Glue
- Small square of bubble wrap
- Foil
- Tape
- Brown paper bag
- Scissors
- String
- Paper
- Dowels

Content information: The literacy book; *The Book and The Airplane*. The students will be familiar with line and bar graphing. Decoding word problems that contains measurement units. The students will need to preview or be familiar with the design loop. Students need to be about to explain word problems is strong effective method (pictures, words, traditional math methods, etc.). Small discussion on who has ever made a paper airplane, how do you make one, do you have to certain materials, etc.

Deliverables: The students need to collaborate with teammate in the decision process along with, activity working within STEM journal and writing journal.

Parameters or Constraints: Each day students can only work on certain parts of the design loop. Materials does have a limit for each challenge. The *catch a plane* needs to a particular height to reach the stuck paper airplane. Students could make a variety of net-like structures to help scoop up the paper airplanes or could even make a type of clamp structure. The paper airplane need to have the right amount of weight to be able to fly the farthest distance. Students are creating a paper airplane out of non-traditional materials that are used.

Evaluation:

Peer Evaluation with Teacher Response- Teachers pay teachers

Name________________________

Group Work Rubric

Fill in the names of each group member, do not rate yourself. Circle a score from 1 to 5 for each team member, with 1 being poor work and 5 being excellent work.

Remember to rate fairly and write a comment about why you gave each person that rating.

Group member's name	Worked as a team Principled, reflective, communicator, open minded, inquirer	Stayed on task Principled, thinker	Politeness Principled, reflective, communicator, thinker, caring	Reflection Here is a space to provide a positive comment and an area to work on
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	

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	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	

Group Reflection for ________________

You were evaluated by your teammates on the following areas in regards to the bridge building project. You received one grade for the entire rubric, but I wanted you to see how your did in regards to the team in each area.

Worked as a team Principled, reflective, communicator, open minded, inquirer	Stayed on task Principled, thinker	Politeness Principled, reflective, communicator, thinker, caring	Comments from your teammates Reflect and Learn

Group Reflection for ________________

You were evaluated by your teammates on the following areas in regards to the bridge building project. You received one grade for the entire rubric, but I wanted you to see how your did in regards to the team in each area.

Worked as a team Principled, reflective, communicator, open minded, inquirer	Stayed on task Principled, thinker	Politeness Principled, reflective, communicator, thinker, caring	Comments from your teammates Reflect and Learn

Name: ________________________ **Date:** ___________________

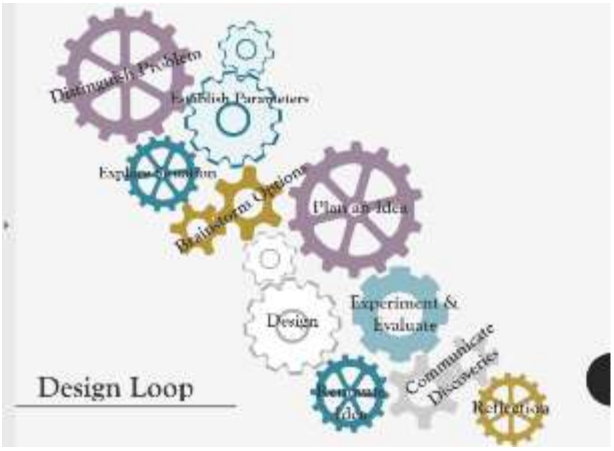
Project Rubric

Requirements	1 Point	2 Points	3 Points
Project Design	I did not label my design. It is hard for other people to understand how my design would work.	My design has some labels. Other people can understand how my design would work, but may have some questions.	My design is labeled. It is easy for other people to understand how my design would work.
Model	My model is not finished or doesn't work in the way it was designed. I did not test my design or improve it.	My model works, but is weak in areas. I have done some testing and tried to improve it.	My model works in the way it was designed. I have tested it and improved it.
Presentation	I can not explain my design, my model or how I tested it so other people can understand.	I can explain some parts of this project. I can talk about my design, how I built my model or how I tested it.	I can explain all parts of this project so other people can understand my design, how I built my model and tested it.

My Points: _/9

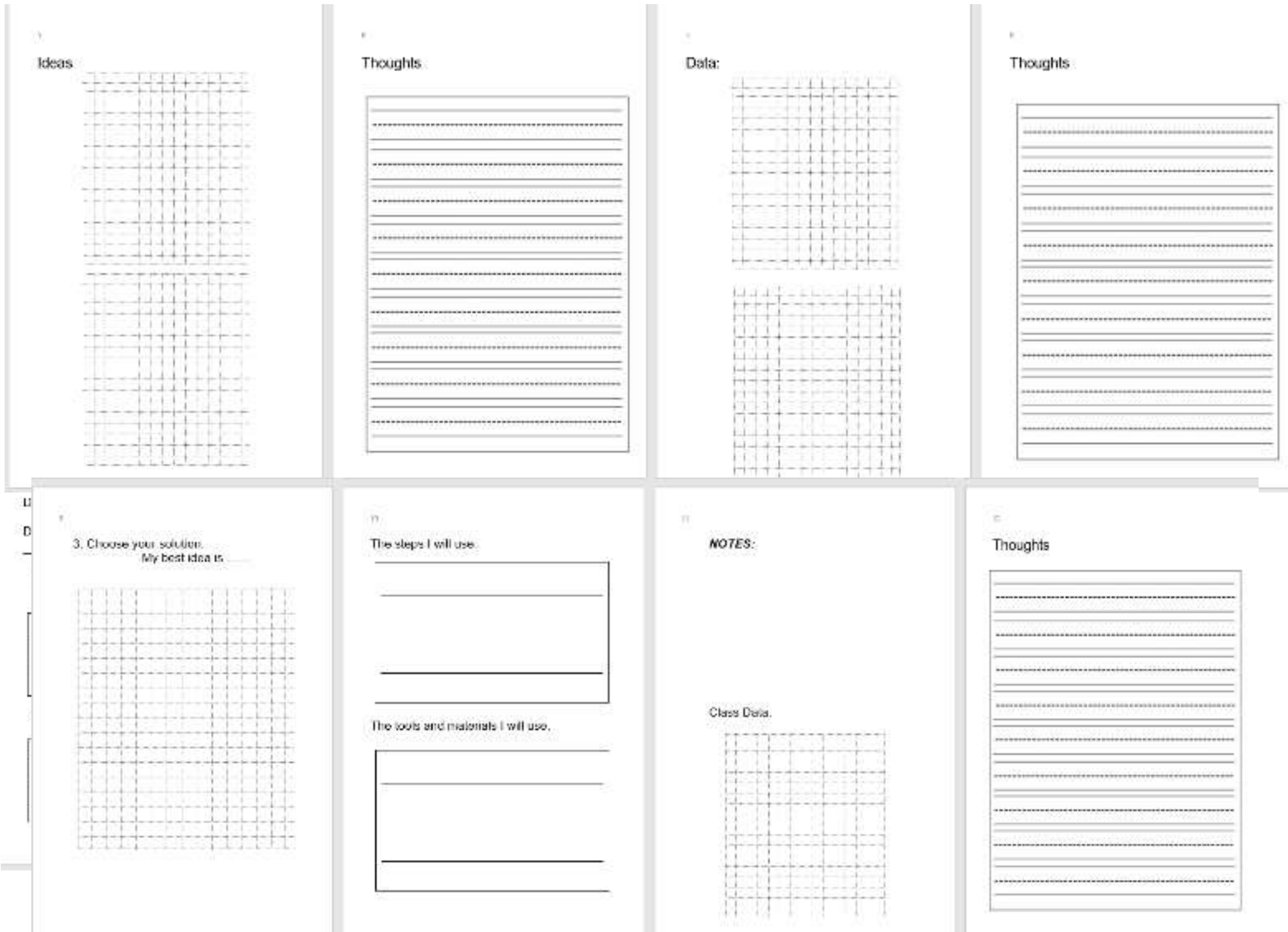
Self Evaluations- Teachers pay teachers

Journal



Having students use STEM journal to keep their research and planning ideas organized. The components of STEM journal for design and engineering projects is to…

1. Distinguish problem
2. Establish parameters
3. Explore situation
4. Brainstorm options
5. Plan an idea
6. Design
7. Experiment & Evaluate
8. Renovate idea
9. Communicate discoveries
10. Reflection



Ideas

Thoughts

Data:

Thoughts

3. Choose your solution.
My best idea is ____

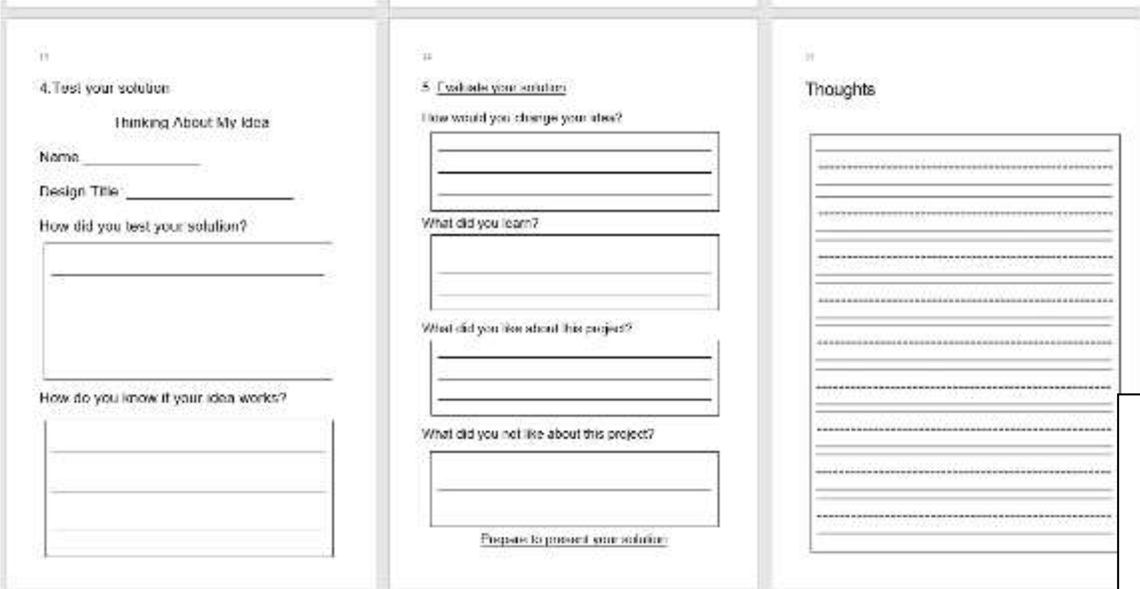
The steps I will use.

The tools and materials I will use.

NOTES:

Class Data.

Thoughts



4.Test your solution

Thinking About My Idea

Name ____

Design Title ____

How did you test your solution?

How do you know if your idea works?

5. Evaluate your solution

How would you change your idea?

What did you learn?

What did you like about this project?

What did you not like about this project?

Prepare to present your solution

Thoughts

Students will be using graphing paper to help students create their ideas in a more logical aspect, for those who may find it difficult to represent their ideas through sketches

This section of the journal can help the teacher find any problems or concerns that certain groups or individuals maybe having. Students will be using this to write down take a-ways for the day

Beekle Pays a Visit: Teacher Guide

Title: Beekle Pays a Visit

Grade Level: 2nd

Disciplinary area: STEM

Content Standards:

Science

Arkansas Science Frameworks:

- 2-ETS1-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
- 2-ETS1-2 Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- ETS1.A: Defining and Delimiting Engineering Problems
    - A situation that people want to change or create can be approached as a problem to be solved through engineering. (2-ETS1-1)
    - Asking questions, making observations, and gathering information are helpful in thinking about problems. (2-ETS1-1)
    - Before beginning to design a solution, it is important to clearly understand the problem. (2-ETS1-1)
- ETS1.B: Developing Possible Solutions
    - Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (2-ETS1-2)
- ETS1.C: Optimizing the Design Solution
    - Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (2-ETS1-3)

Technology

Standards for Technological Literacy:

- Standard 12. Students will develop the abilities to use and maintain technological products and systems.

    A. Discover how things work.

    B. Use hand tools correctly and safely and be able to name them correctly.

    C. Recognize and use everyday symbols.

Engineering

Standards for Technological Literacy:

- Standard 20. Students will develop an understanding of and be able to select and use construction technologies. In order to select, use, and understand construction technologies, students should learn that:

    A. People live, work, and go to school in buildings, which are different types: houses, apartments, office buildings, and schools.

    B. The type of structure determines how the parts are put together.

Math

Arkansas Mathematics Standards: Measurement and Data:

Measure and estimate lengths in standard units

- AR.Math.Content.2.MD.A.1: Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes
- AR.Math.Content.2.MD.A.2: Measure the length of an object twice with two different length units
    - Describe how the two measurements relate to the size of the unit chosen

For example: A desktop is measured in both centimeters and inches. Student compares the size of the unit of measure and the number of those units.

- AR.Math.Content.2.MD.A.3: Estimate lengths using units of inches, feet, centimeters, and meters
- AR.Math.Content.2.MD.A.4: Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit

English Language Arts

Arkansas English Language Arts Standards:

Research to Build and Present Knowledge

- W.2.7: Participate in shared research and writing projects (e.g., read a variety of print and/or digital sources on a single topic to produce a report; record science observations).
- W.2.8: Recall information from experiences or gather information from provided sources to answer a question.

Big Ideas:

- Proper use of the design loop
- Understanding buoyancy
- Understanding the basics of transportation technology
- Estimating lengths to design a water craft

Essential Questions:

How can you design a water craft that will safely transport Beekle and Alice from the real world to the imaginary world?

Scenario:

After the ending of the story in *Beekle,* Beekle and his friend Alice want to visit the imaginary friend world. However, Beekle forgot to tie his boat to the dock where he sailed in to the real world and it floated away. Beekle and Alice look around the city and are able to find a few supplies. They must design a mode of water transportation that can take them to the imaginary world.

Challenge:

Students will work together in groups of four. Using the materials provided, they will build a water craft with the given materials that will take Beekle and Alice to the real world. The water craft will be tested for buoyancy on the second day of the project in a tub of water.

Tools, Materials, and Resources:

Teacher:

- *The Adventures of Beekle: The Unimaginary Friend* by Dan Santat
- Shallow plastic tub big enough to test student designs

Student:

- Scissors
- Hand saw (if needed)
- 4 Dowel rods
- 6 popsicle sticks
- Marshmallows
- String
- Tape
- Cardboard
- Styrofoam pieces
- 10 toothpicks
- 4 plastic sandwich bags
- 5 index cards

Content Information:

- Context: Students have already learned about estimating lengths of various design materials such as string, tape, and dowel rods. They have been introduced to the design loop and have also become familiar with group collaboration. The group collaboration and completing of the design journal will emphasize the English Language Arts content of this lesson. The STEM content will be emphasized through the student's use of the design loop, estimating the length of materials and using tools during the design process, and applying knowledge of buoyancy and transportation basics into the design.
- The book *Beekle* will be read and the extended scenario will be introduced.
- The content will be introduced. Explain to students that:
    - Transportation is essential to modern day society. A mode of transportation must be able to transport people or cargo from one place to another safely.
    - The term *water craft* refers to a mode of transportation that takes people or cargo across a body of water.
    - Buoyancy is the ability of an object to float in water.
- Divide students into groups of four. Explain to students that they will be designing a water craft to transport Beekle and Alice safely to the imaginary world with the provided materials, and that they must complete their own design journals throughout the design process.
- Hand out the design journals and design materials.
- Walk the students throughout the design process, giving ample time in between steps for group collaboration and design. Complete design step 1-4 in the journal. Steps 5-6 and student presentations will be completed on day two.
- When 45 minutes of group design work has been completed, collect and store student designs and leftover materials in a safe place until the next day. Collect design journals.
- The next day, bring the plastic tub filled with water. Pass out student designs, leftover materials, and design journals. One group at a time, have students explain

why they designed the water craft the way that they did and then have students test their designs for buoyancy.

- When every group has had a chance to test their design, give students 15 minutes to work in their groups and improve their designs with the materials they have left. Then, have each group retest their design improvements and record their results in their design journal.
- Closing: Instruct students to fill in the *student* section of the rubric. Have students discuss in their groups what they might do differently next time. Make sure that students have completely filled in their design journals, and then collect the journals and designs.

Deliverables

Students will individually complete and turn in a completed design journal that will show that they understand the content and can explain and defend their design.

Parameters or Constraints:

There will be a time constraint of about 45 minutes to design and build a water craft on the first day. The next day, allow about one hour for student presentation, testing, improving, and retesting. The materials are also limited to those listed above.

Evaluation:

Students will be evaluated by their design journals that they will complete during the design process and turn in after the design process. The rubric is on the last page of the design journal and will show the points possible. The students will self-evaluate their design under the *student* column, and then the teacher will evaluate the project under the *teacher* column.

Beekle Pays a Visit: Student Guide

Remember that:

- Transportation is essential in modern day society
- Buoyancy is an object's ability to float in water
- My water craft must be buoyant enough to transport Beekle and Alice safely across the body of water

What we will be asking:

How can I design a buoyant water craft with my given materials that will transport Beekle and Alice safely to the imaginary friend world?

Scenario:

Beekle and his friend Alice want to visit the imaginary friend world. However, Beekle forgot to tie his boat to the dock where he sailed in to the real world and his boat floated away. Beekle and Alice look around the city and are able to find a few supplies and must design a water craft that can take them to the imaginary world.

My Design Journal:

Beekle Pays a Visit

Follow your design loop!

Remember to:

Ask: What is the problem?

Think: What are the possible solutions?

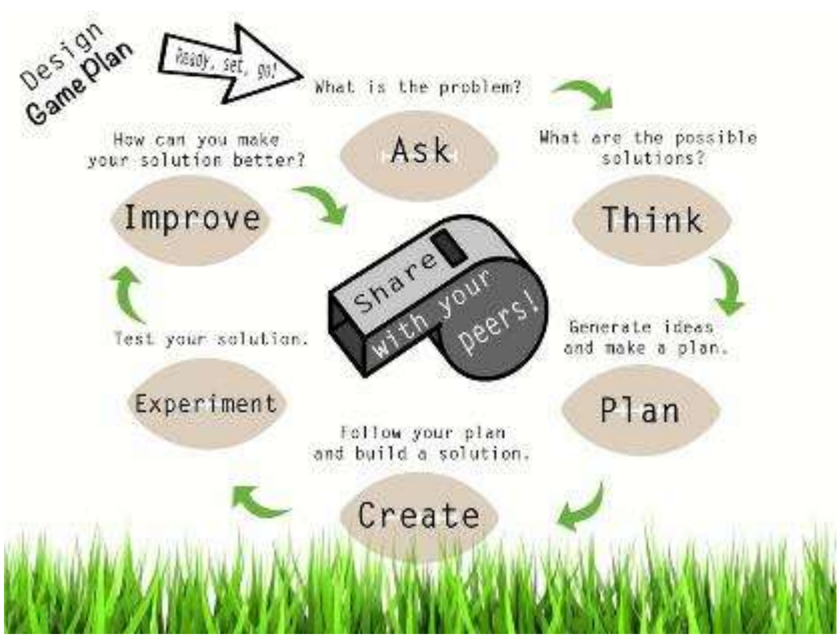
Plan: Generate ideas and formulate a game plan.

Create: Follow your plan and build a solution.

Experiment: Test your solution.

Improve: How can I make it better?

Share with your peers!



Name: ________________________

Date Started: ____/______/_____

Date Completed: ____/______/_____

1. Ask: What is the problem?

2. Think: What are the possible solutions?

3. Plan: Generate ideas and formulate a plan.

4. Create: Follow your plan and build a solution.

5. Experiment: Test your solution.

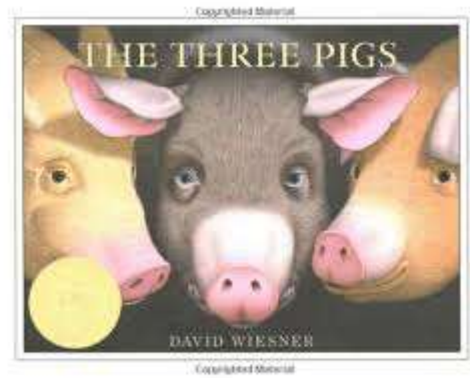
6. Improve: What can I do differently to improve my design?
   What worked and what didn't work when I tested my design?

Prepare to share your design in class!

How Did I Do?	Points	Teacher	Student
I understood the problem I was to solve	10		
I learned things to help me make my project	10		
I made drawings to show my ideas	10		
I solved the problem in a way new to me	10		
My project followed the rules	10		
I used materials and tools correctly	10		
I wrote my ideas in my project notebook	10		
I worked well with my group and managed my time wisely	10		
My project was neat and attractive	10		
My classmates could hear and see my presentation	10		
Total	100		

Teachers guide:

By: Sarah Lee Chism



Title: The Three Pigs. By David Wiesner

Grade level: 1 grade

STEM Content Standards:

Science**:**

-Classify animals into major groups according to their structure:

Math:

-AR.Math.Content.1.G.A.2

- Compose two-dimensional shapes (e.g., rectangles, squares, trapezoids, triangles, half-circles, and quarter circles) or three-dimensional shapes (e.g., cubes, right rectangular prisms, right circular cones, and right circular cylinders) to create a composite shape
- Note: Students do not need to learn formal names such as "right rectangular prism"

Technology Literacy/ Engineering:

- Students will develop an understanding of the core concepts of technology

  - Different materials are used in making things.

- Students will develop an understanding of the attributes of design:

  - Everyone can design solutions to a problem.
  - Design is a creative process

Big Ideas: The major concept is that people build things out of different materials to make things.

Essential Question: When we build things, what is the best material to use?

Scenario: The pigs have landed the field where Hey Diddle Diddle lives, they are happy they are out of the wolf story. But now they must face the challenge of landing there paper airplane that weighs one pound in a safe place in the field. Students I teams of 3-5 will make a platform made out of gum drops and toothpicks that can support the weight of a one pound airplane.

Challenge: The pig need to land there paper airplane in Hey Diddle diddles filed using the design loop and the materials available build a platform for the one pound paper airplane

Tools, Materials:

Group 1: (10) Gum drops (13) Toothpicks

Group 2: (10) Popsicle sticks (4) Rubber bands

Gruop3: (10) straws (4) Rubber bands

Group 4: (10) Marshmallows (13) Toothpicks

Resources:

- The Three Little Pigs book

Content information: make the book available to the students. And the design loop.

Science: -Classify animals into major groups according to their structure:

• Mammals (wolf, pigs, cat, cow, dog, horse, human)

• Birds (duck)

• Fish (fish)

Math:

-Different shape all have different purposes

-Knowing the difference between two-dimensional objects and three-dimensional objects.

Technology Literacy/ Engineering:

-You can build different things out of different materials

Deliverables: Students will need to show the teacher that their platform is able to support the weight of a one pound.

Parameters or constraints: students can only use the materials that are listed, students will be given forty minutes to collaborate with their groups on how to build the platform and to build the platform and test that it works.

Evaluation: This will be a self-evaluation and a teacher evaluation

Student evaluation:

- I understood the point of the project I was doing
- I learned to make things out of different materials
- I worked well with my group members
- I used my time efficiently

Teacher evaluation:

- Observational Group evaluation:
  - Was everyone participating in the group activity?
  - Was one person in the group doing all of the work.

- Individual student evaluation:
  - Ask the students after they build their house if there is any way to improve it with other materials that they were not given.

Students guide:

Title: The Three Pigs. By David Wiesner

Grade level: 1-2 grade

Big Ideas: The major concept is that people build things out of different materials to make things.

Essential Question: When we build things, what is the best material to use?

Scenario: The pigs have landed the field where Hey Diddle Diddle lives, they are happy they are out of the wolf story. But now they must face the challenge of landing there paper airplane that weighs one pound in a safe place in the field. Students I teams of 3-5 will make a platform made out of gum drops and toothpicks that can support the weight of a one pound airplane.

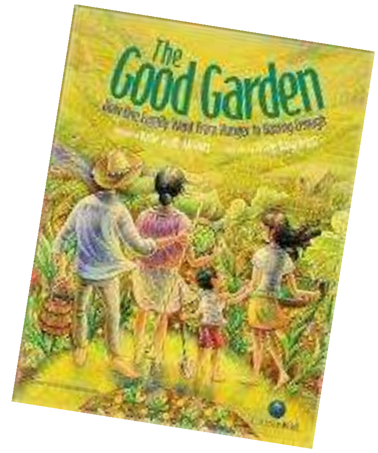
Challenge: The pig need to land there paper airplane in Hey Diddle diddles filed using the design loop and the materials available build a platform for the one pound paper airplane

Tools, Materials, and Resources:

(10) Gum drops (13) Toothpicks

Teacher's Guide
By: Sarah Newhouse

A Place to Grow: Our School Garden



Book: **The Good Garden** by Katie Smith Milway

Grade: 2nd

Standards:

Tech Literacy:

Standard 15: Students will develop an understanding of and be able to select and use agricultural and related biotechnologies.
In order to select, use, and understand agricultural and related biotechnologies, students should learn that:
K-2 Benchmarks

A. The use of technologies in agriculture makes it possible for food to be available year round and to conserve resources.
B. There are many different tools necessary to control and make up the parts of an ecosystem.

Science Standard:

2-ETS1-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

2-ETS1-2 Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

2-ETS1-3 Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Math Standard:

AR.Math.Content.2.MD.A.1	Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes

Big Idea:

The students after reading the book and how a student like them with the help of her teacher was able to make their crops sustainable through the year and able to grow different crops to support their town, they will get to do this themselves. After reading the book, the students will research and use the Design Loop to explore how to make a sustainable garden. We will then test 2 different ways of sustaining crops and plants in our own school garden. They will create their own systems as Maria did with her teacher. Her teacher gave her tips on how to improve the life of their crops. Over a couple of weeks, the students will observe, notice and track the growth of the crops/ plants in different weather conditions and which system worked best for this garden, or if they need to improve both. We will compare these to what farmers use in their fields on a much larger scale.

Students will understand:

- What crops are and what they need to grow
- How to make a sustainable garden
- How to protect crops from the weather
- Why it is important for us and our community to have crops that last all year
- Building a system using the Design Loop that supports all of these

Essential Questions:

At the end of this lesson, the students should be able to answer the question on how crops grow and how the community and even the state, depending on different weather conditions, can use different systems like the ones we created and developed to sustain a garden. Why is this important? How can we apply these in our community?

Scenario:

Students will be put into the spot of Maria, and I as the teacher. What if we were in the situation of having to find ways to make our crops and plants last throughout the year for our community? You have to make sure the whole community can eat throughout the year in different weather conditions. What type of weather conditions occur in Arkansas? How do we adapt to them? How would plants adapt to them?

Challenge:

The class will be split into 2 groups. After researching on how to sustain crops, grow them and create the perfect environment for them in each group, both groups will brainstorm (following the Design Loop) their own idea on how to sustain our class garden. The students will create systems or techniques that they think will best support the crops/ plants that we have in our garden that will stand the test of time and weather as Maria did with her teacher.

Tools/ Materials: (to be supplied when the students decide what they need)			
	• soil	• Shovel for each group	• Gloves
• Clear, rubber tubes	• Water Hose	• Scissors	• Measuring tape
• Yard	• Seeds- children get to pick what they want to plant	• Small plants-trees, cover crops	• Variety of hand tools for the garden
• Area to plant	• Mulch	• Tarp	• Collect their own compost
• Wood	• Saw (for teacher to use)	• Science Journal	• Book and computer resources on plants/crops and gardens

Content Information:

Science: Students as 2 separate groups will need to conduct research before we start our garden on what they will need to create a sustainable garden. They need to know what crops and plants need to grow. They also need to agree on the items they will need to support the crops/ plants they decide to grow. They will be observing and keeping track of the gardens' progress, if they are making any at all, and make conclusions based on their gathered data.

Technology: Each group will come up with their own systems and techniques they will use to make sure their plants are protected and grow better whether that involves building a system or applying techniques that are needed for their crop/plant. To decide this, within each group the students will have to defend what they think is the best system to implement using their research to back up their reasoning. They will plan this out by sketching a model and using the design loop, then we will put it to the test.

Math: When putting their systems to the test, the students will have to be able to measure the area they have to plant and create their systems with measuring tape. They will need to be able to use measuring tape using feet and record these measurements in their journals.

Deliverables:

Students should be able to show me their planning process in their science journals and the different ideas their group has come up with. The students should be able to show and explain to me when they are creating their sustainable garden how it will work and in their journals make predictions on what will happen. During the course of the observing over the weeks on how their plants are doing, they should be noting what they see in both gardens with sketches and descriptions. Their journals will be organized in a section for research, a section for planning, a section for system they intend to construct, a section for observations and data gathering, and then their conclusions they made as a group about their systems. Their journal will be the main thing I collect from them that should contain what we have done throughout this whole experiment and the ending results of the 2 systems. Throughout this observation and testing, we will be conducting class discussions and questioning on what they are seeing and what they think is happening in each system. We will discuss as a class what happened in each, why it might've worked or didn't work and what we could do to improve or change these systems to make a better one and they will note this in their journal and explain why. Once they finish, they will write a letter to the mayor about what they learned, their systems and how they can be applied to the community. This will show understanding of the full project and to make sure they answer the essential questions of this project.

Parameters:

- Time on research: we have to have time to create our systems/ techniques and observe our plants grow.
- Where we can create 2 gardens
- The size of the gardens
- Tools used-we either don't have access to them or cannot use them
- Time of year-weather

Evaluations:

I will keep a checklist for myself to make sure everyone is participating, if not in the research, they help in the design later. Their journals are a great way to evaluate also to see if they are keeping track of their research, design, and process and their conclusions. This will show group effort in research and planning, but also then show individual understanding as they are asking their own questions and expressing their thoughts throughout this experiment. They will write a letter at the end of this project to the mayor telling them about what they learned and how their system can be applied in their town to provide food to the community.

A Place to Grow: Our School Garden

Book: *The Good Garden* by Katie Smith Milway

Situation: What would you do if you were Maria? How would you feed people who need in your own community? You have to find a way to create a sustainable garden as Maria and her teacher did to feed your community (the class and perhaps your town).

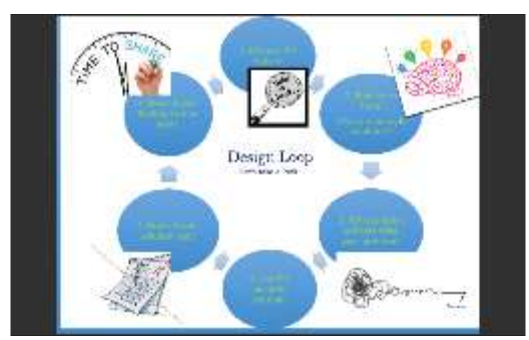
Challenge: You will have to do your own research to see what crops need to grow and what gardens need to sustain through weather conditions and flourish. We will get into 2 teams and create 2 techniques or systems that will support our garden the best and produce enough food for our class. Using the design loop, you will take the steps in creating a system and technique that will support and protect your crops from Arkansas weather conditions that you decide to plant.

Materials:

- Shovel for each group
- Gloves
- Seeds-children get to pick what they want to plant
- Variety of hand tools for the garden
- Area to plant
- Science Journal
- Book and computer resources on plants/crops and gardens

Put it to the test:

1. What is the problem? Start your Design Loop. With your group, decide the situation at hand and what you will need to put a plan into action. You will need facts! Use books and electronic resources to discover what a sustainable garden needs and what you should put in place as a group to create a garden that lasts through weather conditions present these next weeks.
2. After discussing with your group and based on your research, we will make a class garden. You will have to agree with your group on what you would like to plant and put your idea that you have agreed upon to the test.
3. Using your journal, you will write your idea down, why it may work and your predictions on what will happen based on your research.
4. Under your description, sketch a brief drawing of your layout and technique/ system you will be using for your part of the garden.
5. We will be keeping track of our garden and compare the 2 systems over a couple of weeks and keep data and observations will see in your science journal.
6. Towards the end of our design, based on the data we have collected and our end result of our 2 gardens, we will see which one fulfilled our goal the best. You will document this in your journal.
7. As a class, let's talk about what we can do to improve our systems? Why did they work? Why did they not work? What would make them better? What observations did we make throughout this design?
8. Based on the information and data you have collected and also our discussion, you will write a letter to the mayor about what you learned and how you can take this system we created and improved out in your community and why it should be.



Title: How Will You Save the Truffula Trees?

Grade Level: 2nd grade

STEM Content Standards:

Science Standards - Next Generation Science Standards:

A. 2-LS2-2 — Ecosystems: Interactions, Energy, and Dynamics
    1. Plants depend on water and light to grow.
B. 2-ESS2-1 — Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.
    1. Wind and water can change the shape of the land.

Technology and Engineering Standards:

C. Standard 11: Students will develop abilities to apply the design process.
    1. As part of learning how to apply design processes, students should be able to:
    2. K-2 Benchmarks
        a) Brainstorm people's needs and wants and pick some problems that can be solved through the design process.
        b) Build or construct an object using the design process.
        c) Investigate how things are made and how they can be improved.
D. Standard 13: Students will develop the abilities to assess the impact of products and systems.
    1. As part of learning how to assess the impact of products and systems, students should be able to:
    2. K-2 Benchmarks
        a) Collect information about everyday products and systems by asking questions.
        b) Determine if the human use of a product or system creates positive or negative results
E. Standard 15: Students will develop an understanding of and be able to select and use agricultural and related biotechnologies.
    1. In order to select, use, and understand agricultural and related biotechnologies, students should learn that:
        a) The use of technologies in agriculture makes it possible for food to be available year round and to conserve resources.
        b) There are many different tools necessary to control and make up the parts of an ecosystem.

Mathematic Standards - Arkansas Mathematic Standards:

F. AR.Math.Content.2.MD.A.3
   1. Estimate lengths using units of inches, feet, centimeters, and meters
G. AR.Math.Content.2.MD.A.1
   1. Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes
H. AR.Math.Content.2.MD.D.10
   1. Draw a picture graph and a bar graph, with single-unit scale, to represent a data set with up to four categories

Big Ideas:

I. Plants need water and sunlight to grow and thrive
II. We can use everyday materials to create a new product
III. Using the design loop we can solve the problem

Essential Question:

I. What do plants need to grow and thrive?
II. How can we create an environment using the materials and tools given to support the plant's environment?

Scenario:

All of the Truffula trees have been harvested for their fluff to make thneeds and sweaters. The Lorax left one seed, just in case someone came along who cared enough. You have journeyed out to visit the Once-ler and he has given you the last seed that the Lorax left behind. It is now up to you to create an environment for the last Truffula tree to grow and thrive!

Challenge:

Students will work together in groups to create an environment for a plant to grow and thrive. They will use their engineering design journal to guide them in their design process. As well as, to document and track how their design is working and how their plant is growing.

Tools and Materials:

I. Tools
   A. Pliers - teacher
   B. Scissors
   C. Spoon (as gardening trowel)

D. Meter Stick
E. Ruler
F. Yard Stick

II. Materials per group of 4
   A. Chicken wire - teacher
   B. 1 piece of paper
   C. 2 hangers
   D. 4 inch wide terra cotta pot
   E. 2 cups of soil
   F. 1 cup of pebbles
   G. 1 Lima bean seed
   H. 4 popsicle sticks
   I. 4 twist ties
   J. 2 feet of yarn

Content Information:

I. Science
   A. Plants need Sunlight and water to thrive
   B. Plants start out as a seed and grow into a plant - Plant life cycle
      1. https://www.youtube.com/watch?v=ZCYbwis2twM
      2. http://secondgradeplants.weebly.com/life-cycle-of-a-plant.html

II. Technology and Engineering
   A. Tools have been developed to help plants to grow
   B. Gardening Tools worksheet
   C. A trowel is a small shovel
   D. Gardening gloves are to protect your hands
   E. A gardening fork is to help till the soil
   F. Planting pots are our plants home
   G. Seeds are baby plants
   H. A watering can helps us give our plant the water it needs to thrive
   I. Gardening boots protect our feet

III. Mathematics
   A. Estimate lengths by using our prior knowledge of the lengths of ordinary objects
   B. Measure objects accurately by using the appropriate tools
   C. Rulers
   D. Meter sticks
   E. Measuring tapes
   F. Track the growth of our plant with bar graphs

Deliverables:

I. Engineering Journal

Parameters and Constraints:

The protective design must stay in the pot

The protective design must not be higher than 6 inches

Evaluation:

Rubric for their Engineering Journal

Completed Engineering Journal	___/10
Model follows parameters instructed	___/5
Students Collaborated well throughout the entire project (teacher observed throughout)	___/10
Reflections completed after daily entries	___/10
Reflection and improvement ideas that could be made to model	___/10
Total	**___/45**

How will you save the last Truffula Tree?

All of the Truffula trees have been harvested for their fluff to make thneeds and sweaters. The Lorax left one seed, just in case someone came along who cared enough. You have journeyed out to visit the Once-ler and he has given you the last seed that the Lorax left behind. It is now up to you to create an environment for the last Truffula tree to grow and thrive!

You will have 3 science classes to design and build your model to save the Truffula trees. Follow the design loop to design your model to save the Truffula trees. These are the materials and tools that you will have access to. You do not have to use all of them.

Tools	
Pliers Scissors Spoon	Meter Stick Ruler Yard stick
Materials	

Chicken wire - teacher 1 Piece of paper 2 hangers 4 inch wide terra cotta pot 2 cups of soil	1 cup of pebbles 1 lima bean seed 4 popsicle sticks 4 twist ties 2 feet of yarn

What is the problem?

____

____

____

What ways can we solve this problem? Sketch and/or write

your ideas in the boxes below

What is your best solution and why?

____

____

____

____

____

____

Create your prototype/model!

What materials will you need?

____

____

____

____

____

____

What is your process for building this prototype/model?

____

____

____

Test out your prototype/model!

Record your observations on the pages below

Day 1

How much has your plant grown?

Inches:________________________________

Centimeters:____________________________

What does your model look like today?

Observations:

____
____
____
____
____
____
____

____

____

____

____

Day 2

How much has your plant grown?

Inches:_____________________________

Centimeters:__________________________

What does your model look like today?

Observations:

____

____

____

____

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____

____

____

____

____

____

Day 3

How much has your plant grown?

Inches:___________________________

Centimeters:________________________

What does your model look like today?

Observations:

____

____

____

____

____

____

____

____

____

____

Day 4

How much has your plant grown?

Inches:______________________________

Centimeters:___________________________

What does your model look like today?

Observations:

____

____

____

____

____

____

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____

____

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____

Day 5

How much has your plant grown?

Inches:______________________________

Centimeters:___________________________

What does your model look like today?
Observations:

____

____

____

____

____

____

____

____

____
____
____

Day 6

How much has your plant grown?

Inches:______________________________

Centimeters:__________________________

What does your model look like today?

Observations:

____
____
____
____
____
____
____

____

____

____

____

Day 7

How much has your plant grown?

Inches:______________________________

Centimeters:__________________________

What does your model look like today?
Observations:

____

____

____

____

____

____

____

____

____

____

____

Day 8

How much has your plant grown?

Inches:_____________________________

Centimeters:_________________________

What does your model look like today?

Observations:

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Day 9

How much has your plant grown?

Inches:______________________________

Centimeters:__________________________

What does your model look like today?

Observations:

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Day 10

How much has your plant grown?

Inches:______________________________

Centimeters:___________________________

What does your model look like today?

Observations:

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Day 11

How much has your plant grown?

Inches:_____________________________

Centimeters:_________________________

What does your model look like today?

Observations:

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Day 12

How much has your plant grown?

Inches:_____________________________

Centimeters:__________________________

What does your model look like today?

Observations:

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Day 13

How much has your plant grown?

Inches:______________________________

Centimeters:___________________________

What does your model look like today?

Observations:

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Day 14

How much has your plant grown?

Inches:______________________________

Centimeters:___________________________

What does your model look like today?

Observations:

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____

Let’s analyze our results!!

Make a bar graph of your results!

How well did your plant grow?

____

____

____

____

____

Reflection

What can you do to make your model better? How did your model perform?

____

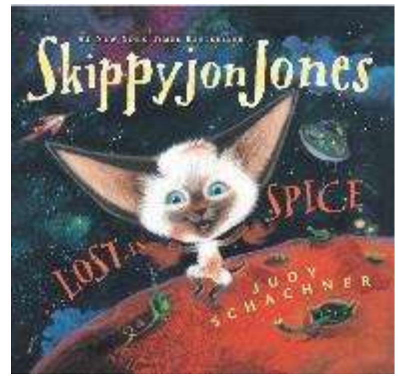
____

____

____

____

Teacher's Guide



Title: The Spicy Pipeline Transport

Grade Level: 3rd

Media: *Skippyjon Jones Lost in Spice* by Judy Schachner

STEM Standards:

Arkansas Science Standards

PS2.A: Forces and Motion: Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.)

(3-PS2-1) Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

Standards for Technological Literacy

Standard 8: Students will develop an understanding of the attributes of design.

A. The design process is a purposeful method of planning practical solution to problems.
B. Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.

Standard 9: Students will develop an understanding of engineering design.

C. The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.
D. When designing an object, it is important to be creative and consider all ideas.
E. Models are used to communicate and test design ideas and processes.

Standard 10; Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

A. Troubleshooting is a way of finding out why something does not work so that it 4an be fixed.
B. Invention and innovation are creative ways to turn ideas into real things.
C. The process of experimentation, which is common in science, can also be used to solve technological problems.

Standard 18: Students will develop an understanding of and be able to select and use transportation technologies.

D. The use of transportation allows people and goods to be moved from place to place. .

E. A transportation system may lose efficiency or fail if one part is missing or malfunctions or if a subsystem is not working.

<u>Arkansas Math Standards</u>

Measurement and Data: Represent and interpret data

AR.Math.Content.3.MD.B.4 • Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch • Show the data by making a line plot, where the horizontal scale is marked off in appropriate units— whole numbers, halves, or quarters

Measurement and Data Geometric measurement: understand concepts of area and relate area to multiplication and to addition

AR.Math.Content.3.MD.C.6 Measure areas by counting unit squares (square cm, square m, square in, square ft., and improvised units)

Big Ideas:

- The use of the engineering design loop
- Properties of materials to create a mode of transportation for goods
- Creating a model within specific parameters

Essential Question:

How can you create a mode of transportation for the spices found on Mars to travel down the Spicy Pipeline to Earth?

Scenario:

Los Chimichangos want to send the chili powder found on Mars to Earth to keep them warm in the winter. They have already created a pipeline, a tube that runs from the surface of Mars to the surface of Earth, for the spices to travel down. However, Los Chimichangos need a mode of transportation in order to move these *muy caliente* spices down the pipeline!

Challenge:

Your task is to create a mode of transportation to move the spices along the pipeline. The pipeline, though in outer space, has artificial gravity. The pipeline begins with a ramp. A 2-inch by 2-inch packet of “spices” must stay on the model as it moves down the pipeline. Models will be created in groups of 3 or 4. Before receiving your materials, you must investigate possible solutions to the problem using your Design Journal pages. Once your team has chosen a plan for your model, you will receive your supplies.

Materials:

(4-6) bottle lids	(6) dowel rods or pencils	(2) balloons
(2) 3x5 inch pieces of cardboard	(6) rubber bands	(4) plastic spoons

Any found or recycled materials the teacher or students see fit to include.

Tools:

- Scissors
- Tape
- Glue

Content Information:

Area is a measure of how much space there is on a flat surface. For example, two sheets of paper have twice the area of a single sheet, because there is twice as much space to write on. We find area by multiplying the length by the width of an object. Keep in mind area is only used for a *flat* surface. *http://www.mathopenref.com/area.html

A *force* is a push or pull upon an object resulting from the object's *interaction* with another object. Whenever there is an *interaction* between two objects, there is a force upon each of the objects. When the *interaction* ceases, the two objects no longer experience the force. Forces only exist as a result of an interaction. * http://www.physicsclassroom.com/class/newtlaws/Lesson-2/The-Meaning-of-Force

Motion is the act of changing location from one place to another. In other words, motion is the way things get from place to place. *https://www.vocabulary.com/dictionary/motion

> Newton's First Law of Motion**:** An object at rest will remain at rest unless acted on by an unbalanced force. An object in motion continues in motion with the same speed and in the same direction unless acted upon by an unbalanced force. This law is often called "the law of inertia". This means that there is a natural tendency of objects to keep on doing what they're doing. All objects resist changes in their state of motion. In the absence of an unbalanced force, an object in motion will maintain this state of motion.
> *http://teachertech.rice.edu/Participants/louviere/Newton/law1.html

Modes of Transportation**:** Transport modes are the means by which people and freight achieve mobility. They fall into one of three basic types, depending on over what surface they travel – land (road, rail and pipelines), water (shipping), and air. *https://people.hofstra.edu/geotrans/eng/ch3en/conc3en/ch3c1en.html

Resources:

Pipeline video – discusses the use of pipelines for oil and gas.

https://www.youtube.com/watch?v=aTTJeTaYDyc

Deliverables: Within your group, you will use the Design Journal in order to design and create a model to successfully transport spices as far as possible down the Spicy Pipeline. You will submit your design journal for grading. The models will be graded when everyone's models are tested on the Spicy Pipeline

Parameters: Your completed mode of transportation must:

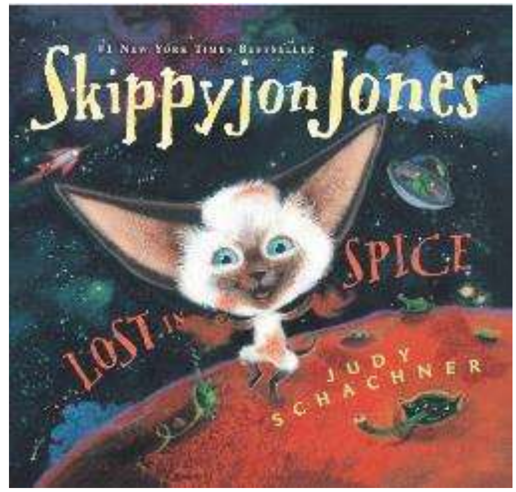
- Have a base that does not exceed an area of 25^2 inches (5 inches x 5 inches) and be less than 8 inches tall.
- Use the provided materials.
- Be designed using the engineering design loop.
- Move on its own down the ramp (no pushing or pulling the model is allowed.
- Be completed after two one-hour sessions.
- Be turned in to the teacher along with the Design Journal pages to show thoughtful planning, creating, and reflection of the design project.

Evaluation:

Spicy Pipeline Transport Rubric

	Self-Evaluation (Please put a check mark next to each item if you completed to the best of your ability. Put an X if you did not complete the item.)	**Teacher Evaluation**
Completed model and Design Journal were submitted.		**_______/30 (_____/15 for model ______/15 for Design Journal)**
I used my materials and tools wisely and correctly.		**________/ 10**
I stayed within the parameters of the challenge.		**_______/ 20**
Our model made it down the pipeline.		**________ / 15**
I participated in the presentation of my group's model.		**________/ 25**
TOTAL:		**_________/ 100**

The Spicy Pipeline Transport
Student Copy



Big Ideas:
- The use of the engineering design loop
- Properties of materials to create a mode of transportation for goods
- Creating a model within specific parameters

Essential Question: How can you create a mode of transportation for the spices found on Mars to travel down the Spicy Pipeline to Earth?

Scenario:
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Challenge:
Your task is to create a mode of transportation to move the spices along the pipeline. The pipeline, though in outer space, has artificial gravity. The pipeline begins with a ramp. A 2-inch by 2-inch packet of "spices" must stay on the model as it moves down the pipeline. Models will be created in groups of 3 or 4. Before receiving your materials, you must investigate possible solutions to the problem using your Design Journal pages. Once your team has chosen a plan for your model, you will receive your supplies.

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Tools:
- Scissors
- Tape
- Glue

Deliverables: Within your group, you will use the Design Journal in order to design and create a model to successfully transport spices as far as possible down the Spicy Pipeline. You will submit your design journal for grading. The models will be graded when everyone's models are tested on the Spicy Pipeline.

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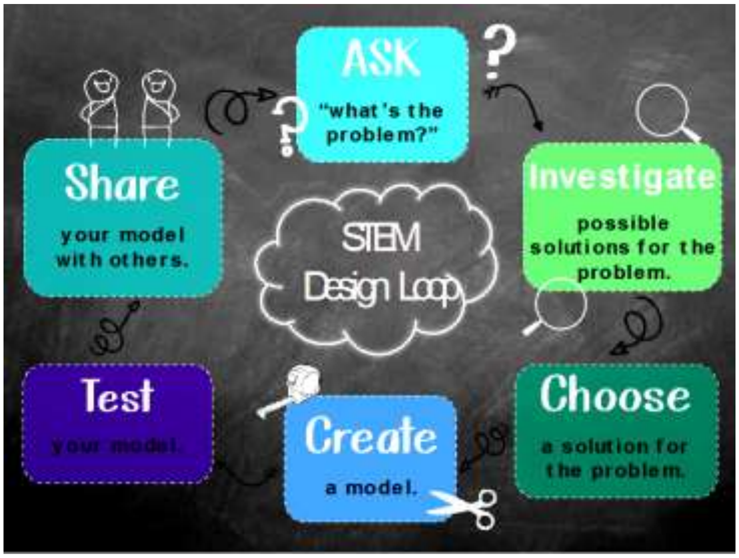
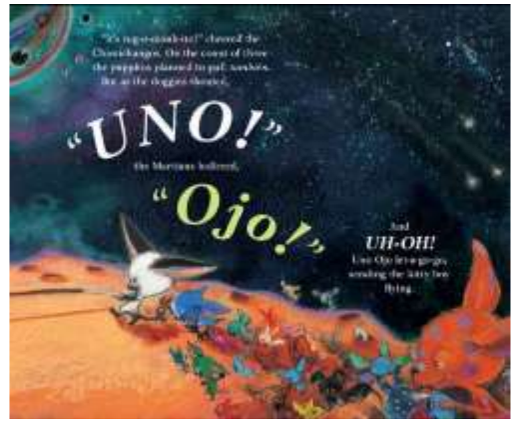
- Use the provided materials.
- Be designed using the engineering design loop.
- Move on its own down the ramp (no pushing or pulling the model is allowed.
- Be completed after two one-hour sessions.
- Be turned in to the teacher along with the Design Journal pages to show thoughtful planning, creating, and reflection of the design project.

Name: ________________________’s Design Journal





<u>Ask</u>: “What is the problem I need to solve?”

<u>Investigate</u>

What are some of my ideas?

What are some of my ideas?

Choose: This is my group's final idea!

Create: We will use these materials to create our model:

We found the area of the base of our model. It is ________________________ square inches.

Test: This is what we found when we tested our model:

Self-Evaluation:

How did you create a mode of transportation for the spices found on mars to travel down the Spicy Pipeline to Earth?

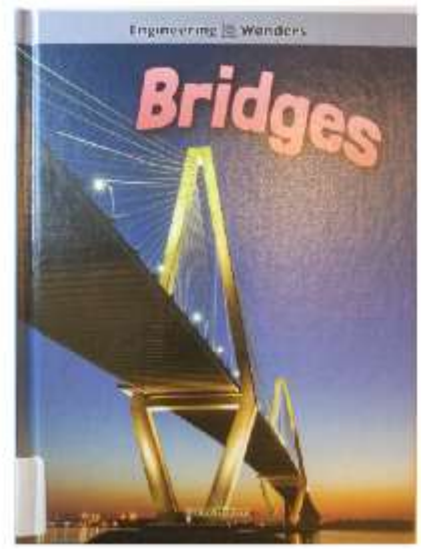
I know our idea works because…

If you could do the challenge again, would you make any changes? If so, what?

Spicy Pipeline Transport Rubric

	Self-Evaluation (Please put a check mark next to each item if you completed to the best of your ability. Put an X if you did not complete the item.)	**Teacher Evaluation**
Completed model and Design Journal were submitted.		**_______/30 (_____/15 for model _____/15 for Design Journal)**
I used my materials and tools wisely and correctly.		**________/ 10**
I stayed within the parameters of the challenge.		**_______/ 20**
Our model made it down the pipeline.		**________ / 15**
I participated in the presentation of my group's model.		**________/ 25**
TOTAL:		**_________/ 100**

Cardboard Foot Bridge



Grade Level: 8th

Discipline: STEM

Unit: Construction Technologies

Literacy: *Bridges,* by Joanne Mattern

Content Standards:

<u>Technology:</u>

Standard 9. Students will develop an understanding of engineering design.

F. Design involves a set of steps, which can be performed in different sequences and repeated as needed.

G. Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum.

H. Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.

<u>Science:</u>

Motion and Forces; Students shall demonstrate and apply knowledge of motion and forces using appropriate safety procedures, equipment, and technology.

PS.6.8.1 Model how motion and forces change Earth's surface:
- Compression
- Tension

<u>Mathematics:</u>

Geometry; Understand and apply the Pythagorean Theorem

AR.Math.Content.8.G.B.6 Model or explain an informal proof of the Pythagorean Theorem and its converse

Big Ideas:

The class needs to learn the design loop. Using the design loop workbook the teams should be able to see the process of design and the benefits of using a system. Students should discover the use of triangles in construction and how important they are to the strength of bridges and structures as a whole. Using Pythagorean Theorem the students can make their bridge fairly accurate as far as being square and straight. The students should gain an understanding of what compression and tension means in bridge building. Team members should work together using each other's strengths to accomplish the project. Team work is essential.

Essential Question:

How can a bridge be built using the materials available that will support at least one of the students on the team? What are the shapes that are found on bridges and what shapes are the strongest?

Scenario:

The high school you attend has an awesome drama club but the school is facing budget cuts. The club is planning a play where they need a usable bridge built. They have ask this class to help them with building this prop. The only materials that are available are cardboard, tape, and glue. You have five days to build bridge.

Challenge:

The challenge is to make a bridge using the design loop that will support the weight of at least one of the students per team. Using the materials listed. The bridge needs to be at least 6' long and 2' wide. The bridge will be designed to fit on the abutments set by the teacher (i.e. Blocks, cafeteria table benches,). The bridge must support the weight of an average student.

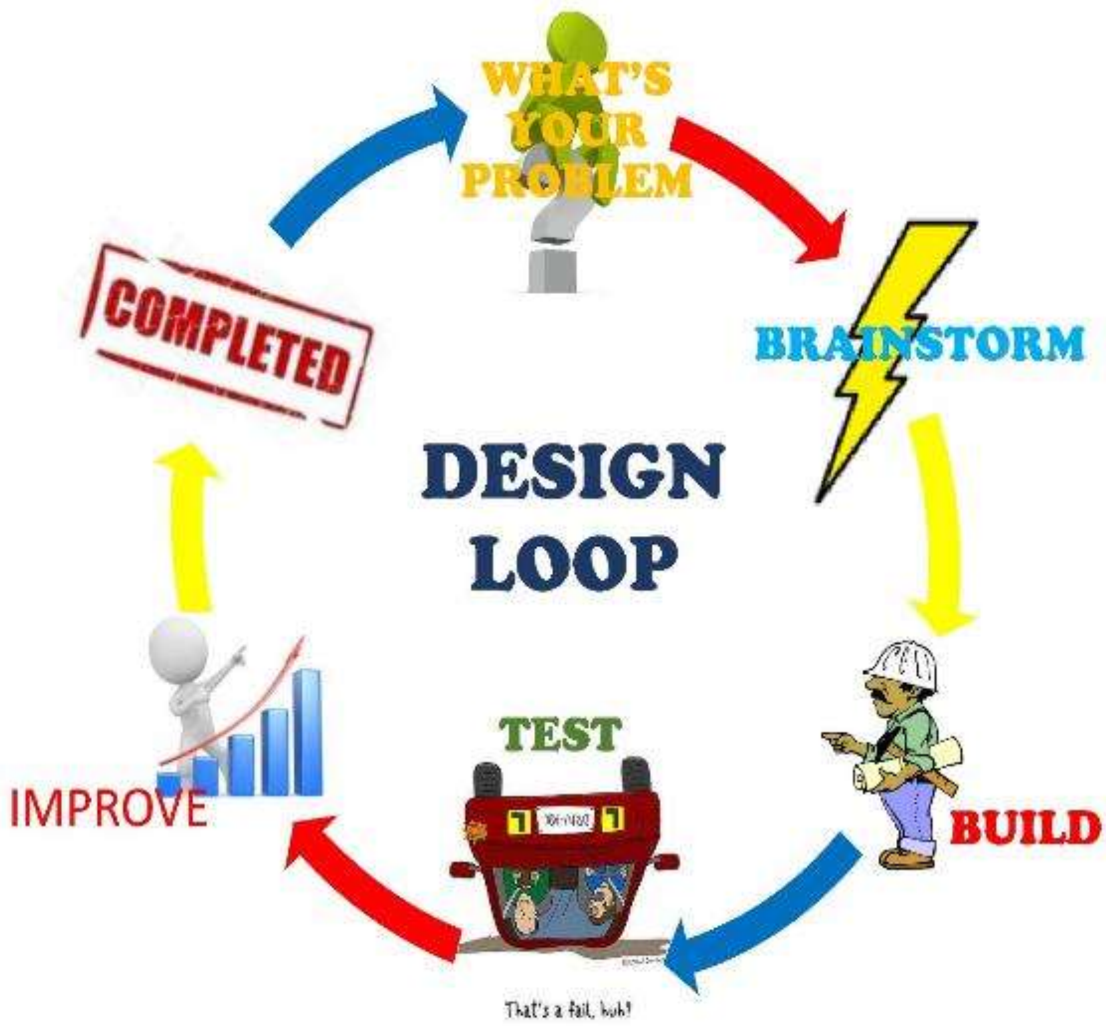
Note: Splitting class into teams is required to allow for completion of objectives. Also depending on how much cardboard can be collected via. School compactor, department stores, students bringing it, this will determine how large the teams are. There will need to be a substantial amount of card board to accomplish the challenge per team. Approximately 6 refrigerator boxes per team.

Tools, Materials, and Resources:

Tools needed: scissors, tape measures or rulers. Also two benches to set bridges on or maybe cafeteria tables (use benches on tables).

2” masking tape, glue, cardboard.

The book: *Bridges,* by Joanne Mattern.
Watch short video of the collapse of the Tacoma Narrows Bridge on YouTube.
Design loop
Design loop Journals


WHAT'S YOUR PROBLEM
BRAINSTORM
DESIGN LOOP
COMPLETED
BUILD
TEST
IMPROVE
That's a fail, huh!

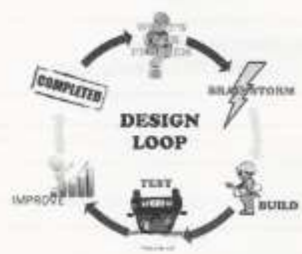
Example of Design Loop Journal

1

Using an Engineering Journal

Having students use an engineering journal or portfolio is a great tool to help them stay on task, keep their research and planning ideas organized in one area, and provide a place for them to reflect on and evaluate their work. The components of an engineering journal would vary according to the teacher's preferences, the grade level of the student and the complexity of the project. Listed below are possible components of an engineering journal for design and engineering projects.

a. State problem, criteria, constraints
b. Space for research/investigation notes
c. List of tools and materials
d. Outline of steps to follow
e. Brainstorming space
f. Final design sketch
g. Special worksheets (data collection)
h. Presentation organizer
i. Personal reflections
j. Redesign space and time
k. Assessment (teacher, student)



2

Name: ______________________

Date Started: ____/_____/_____

Date Completed: ____/_____/_____

Design Brief Title:

____

1. What is the problem?
   What do I need to do?

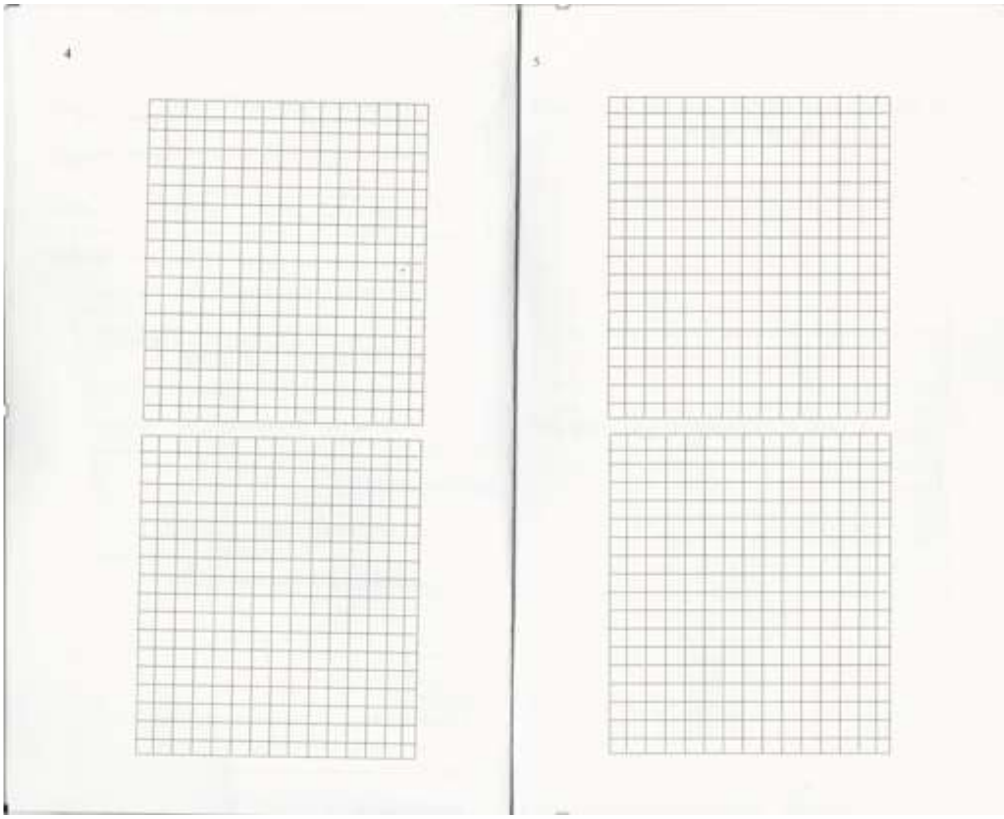
2. Brainstorm solutions –
   What do I already know?

3

What do I need to find out?

What did I find out?

My First Ideas:



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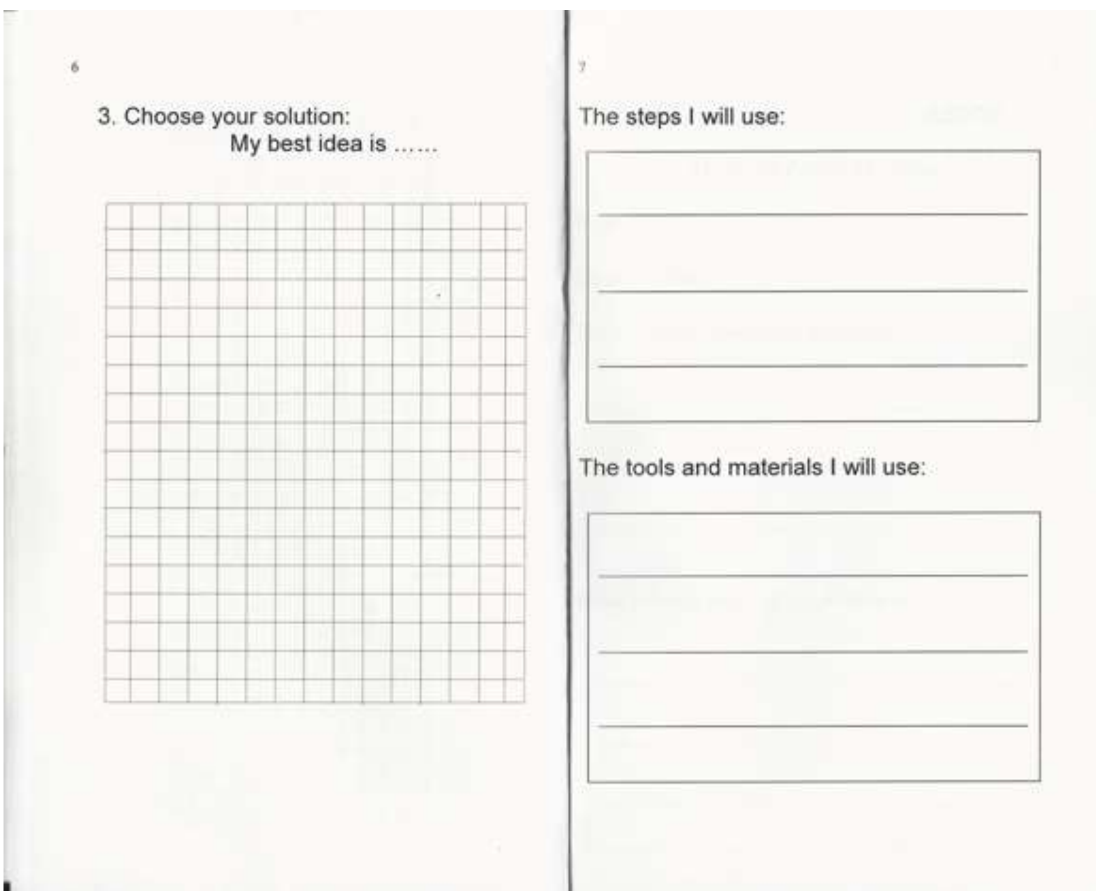


6

3. Choose your solution:
My best idea is ......

7

The steps I will use:

The tools and materials I will use:

8

NOTES:

9

4. Test your solution

Thinking About My Idea

Name _______________

Design Title: _____________________

How did you test your solution?

How do you know if your idea works?

10

5. Evaluate your solution

How would you change your idea?

What did you learn?

What did you like about this project?

What did you not like about this project?

Prepare to present your solution

Content information:

Students need to have read the book to understand the different types of bridges. Through observing these bridges they should find a common theme of triangles being used through the construction. This will greatly benefit them when making their designs.

Deliverables:

The journal and a finished bridge.

Parameters or constraints:

Must be made out of cardboard tape and glue. The only constraints are the bridge is to be 6' long and 2' wide. Also the design journal must be completed. Five days to complete Bridge.

Evaluation:

Completion of the design loop workbook is a requirement. One work book individually done and one that represents the team's decisions on how to perform the project. Completion of a working bridge is also essential. Do they understand how they can use Pythagorean Theorem to help in designing the triangles needed and in making the bridge square and proportional? And do they understand compression and tension forces? Did they work together as a team to complete project.

The teams will present their bridges and show that the bridge will hold the weight of average student.

Rubric

Key Factors	Points	Score
Did student show an understanding of the design loop?		
Did student use and complete the design journal?		
Did student grasp the idea of compression and tension?		
Did student use the Pythagorean theorem?		
Did student use tools correctly		
Did student work well with the group?		
Project was neat and uniform		
Did student use time wisely?		
Was the project a success?		

<u>Student Copy</u>

Scenario:

The high school you attend has an awesome drama club but the school is facing budget cuts. The club is planning a play where they need a usable bridge built. They have ask this class to help them with building this prop. The only materials that are available are cardboard, tape, and glue. You have five days to build bridge.

Challenge:

The challenge is to make a bridge using the design loop that will support the weight of at least one of the students per team. Using the materials listed. The bridge needs to be at least 6' long and 2' wide. The bridge will be designed to fit on the abutments set by the teacher (i.e. Blocks, cafeteria table benches,). The bridge must support the weight of an average student.

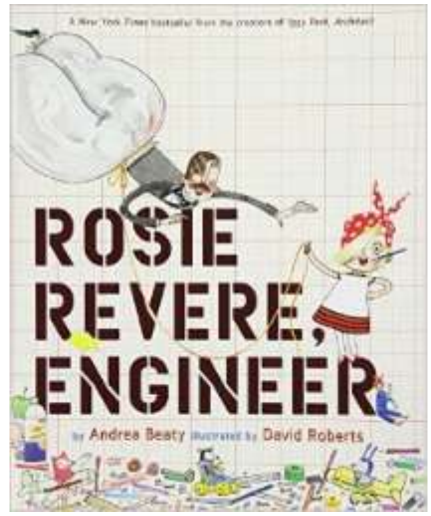
Tools, Materials, and Resources:

Tools needed:
Scissors, tape measures or rulers.

Materials available:
2" masking tape, glue, cardboard.

Resources:
The book: *Bridges,* by Joanne Mattern.
Design loop
Design loop Journals

ROSIE'S NEXT NEW DOOHICKEY DOO



Book: Rosie Revere Engineer
Author: Andrea Beaty
Illustrated by: David Roberts

Grade Level: 2nd

STEM Content Standards

Arkansas Science Standards

NS.1.2.4
Estimate and measure length and *temperature* using International System of Units (SI)
NS.1.2.5
Collect measurable *empirical evidence* in teams and as individuals
NS.1.2.6
Make predictions in teams and as individuals based upon *empirical evidence*
NS.1.2.7
Use age appropriate equipment and tools in *scientific investigations* (e.g., balances, hand lenses, rulers, and *thermometers*)
PS.5.2.2
Investigate the effect of physical phenomena on various materials (e.g., heat absorption by different colored materials)

The Standards for Technological Literacy

Standard 8: Students will develop an understanding of the attributes of design.
Benchmark B: Design is a creative process
Benchmark C: The design process is a purposeful method of planning practical solutions to problems.
Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
Benchmark A: Asking questions and making observations helps a person to figure out how things work.
Benchmark E: The process of experimentation, which is common in science, can also be used to solve technological problems.

Arkansas Mathematics Standards.

AR.Math.Content.2.MD.A.1
Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes

AR.Math.Content.2.MD.C.7

Tell and write time from analog and digital clocks to the nearest five minutes, using a.m. and p.m.

Big Ideas:

- Materials that many people consider waste can be used to create new and useful things.
- Buoyancy
  - Lighter materials help a boat float while heavier ones make it sink.
  - An object will float best when it takes up a lot of space on the water and it made of light materials.
- Problem solving
- Proper use of design process
- Failure is part of figuring out a problem.

Essential Question

How can you design and construct a machine that will carry Rosie and her inventions across the lake to great-great-aunt Rose?

Scenario

After she finished her flying machine, Rosie gave the cheese-copter to great-great-aunt rose as a present. She was very grateful for the gift and flew it all the way home. Rosie has made lots of new inventions since she left and she just can't wait to show her! Sadly, this time great-great-aunt Rose can't come to Rosie. Rosie has to find a way to bring all of her inventions to her great-great-aunt Rose, who lives across the lake. As usual, Rosie only has a trashcan to get her materials from. Rosie needs to build a machine that will carry all her inventions and her across the lake so she can show all of her great new gizmos and gadgets and doohickeys to great-great-aunt Rose using only the items she can find in her trash can.

Challenge

In teams of three, the students will be required to design a machine that can carry Rosie and all of her inventions across the lake to great-great Aunt Rose using items found in a "trash can".

Tools, Materials, and Resources

Because all of the resources and materials that Rosie uses come from the trash, all of the materials the students will have will be items that are commonly found in the trash.

- Tools:
  - Tape
  - Glue
  - Scissors
  - Ruler
  - Scale

- Materials: (given in a little "trash can")
  - 1 Plastic water bottle
  - 1 Styrofoam cup
  - 2 Corks
  - 5 Rubber bands
  - 10 Straws
  - Aluminum foil
  - 1 sheet of Paper

Content information

The students will have to have some understanding of basic buoyancy and what floats and what sinks. They will need to know how to measure as well as use a scale.

Deliverables

Each student will need to turn in their Rosie Revere engineering design notebook and their group's machine to the teacher at the end of the assignment. Students will be expected to present their machine to the class and explain why their machine works as well as why they used the materials they did.

Parameters or constraints

Students are only allowed to use the items found in their groups "trash can". It cannot be bigger than six inches long and six inches wide. The boat can be as tall as the students choose. The machine must have space for Rosie and her inventions to sit. The machine has to be able to stay above the water without any student help. The machine needs to be able to stand on its own in the water and hold weight.

Evaluation

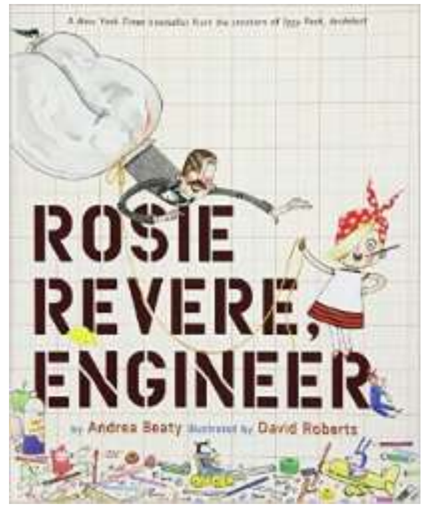
The teacher will test the students' machines by filling a large bucket with water and seeing if their machine can get across the "lake". If the boat gets across the lake, they get a passing grade. Weight will be added to their machines to see if the machine will still stay above the water. Weight will be added in the form of pennies. Students will be expected to weigh the pennies on a scale and record how much weight their machine can hold. The group that builds the boat that can hold the most weight (the highest number of Rosie's inventions) wins a small prize. All three members of the group will be expected to present their machine to the class and explain why their machine works and why they used the materials they did.

Rosie Revere Engineer Project

	Beginner 1	Developing 2	Accomplished 3	Advanced 4
Engineering Notebook	Notebook was not turned in	Notebook was turned in but was missing information	Notebook was turned in and completed but does not include detail	Notebook was turned in and completed with detail, following the engineering design loop and scientific process
Machine effectiveness	Machine was unfinished	Machine was turned in but did not float on its own or did not hold weight Machine did not follow constraints	Machine was turned in and held weight Machine did not need student assistance	Machine was turned in and held more than the minimum weight Machine did not need student assistance
Presentation	Student did not participate in presentation	Student participated in presentation but seemed confused or said very little	Student participated in presentation including speaking about why the machine worked	Student participated in the presentation as well as explained both why ideas worked and didn't work
Weight	Students do not understand how to weigh what their boat can hold	Students have a slight understanding of how to weigh objects on a scale	Students have an understanding of how to weigh objects on a scale	Students can weigh objects on a scale as well as record the weight.

Teacher Comments:

ROSIE'S NEXT NEW DOOHICKEY DOO



Book: Rosie Revere Engineer
Author: Andrea Beaty
Illustrated by: David Roberts

Scenario

After she finished her flying machine, Rosie gave the cheese-copter to great-great-aunt rose as a present. She was very grateful for the gift and flew it all the way home. Rosie has made lots of new inventions since she left and she just can't wait to show her! Sadly, this time great-great-aunt Rose can't come to Rosie. Rosie has to find a way to bring all of her inventions to her great-great-aunt Rose, who lives across the lake. As usual, Rosie only has a trashcan to get her materials from. Rosie needs to build a machine that will carry all her inventions and her across the lake so she can show all of her great new gizmos and gadgets and doohickeys to great-great-aunt Rose using only the items she can find in her trash can.

Big Ideas:

- Materials that many people consider waste can be used to create new and useful things.
- Buoyancy
  - Lighter materials help a boat float while heavier ones make it sink.
  - An object will float best when it takes up a lot of space on the water and it made of light materials.
- Problem solving
- Proper use of design process
- Failure is part of figuring out a problem.

Essential Question

How can you design and construct a machine that will carry Rosie and her inventions across the lake to great-great-aunt Rose

Challenge

In teams of three, you will be required to design a machine that can carry Rosie and all of her inventions across the lake to great-great Aunt Rose using items found in a "trash can".

What can I use?

Because all of the resources and materials that Rosie uses come from the trash, all of the materials you will have will be items that are commonly found in the trash.

- Tools:
  - Tape
  - Glue
  - Scissors
  - Ruler
  - Scale
- Materials: (given in a little "trash can")
  - 1 Plastic water bottle
  - 1 Styrofoam cup
  - 2 Corks
  - 5 Rubber bands
  - 10 Straws
  - Aluminum foil
  - 1 sheet of Paper

What do I turn in?

At the end of the project, you will need to turn in your Rosie Revere engineering design notebook and your group's machine to your teacher. Be ready to present your machine to the class and explain why your machine works. Explain why you chose your materials and what you found out doesn't work.

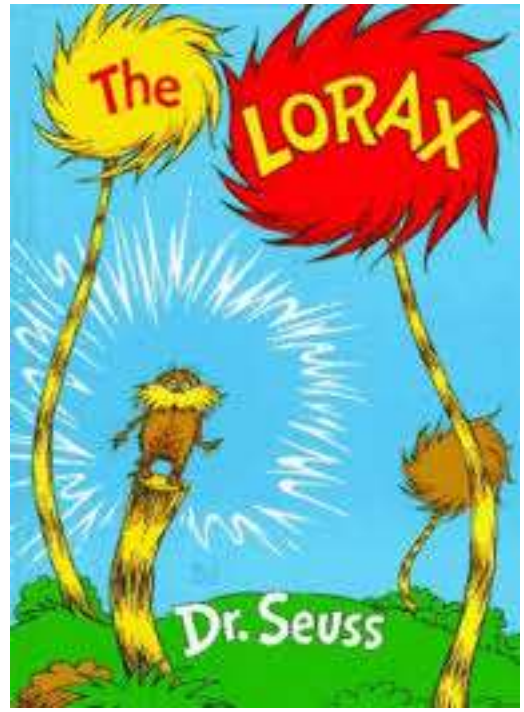
What are the Rules?

You are only allowed to use the materials found in your groups "trash can". Your machine cannot be bigger than six inches long and six inches wide. The boat can be as tall as you choose. The machine must have space for Rosie and her inventions to sit. The machine has to be able to stay above the water without any student help. The machine needs to be able to stand on its own in the water and hold weight.

How will I be graded?

The teacher will test the students' machines by filling a large bucket with water and seeing if your machine can get across the "lake". Weight will be added to your machine to see if it will still stay above the water. The group that's boat can hold the most weight (the highest number of Rosie's inventions) wins a small prize. All three members of the group will be expected to present your machine to the class and explain why it works and why you used the materials you did. You will have to talk about why things you tried that didn't work and why it didn't.

Saving a Truffula Tree
Grade: 3rd grade
Disciplinary Area: STEM
Literacy: *The Lorax* ,by Dr.Seuss



Content Standards:

Science:
NS.1.3.8
Use simple equipment, age appropriate tools, technology, and mathematics in scientific investigations (e.g., balances, hand lenses, microscopes, rulers, thermometers, calculators, and computers)

Technology:
Standard 5: Students will develop an understanding of the effects of technology on the environment.
C.The use of technology affects the environment in good and bad ways.

Standard 9: Students will develop an understanding of engineering design.
C. The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.
D. When designing an object, it is important to be creative and consider all ideas.
E. Models are used to communicate and test design ideas and processes.

Mathematics:
AR.Math.Content.3.MD.B.4
- Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch

Big Ideas:
- Proper understanding and use of the Design Loop.
- Design and construct a device without step by step instruction.
- Students will be able to value the ecosystems and will be able to research an eco-friendly way to satisfy a manufacturing need.

Teacher Copy

Essential Question:
How can we construct a device that will allow Mr. Once-ler to get his tuff from the tuffula trees without chopping down the entire tree?

Scenario:
The Lorax is very distraught over the Once-ler chopping down all of the Truffula trees. Your job is to help find a compromise. Design a device that can be used to pluck the tuff from the Truffula trees without chopping down the entire tree. This should be done in groups of 2 using the available resources. Be creative in your thinking and design. You may not simply pluck the tuff by hand! Make sure you are careful not to pull down the entire Truffula tree. You will be testing your device on the Truffula tree in the front of the classroom.

Materials:
8 popsicle sticks
4 big straws
4 skewers
Scissors
Masking tape
The choice of either:
4 rubber bands or 2 pipe cleaners

Content Information:
The students will be shown a presentation over multiple types of devices that can be used to pick things up. The presentation will introduce the idea of real life extendable grabbers. This will allow the students to see the mechanics behind how the devices are made and how they work.

Deliverables:
Students will present a neat device that will be tested at the front on the classroom. The students will present their device as well as a description as to why they designed it the way they did. They will be in a competition of who can collect the most "tuffs" off of the Truffual tree. The Truffual Tree will be made of a paper towel roll that is decorated and attached to a piece of cardboard with a paper cup on the top of it (which will also be decorated). The goal is to remove the cup without knocking over the base of the tree. The students will also

Parameters:
- Being able to pick up the paper cup without knocking over the base of the Truffula tree

- Be easy to operate
- Be designed with the Design Loop
- Be easily described/defended
- Be turned in along with the design loop worksheet, peer review and self-reflection
- Demonstrate the importance of technology in the environment through the self-reflection paper
- The device may not have a height taller than 1 foot or a width wider than 1 foot and 6 inches

Evaluation:

See next page.

Rubric

The device picks up the paper cup without knocking over the base	/5
Students are able to defend/ describe device	/5
The device meets length and width requirements	/10
Collaborated with partner	/5
Turned in completed design loop	/10
Turned in peer review for partner	/5
Turned in reflection	/10
Total:	/50pts.

Comments:

Design Loop:

What is the Problem?

What are three possible solutions? Sketch these below

1.

2.

3.

Which solution did we choose and why?

List the steps you used to create the device

What materials did you choose and why?

Notes:

Evaluate/Reflection

How did your device work? Did it lift the cup without knocking over the base?

What would you change to make your device better?

What did you learn?

What did you like about this project?

What did you dislike?

Peer Evaluation:

Please complete one of these for your partner:

Partner's name:

Did this partner participate in the design process?	Yes/no
Did this group member contribute to discussion?	Yes/no
Did they help answer questions you had?	Yes/no
Did they help construct the device?	Yes/no
Did they help in preparing the presentation?	Yes/no

Student Copy

Scenario:

The Oncler has taken over and is cutting down all of the Truffula Trees for their prized Tuff. The Lorax needs your help in saving the poor Truffula Trees. They need to find a compromise fast! Construct a device that can help take the Tuff off of the Truffula Trees without destroying the entire tree. You will work in groups of 2 and use the given materials below. Be creative and remember to not knock down the Truffula Tree in the process!

Materials:

- 8 popsicle sticks
- 4 big straws
- 4 skewers
- scissors
- masking tape
- The choice of either:
  4 rubber bands or 2 pipe cleaners

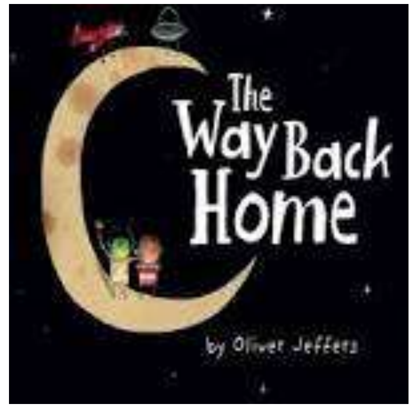
Parameters:

- Being able to pick up the paper cup without knocking over the base of the Truffula tree
- Be easy to operate
- Be designed with the Design Loop Handout
- Be easily described/defended
- Be turned in along with the design loop worksheet, peer review and self-reflection
- Demonstrate the importance of technology in the environment through the self-reflection paper
- The device may not have a height taller than 1 foot or a width wider than 1 foot and 6 inches

Natalie Shepperd
Teacher Copy

Narrative Curriculum Development

Title: "Jumping From the Moon"



Literacy: The Way Back Home by Oliver Jeffers

Disciplinary Area: STEM

Grade Level: 2nd

STEM Content Standards:

- Science**:** Strand 3: Physical Science
  Standard 6: Motion and Forces – Students shall demonstrate and apply knowledge of motion and forces using appropriate safety procedures, equipment, and technology.
  PS.6.2.1 Investigate the relationship between force and motion

- Technological Literacy**:** Standard 9: Students will develop an understanding of engineering design.
  In order to comprehend engineering design, students should learn that:
  A. The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.
  B. Expressing ideas to others verbally and through sketches and models is an important part of the design process.

- Mathematics**:** Number and Operations in Base Ten: Understand place value
  AR.Math.Content.2.NBT.A.2
  -Count within 1000
  -Skip-count by 5s, 10s, and 100s beginning at zero

Big Ideas: Students will use the design loop to create a parachute that is strong enough and secure enough to allow a plastic egg to fall safely to the ground without breaking when dropped from 6 feet. Students will demonstrate an understanding of how to count to 1,000 by using 100's. They will be able to express their ideas and sketches using the design loop with their partner and come to an agreement on how to build the best parachute. They will also demonstrate an understanding that gravity pulls objects towards the earth and some objects have air resistance.
Essential Question: By completing the design loop and worksheet, students will be able to recognize the best way to utilize the tools provided to construct a parachute that has air resistance and can support a plastic egg when dropped from 6 feet. After the activity, they

will be able to understand that gravity is a force that pulls objects towards the earth and that certain materials create air resistance to slow down the process of falling.

Scenario: Imagine that you have found an airplane that can take you up into space. You decide to take it for a ride and fly it higher and higher until you are circling around the planets, moon, sun, and stars. Suddenly you realize that you are quickly running out of fuel…Uh oh! You crash land on the nearest planet and it just so happens to be the moon. Now you are stranded. How are you going to get back to earth? Using the materials that you have in your airplane, you must create a parachute that will allow you to land safely back to earth.

Challenge: Build a parachute using only the materials provided that can protect a plastic egg from breaking when dropped from 6 feet in the air. The parachute must help the egg land gently to the ground. Test the parachute by using the stepping stool provided along with the 6 feet measurement mark on the wall.

Tools, Materials, and Resources:

- Garbage bag
- Grocery bag
- Paper towels
- Construction paper
- Tape
- Scissors
- String (pre-cut)
- Weights (plastic eggs)

Content Information:
Students must understand what a parachute does and utilize the materials to the best of their ability to protect the egg from breaking apart. They should understand that gravity is a natural force that causes things to be pulled down towards the earth, and some objects have air resistance. They must also understand how to count to 1,000 by using 100's and starting from zero.

Deliverables:
In pairs, the students must work together by completing the worksheet and a design loop to build a parachute that can hold an egg and resist the pull of gravity so that it falls to the ground slowly. Students must able to demonstrate the parachute without the egg breaking apart and falling slowly to the ground. The students will test their parachutes by using the testing area in the classroom. There will be a stepping stool provided and a measurement on the wall marking 6 feet. They must be able to see where changes need to be made and to modify their parachute so that it works. After the activity, students will turn in their completed worksheet and design loop.

Parameters or Constraints:

- Partners will be assigned
- Students can only use the materials provided
- 4 pieces of string only
- 1 plastic egg per group
- Students will have 30 minutes to complete the worksheet and design loop provided
- Students will have an hour to construct their parachute and test it
- There will be at least 20 minutes at the end of the activity for each group to demonstrate their parachute to the class and explain their thinking/reasoning behind their design

Evaluation:

"Jumping From The Moon" Rubric

(50 Points Total)

1. Did the student properly complete the worksheet and demonstrate an understanding of how to count to 1,000 using 100's and starting from zero? (10 points)

2. Did the student complete the design loop using creativity? (10 points)

3. Did the student work well with his/her partner and contribute to the activity? (10 points)

4. Did the student follow the directions and use only the materials provided? (10 points)

5. Did the student demonstrate a proper understanding of how a parachute works, and the concept of gravity/air resistance? (10 points)

Student Copy

"Jumping From the Moon" Design Challenge

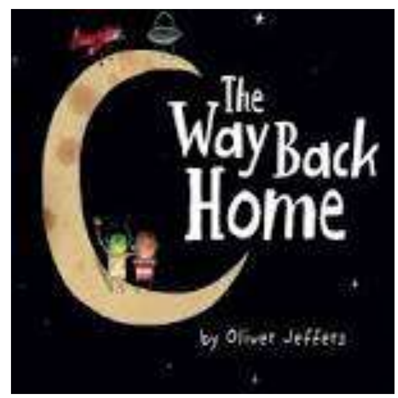
Book: The Way Back Home by Oliver Jeffers

Scenario: Imagine that you have found an airplane that can take you up into space. You decide to take it for a ride and fly it higher and higher until you are circling around the planets, moon, sun, and stars. Suddenly you realize that you are quickly running out of fuel…Uh oh! You crash land on the nearest planet and it just so happens to be the moon. Now you are stranded. How are you going to get back to earth? Using the materials that you have in your airplane, you must create a parachute that will allow you to land safely back to earth.

Challenge: You need to build a parachute with air resistance that allows a plastic egg to land safely and gently on the ground without breaking apart when dropped from 6 feet.

Materials available to use:

- Garbage bag
- Grocery bag
- Paper towels
- Construction paper
- Tape
- Scissors
- String (already cut)
- Weights (plastic eggs)



Rules:

- Work with your partner
- You can only use the materials provided
- 4 pieces of string only
- 1 plastic egg only
- You will have 30 minutes to complete the worksheet and design loop provided
- You will have an hour to construct your parachute and test it at least once
- After the activity, you will demonstrate your parachute to the class and explain your design

Evaluation: Your teacher will grade you by using the rubric that is attached.

Name:

How Far is The Moon from the Earth?

Imagine that the moon is only 1,000 feet from the earth (we know that it is MUCH farther than that). Starting from the earth, zero feet, count to 1,000 feet to reach the moon by using 100's.

Finish: 1,000 Feet

Moon

________ feet

________ feet

________ feet

________ feet

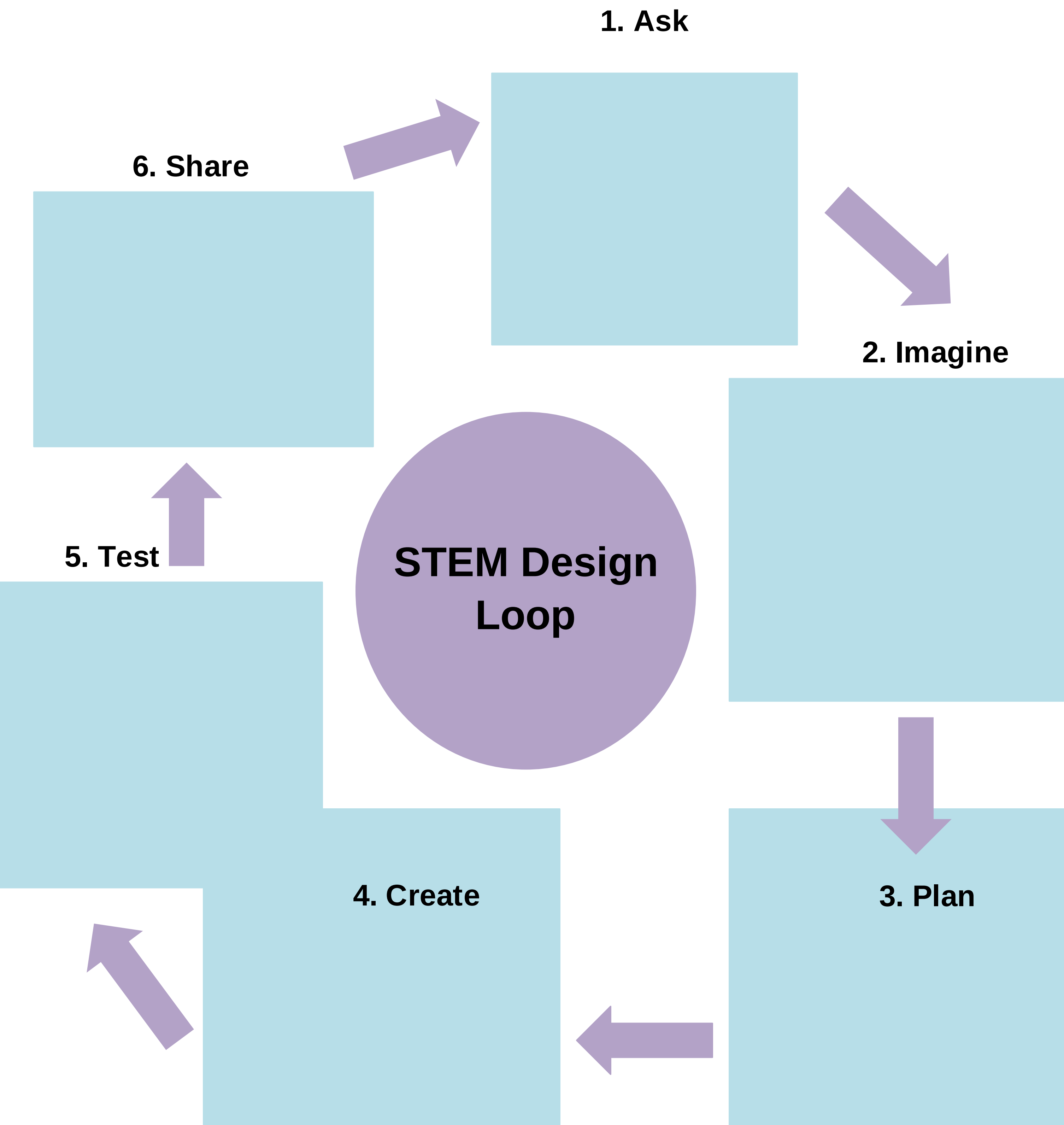
________ feet

Earth

________ feet

Start: 0 Feet

Name:



“Jumping From the Moon” Student Rubric

(50 Points Total)

1. Did the student properly complete the worksheet and demonstrate an understanding of how to count to 1,000 using 100’s and starting from zero? (10 points)

2. Did the student complete the design loop using creativity? (10 points)

3. Did the student work well with his/her partner and contribute to the activity? (10 points)

4. Did the student follow the directions and use only the materials provided? (10 points)

5. Did the student demonstrate a proper understanding of how a parachute works, and the concept of gravity/air resistance? (10 points)

Get My Gravity Back!

Teacher Curriculum Guide

Grade Level: Third Grade

Science Frameworks

a. 3-PS2-1 Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
b. 3-PS2-2 Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
c. 3-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
d. 2-PS1-2 Analyze Data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.
e. 1-ETS1-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
f. K-PS2-1 Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

Math Standards

g. AR.Math.Content.3.MD.B.4 Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch

Standards for Technological Literacy

h. Standard 8: Students will develop an understanding of the attributes of design. In order to comprehend the attributes of design, students should learn that:
    A. Everyone can design solutions to a problem.
    B. Design is a creative process
i. Standard 9: Students will develop an understanding of engineering design
    A. The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others

B. Expressing ideas to others verbally and through sketches and models is an important part of the design process

Big Ideas

j. Gravity is a force that affects the motion of objects. In this case, the force of gravity is something we want to mimic or simulate so that the toy Alice attached to the helium balloon can come back to the ground!
k. Pushing or pulling can stimulate the way gravity works. Depending on the device the students create, ultimately it will either be pushing Alice down or pulling her to the ground, so students will understand the effects of gravity's downward motion.
l. There is more than one way to solve a problem. As long as students follow directions and use only the materials and time given, there could be multiple designs that accomplish the goal of the lesson!
m. Making decisions about what materials work best and where. Students will have to consider the properties of the materials they're given to determine what would work best together to get Alice back down to the ground.
n. Developing new or improved creations from old or simple materials. Students will construct something out of the materials; not just use them apart from each other!
o. Understanding how to measure using a ruler or tape measure for construction purposes. Students will be given several materials that may need to be reshaped, so they will have to use the ruler/tape measure and scissors to precisely make their design (and so they can draw it to scale on their final illustration).
p. Students will have fluent knowledge on how the engineering design loop process works.

Essential Questions

q. Questions that can be understood through the video and article resources for the students:
    i. What kind of force is gravity? What direction?
    ii. How does weight relate to gravity?
r. Questions that can be understood through the design process of the lesson:
    i. What is the result of forces that push and pull?
    ii. How can simple machines stimulate pushing and pulling?
    iii. How can simple machines stimulate gravity and how it acts on an object?
    iv. How do we use the engineering design process to solve problems?
    v. How do we measure and draw something to scale?
    vi. How do we measure and manipulate materials to construct a new design?

Scenario

s. The scenario is that Alice, from the book, has "lost" her gravity, and her brother Eric must bring her back to the ground safely. Students will design and test ideas to help Alice stay on the ground. These ideas will need to push or pull Alice to the ground within the parameters listed below.

Challenge

t. Alice will be a plastic toy attached to a small, helium-filled balloon tied around each pair's desk 3 feet above the ground. The students will, essentially, be finding ways to help increase gravity on Alice—this can be done by adding weight to Alice herself, or by creating a device that exerts a force (like gravity does) on Alice to get her to the ground.

Materials and Tools

u. Materials
   i. Teachers
      A. Technology that can show a YouTube video to the class prior to the assignment
      B. The book Eric The Boy Who Lost His Gravity
      C. Copies of the two pdf research papers
      D. Appropriate amount of small helium-filled balloons (about the size of a grapefruit)
      E. Appropriate amount of 3 foot long strings
      F. Plastic toy people to attach to the balloons (with the glue).
   ii. Students
      A. 20 paper clips
      B. 2 ft. string
      C. 10 marbles
      D. 10 sticky notes
      E. 2 pencils
v. Tools
   i. Teachers (however much of each he/she needs)
      A. Scissors
      B. Glue
      C. Meter stick (to measure the 3 foot string)
      D. Tape
   ii. Students
      A. 1 pair of scissors per group
      B. 1 measuring tape/ruler per group
      C. ¼ stick of sticky tack
      D. 6 in. masking tape

Content Information

w. Students, prior to reading the book, should have some knowledge on the subject of gravity. Have them watch this short tutorial before they begin as a way to add to their research portion of the design loop: https://youtu.be/ljRlB6TuMOU
x. If students are having a difficult time grasping the concept of gravity, have them take more time in the research step. I have two pdf printables for kids

to read through and use during their design if they want to research further (see attachment at the end of this document).

Deliverable

y. Students will bring the teacher their completed design challenge sheet, illustration drawn to scale, and blueprint of how it works. Each student turns in an individual design sheet, and the pair collectively turns in one illustration and one blueprint.

Parameters

z. Students need to SAFELY lower Alice to the ground—this prevents them from using materials to simply pop the balloon or cut Alice off of it to get her to the ground. Students themselves cannot touch Alice or the balloon directly to drag her to the ground—they must use the materials given.

aa. Students can ONLY use materials given.

bb. Students will have 2 class periods to complete the assignment: One 30 minute class period to research and plan and One 30 minute class period to test, redesign, and share.

Evaluation

cc. During the student's presentation in class of how they lowered Alice to the ground, the teacher will evaluate them using the rubric below:

Criteria	Excellent (5 points)	Satisfactory (3 points)	Unsatisfactory (1 point)
Group is able to recreate lowering Alice to the ground during presentation	Alice is lowered all the way to the ground during recreation	Alice is lowered at least half way to the ground during recreation	Alice remains in the same spot or is moved insignificantly during recreation
Group members share an accurate definition of gravity	One or both group members state explicitly what gravity is and are correct	One or both group members have an idea of gravity, but it's not totally accurate	Group members do not share a definition of gravity during presentation
Group members share clearly why their design did or did not work	Both group members are able to explain what they did correct *and* what they could have done better	At least one group member can explain what they did correctly *or* what they could have done better	Neither group member shares why their design did or did not work
Group is able to recall information from the book during presentation	One or both members make a reference to gravity in the story	At least one group member recalls information in the story, even if it is not directly about gravity	Neither member of the group makes any reference to the story
Both design sheets, illustration, and blue print are turned in at the time of presentation	All are present and completed at the time of presentation	All are present but may be incomplete at the time of presentation	One or more items listed are not present at the time of presentation
Total Points /25:			

"Get My Gravity Back!" Design Challenge

Scenario:

Oh, no! Eric's sister, Alice, has thrown a tantrum and lost her gravity! Eric has to help her! He needs to weigh her down to the ground so she can have her bunny! Can you help Eric design a way to get Alice's gravity back?

Challenge:

With a partner, construct a plan to safely lower Alice all the way down the floor using the materials in your paper sack. Use the design loop to plan your solution. Your plan must include safely lowering Alice all the way to the ground without popping the balloon or removing Alice from it.

Tools and Materials:

20 paper clips
2 ft. of string
10 marbles
10 sticky notes
1/4 stick of sticky tack
1 pair of scissors
1 measuring tape or ruler
2 pencils

Test:

1. Test out your design and make changes or adjustments if you need/want
2. Draw an illustration to scale of your final plan and a blueprint of how it will work
3. Present to the class how you lowered Alice to the ground and why it did or did not work

Name:___________-

Design Loop Sheet

Question: How do we lower Alice to the ground using the materials given?

Background Knowledge:

What do I know about gravity? How will this help?

Researched Knowledge:

What other information can help me?

What materials will I use?

Materials	Amount
Paper clips	
String	
Marbles	
Sticky Notes	
Sticky Tacks	

Tools	Amount
Scissors	1 pair
Ruler/Measuring Tape	1

Was the test successful? _____________

What could be improved for next time?

____

____

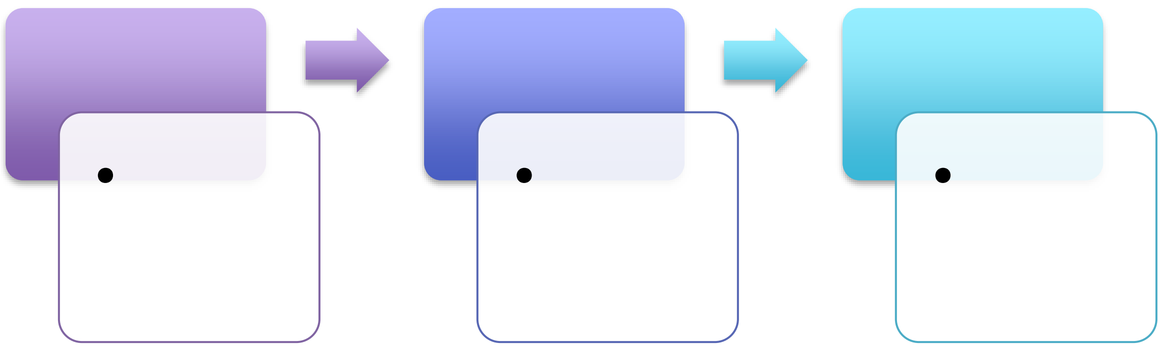
Possible Solution 1: Draw and Explain

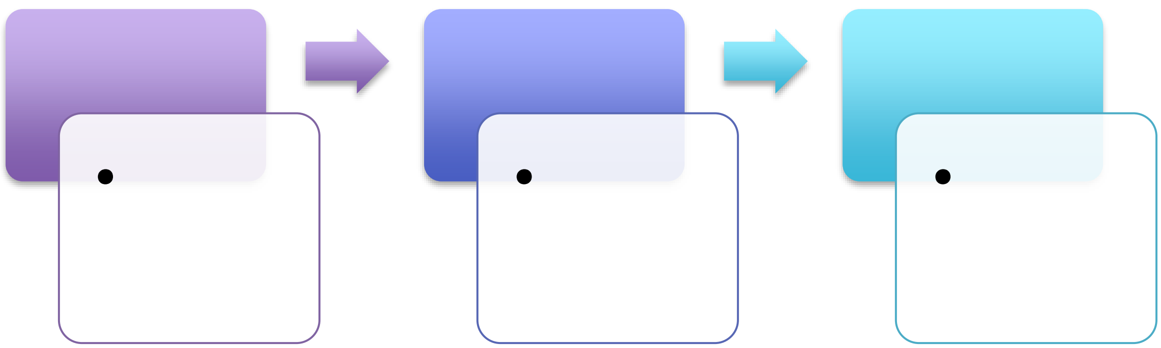
Possible Solution 2: Draw and Explain

Illustration

(Drawn to scale of your real-life model)

Blueprint





Tricky Bag, Little Critter

Grade Level 3rd grade

Standards

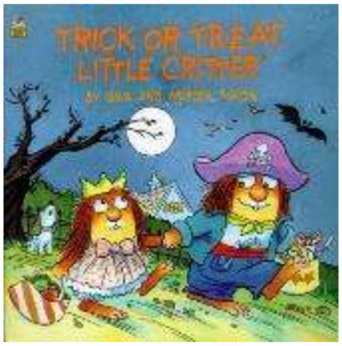
Standards for Technological Literacy
-**Standard 9.** Students will develop an understanding of engineering design.

Arkansas Science Standards
-3-PS2-1 Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object

Arkansas Math Standards
-AR.Math.Content.3.MD.C.6 Measure areas by counting unit squares (square cm, square m, square in, square ft., and improvised units)

Materials

- Trick or Treat, Little Critter by Gina and Mercer Mayer
- Construction paper (4 pieces per group)
- Tin Foil (2 feet per group)
- 36-inch-long; 0.5-inch-thick Dowel Rod— (one per group)
- Masking tape
- Scissors
- Hand saw (that can be used by students)
- Ruler
- Halloween candy
- Baggies (enough for each student)



Preparation

Before the lesson, be sure to decide how many students you would like to work in a group. I recommend 3 or 4 students per group. Each group will get construction paper, tin foil, a Dowel Rod, a roll of masking tape, and scissors.
Also, separate the Halloween candy into the small baggies equally. These will be used as weights to test the students' design.

Introduction of Concept

After reading Trick or Treat, Little Critter, ask students to brainstorm ideas of why they think Little Critter's basket broke open and all the candy fell out. Once students have generated their ideas, identify the concept of force—the weight of the candy.

Real world help: Ask students if they have ever had a grocery bag bust and pour the groceries all over the ground? Why might the bag have busted?

Scenario

"One year later, Little Critter is ready to rock Halloween! This year his mom cannot buy him a new bucket for trick or treating, but he found a long stick and has a bunch of construction paper and tin foil laying around. He needs your help to be able to create a container that will withstand his trick or treating festivities!"

Challenge

In groups of 3 or 4, students will have 1 hour to use their design loop to innovate their very own candy holding container. They should map out their design before even attempting to build. This means they should provide area measurements for the whole container. Whose group can create a container that withstands the weight of the candy AND the swinging of the container as Little Critter skips down the street.

Essential Questions

How does the weight of the candy effect the container?
How does the swinging motion of the container effect the force of the candy?

Deliverables

After completion, the students should be able to deliver a hand-made container. Also, they should be able to turn in a design loop worksheet (one from each group), the area measurements of their container and the work they used to find their measurements, and their notes about the introduced concept of force. The notes should be written in their science notebook for later reflection.

Parameters & Constraints

- Students will have only one hours to brainstorm, build, and fix their design through a design loop worksheet.
- They may only use the materials provided (they do not have to use all of them, I just choose not to tell them that!)
- Their design must contain measurements before they begin to build, including area.
- Has to have some sort of handle.

Evaluation

Groups will take turns placing candy pouches in their container one at a time. If there is a tie, the winner will be decided on who can skip and swing their basket down the hallway (or outside) and back without having their basket break. First one back wins!
Afterwards have students discuss why they think some containers broke.
When was the container put through the most stress? What caused the stress? (Force of the candy)
Also, students will have completed the worksheets to turn in.

Science notebook: If your students have science journals, I recommend having them jot down what they have learned.

If you are unsure about the concept of force, there are many websites that may help you understand this concept in an easy way! A basic definition of force would be: any interaction that, when unopposed, will change the motion of an object. In other words, force is anything that *forces* an object to move. Gravity is an example of force. The weight of the candy is the force which is acting upon the trick or treat bag. If you were to kick a ball sitting on the playground, the force would be the kick.

Here are some easy websites that may help you understand force more clearly:

- www.physics4kids.com

Little Critter needs your help!!

Scenario	One year later, Little Critter is ready to rock Halloween! His mother cannot buy him a new bucket for trick or treating, but he found a long stick, construction paper, and tin foil laying around. He needs your help to create a container that will withstand his trick or treating festivities!
Materials	• 4 pieces of construction paper • 2 feet of tin foil • Dowel Rod • Masking tape • Scissors • Hand saw (with teacher supervision) • Ruler
Challenge	In groups of 3 or 4, you will have 1 hour to use your design loop to innovate your very own candy holding container. First, use the design loop worksheet to create a design. **You must provide both area and perimeter of your container before you can begin to build.** Whose group can create a container that withstands the most weight? The winner will win twice the amount of candy as the rest of the class!
Please Remember	• You may only use the materials provided. • The design must contain measurements before you begin to build. • The container must have some sort of handle. • You have one hour, GO!

Name: ____

Tricky Bag, Little Critter!

Recognize the problem:

How can it be fixed?

Sketch YOUR solution:

Results of group design:

How might you improve it?

Name: ____

Innovation, Little Critter

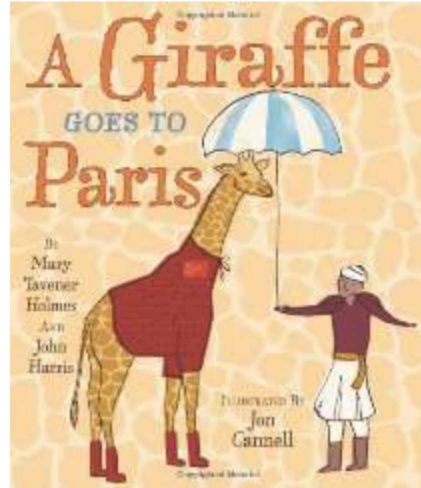
Discuss with your group whose sketch is the best fit for holding all of Little Critter's Halloween candy. After your group has chosen, create a blueprint of the design. Include which materials will be used and identify the area and perimeter.

Materials that will be used:

Total perimeter:

Area:

Take a Giraffe to Paris



Grade Level: 3rd Grade

STEM Content Standards:
Arkansas Math Frameworks

M.13.3.9
Estimate and measure length, capacity/volume and mass using appropriate customary units
Length: 1 inch
*Perimeter***:** inches, feet, etc.
Area: square inches (Use models)
Weight: Pounds/ounces
Capacity: cups, pints, quarts, gallons

Standards of Technological Literacy
Standard 8: Students will develop an understanding of the attributes of design.

- The design process is a purposeful method of planning practical solution to problems.
- Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.

Standard 9: Students will develop an understanding of engineering design.

- The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.
- When designing an object, it is important to be creative and consider all ideas.
- Models are used to communicate and test design ideas and processes.

Standard 11: Students will develop abilities to apply the design process.
Test and evaluate the solutions for the design process

Standard 19: Students will develop an understanding of and be able to select and use manufacturing technologies.

Manufacturing processes include designing products, gathering resources, and using tools to separate, form, and combine materials in order to produce products.

<u>Arkansas Science Frameworks</u>

3-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Big Ideas:

- Building structures
- Understanding how certain materials react with water
- Team work and team building
- Solving a problem: deciding on a solution and working together to create a final product

Essential Questions:

How can you build a structure that will float on water?

Using the materials given, how can you make a boat that can get the "giraffe down the river"?

How will the materials given react when placed in water?

After a test run, how can my team make our boat more efficient? I.E the amount of time it takes to float "down the river", not getting water in the boat etc.

Scenario:

In our story A Giraffe goes to Paris, Belle the giraffe is taken down the Nile River in a very unusual way. The Captain cut a hole in the top of the boat and put an umbrella over her head! The captain had to improvise in his situation, but what would you do differently if you had to build a boat for her? Would it be tall like Belle? Or long and open? Today you are ship engineers and it is your job to get Belle down the Nile River in a boat that you will create.

Challenge:

As a team, create a boat that will hold the weight of the giraffe provided and float on our makeshift river (in a long narrow container filled with water). You will be provided with materials to create a boat and it will need to safely carry the giraffe from one end of the river to another, this will be possible by the construction of a sail with wind power

Tools, Materials, and Resources:

Materials

- 10 straws
- 2 feet of saran wrap
- 5 ft of duct tape
- 4 large index cards
- 2 pieces of cardboard
- 6 popsicle sticks

Tools

- Scissors
- Water tank to test the boat: 3 feet long, 1 foot wide, 1 foot deep clear, plastic container filled about 1/2 way with water
- A 3 inch tall toy giraffe that has to float in the boat
- Hair dryer to propel the boats

Content information:

Students will be provided with a presentation on measurements, building structures and understanding solids and liquids before being given their challenge. This presentation may also expand into a lesson on buoyancy and understanding how different materials will float and sink in water. Questions will be posed to students around the topic of efficient structure building, this will be a key factor in their project. Students will need to understand that they are provided with a limited amount of supplies that can be used to create their boat. Students will need an understanding of brainstorming as well as successful teamwork in order to complete this project as they will work in pairs for this assignment. Students will need to understand how placing weight in or on their structure will effect if their boat floats on the "river" or not.

Deliverables:

Students will need to deliver a completed structure that does in fact float on the water. Students will have 20 minutes to brainstorm and create an initial model before it needs to be tested. Students will then have another 10 minutes to make modifications before submitting their final product. Students will be given a brainstorm sheet that each student will have to fill out individually before beginning the actual construction of their model. As a pair, students will also complete a planning sheet. It will show that they both decided on a plan for their structure and the materials that they plan to use. After completing their modifications they will list, as specifically as possible the materials they used to build their final product. This is where measurements will be an important factor as they will need to measure the remaining materials and make an educated estimation or conclusion of what materials were used. Students will individually reflect on the process that they went through to come to their final product, discussing how they initially came up with the concept, the challenges that they faced when creating the structure, the modifications that they made to make it more efficient, what the final product ended up being as compared to their first plan and finally, what they would do differently if they could start over and complete the project again. Students would also complete and individual and peer evaluation forms to reinforce the idea of teamwork and creating an atmosphere of self-reflection to make sure students understand a balance in work load and cohesive project completion.

These forms are attached at the end of this document:

- Completed boat
- Brainstorm sheet
- Reflection on notebook paper following this prompt: Describe in detail the process you and your partner took to complete your final product. How did you initially come up with this concept? What were some of the challenges you faced when creating the model? What modifications did you make after the first run? How was your final product different than your first model? What would you do differently if you could start this project over?
- Self/Peer Evaluation

Parameters or constraints:

The structures that students complete will have to be small enough to fit in the tank provided for testing the structures, ideally this container would not exceed a width of 12 inches but would have a large enough length to mimic the idea of a river.

Students would have specific parameters for how much of the materials they would be provided with:

- 10 straws
- 1/2 roll of saran wrap
- 5 ft of duct tape
- 4 large index cards
- 2 pieces of cardboard
- 6 popsicle sticks

Students will be limited in the amount of time they have to complete the assignment:

- 10 minutes to brainstorm
- 20 minutes to build their structure before testing it the first time
- 10 more minutes to make modifications before testing it the second time
- Students would then have 20-30 minutes depending on the time frame available to complete their reflections and evaluations as well as clean up the classroom.

Evaluation:

Students will be evaluated based on several factors over the course of the project:

- Students teamwork skills will be evaluated based on the teacher's observations as well as the student self-evaluations and peer evaluations
- The actual completion of the structure and turning in a final product where it is apparent that the pair worked to accomplish the tasks and made changes to their structure if it did not work the first time or it was made more efficient after the first test.
- Students will be graded for completion of all supplemental worksheets given for the project, such as the brainstorming sheet, planning sheet, evaluations and final reflection.

Brainstorm Guide:

Draw a picture of what you want your boat to look like:

What materials will you need you create this?

Draw a second plan and list the materials you'll need:

Other ideas/notes you might have before starting:

Peer/Self Evaluation:

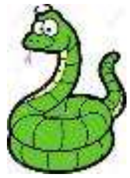
Name:

Write the name for your partner in the empty box to the right of the box that says "myself". Then, assign yourself a value in each category as well as your partner and total the values.

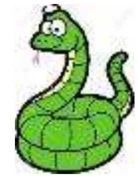
5 = amazing!   4 = extra helpful   3 = okay   2 = not great   1 = bad

Attribute	Myself	
Participated in discussion		
Stayed on task		
Contributed productive ideas		
Amount of work done		
Quality of work		
Respectful		
TOTAL:		

Quick Challenge



The Charming Snake Quick Challenge



Standard:

PS.7.1.5: Demonstrate methods of producing static electricity (e.g., balloons, shuffling across carpet).

Content Information/Outline:

A static charge is formed when two objects rub against each other and the electrons move from one object to the next. This creates a magnetic like charge that will cause one object to stick to other objects or surfaces. In a hands-on way, this activity will reveal to students a different avenue to create static electricity and the effects it has on objects. Most importantly, after this challenge students will have a better understanding on the concept of static electricity, and it will open the door to discuss other ways to create static electricity using different materials.

Challenge:

Using the provided materials, create a tissue paper coiled snake. Then using the ruler and the wool fabric see if you can create static electricity to “charm” the snake and lift up his head!

Essential Question:

How can you create static electricity on the ruler and then touch the snake to make him come alive and lift up his head?

Further Instructions:

1. Students will cut out a coiled snake using the provided tissue paper.
2. They will then experiment to try and create static electricity using a ruler and wool fabric.
3. They will test their ruler to see if it is statically charged by touching the head of the snake and seeing if he lifts his head!

Materials:

- Tissue Paper
- Scissors
- Small Plastic Ruler
- Markers
- Wool Fabric

Methodology:

The teacher will implement this quick challenge at the beginning of the school day or the beginning on a lesson that dives deeper into static electricity. This activity is only meant to interest the students on static electricity and help them visually see what it is capable of doing. They will also use a curtailed version of the design loop to figure out and come to a conclusion on how to create static electricity. The teacher will know if the students grasped the concept if they are able to lift the snake's head with the ruler.

Student Feedback:

While experimenting with static electricity and completing this activity, the teacher will walk around further explaining directions if needed as well as complimenting and encouraging students that have successfully completed the challenge. Since this will not be graded, the teacher will simply express feedback verbally to the students during and at the end of the activity.

Larger STEM Challenge:

A larger STEM challenge that could follow this hook activity or quick challenge could include exploring the virtual balloons and watching what happens to the electrons when you rub them together, and why/how they become charged. This would expand upon this quick challenge because it would explain as well as show students why and how objects are capable of sticking to things when they are rubbed together.

Quick Challenge

Content Information

A lunch box is something we all mostly use every day that we bring to school. The handle makes it easier to carry and the latch secures all the yummy food inside. Lunch boxes can be made out of tin or softer material.

Challenge

Using the materials supplied you are going to be working with a partner to build a lunch box that has a handle, and a latch. The trick is, you have to work with your partner and give directions such as, up, down, left, right, etc to build the lunch box as a team.

Essential Question

How well can you demonstrate spatial relationships with your partner by building a lunch box with a latch and handle by only listening to directions?

Materials

- Two sheets of paper
- 3 pipe cleaners
- scissors
- scissors

SKYCRAPERS!

2nd grade

Standard:
CCSS.MATH.CONTENT.2.MD.A.1
Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.

Quick Challenge:
Skyscrapers can be found all over big cities. These are the buildings that are extremely tall. They must be built in a very specific way in order to be as tall as they are. With only play dough and toothpicks, design the *tallest* skyscraper in the city!

Methodology:

- Students will work in partners to create their skyscraper
- *Materials:* The teacher will need to provide students with 1 tub of play dough and 20 toothpicks. These are the only materials the students can use for the challenge. Students will also be given a measuring tape to measure how high their skyscraper is.
- *Evaluation:* Teacher will test whether they have made a tower using only the materials given. The tower must be at least 6 inches tall. Teacher will evaluate through observation on teamwork and completion of the tower.
- Teacher will reinforce and review measuring with the students to insure they are prepared for this quick challenge.

**There is not to be a student handout for this activity. The teacher will give the instructions of the quick challenge and let the students start on the activity at the conclusion of the instructional period. This will challenge the students to listen and remember the directions, as well as the quick challenge itself. This activity should not take more than 20 minutes for the students to complete.

Student Feedback:
The students will receive feedback from their teacher when the time of completion of their tower has finished. They will receive the feedback when the instructor walks around and watches the students measure the height of their skyscraper.

Content Outline:
Students will need to understand:

- Building structures
- Height and weight
- Gravity and force
- Measurement

All of these concepts must be understood for the students to advance to the larger STEM challenge.

Larger STEM Challenge
A larger STEM Challenge that can be paired with this Quick Challenge is an assignment to create the *sturdiest*, tallest structure. This structure will have to hold an apple at the top of it. This will expand on the quick challenge by adding another element that will really make the students think and problem solve. They can learn about force, gravity, and height with this larger STEM challenge.

Drop the Golf Ball (2nd grade)

Standard: 1-ETS1-2- Developing Possible Solutions: Designs can be conveyed through sketches, drawings, or physical models to illustrate how the shape of an object helps it function as needed to solve a given problem.

The Scenario: The golf course needs help creating a new container that will catch the golf balls that are hit at the driving range. Construct your own container that will catch a golf ball that is dropped above it.

The Challenge: The goal for the students is to build a container that has a bottom support that will catch a golf ball that is dropped from 5 feet. They are to use only the materials given to construct their container.

Procedure (read to class orally)

1. Construct a container from the materials in groups of 4-6
2. Each team needs to select their "ball dropper" to drop the golf ball from the 5ft height
3. Place the container on the floor
4. Hold the ball above the container, where you think it will land and be caught
5. Each team gets 3 attempts, and the team that makes their golf ball stay land and stay in container wins.

Materials: *12 straws *18" masking tape
Tools: *1 golf ball *scissors

Content: This activity is to get their schema activated in the concepts and ideas in gravity and forces. This quick challenged can be used for a bigger activity on Newton's laws, and forces in physics.

<u>Kindergarten Quick Challenge</u>

PS.6.K.3

Demonstrate the effects of the *force of gravity* on objects

Materials:

Plastic Cups

Styrofoam Cups

(No more than 15 cups total)

3 Pieces of Computer Paper

Scissors

Teacher says orally: Gravity is the force that causes things to drop to earth. Every physical object has gravitational force, including you! For this challenge you need to build the tallest tower you can using the given materials. The tower has to be built sturdy or gravity will cause your tower to fall down. Work in groups of two.

*If students are only stacking the cups inside of each other, encourage them to use some of the other materials to see if they can build an even taller and sturdier tower.

After the quick challenge:

- Gravity- why things fall to the earth when we drop them
- Center of Gravity
- Air resistance- do all things fall at the same rate? Demonstrate that some things fall slower because of air resistance.

Larger STEM challenge:

Using the concept of air resistance, how can you counteract gravity and slow down a cup falling so that it floats down slower while gravity pulls it down.

Quick Challenge: Marble Maze

Grade: Kindergarten

Standard: PS.6.K.2 Demonstrate various ways that objects can move, including but not limited to: straight, zig-zag, back and forth, round and round, fast and slow

Scenario: Mario just got a new car and he needs to figure out how it moves before he can race it! He needs his pit crew to build a race track that makes his car move in as many directions as possible so he can feel prepared on race day.

Task: Design a maze that will make the marble move in as many different ways as possible by tilting the shoe box lid.

Materials:

- 1 shoe box lid or piece of cardboard about the size of a sheet of copy paper (per group),
- 10 straws
- Masking tape
- Scissors
- 1 marble

Questions for Discussion:

- Describe the different ways you saw your marble move
- What ways did you plan on it moving?
- What ways did it move that you didn't plan on?
- What difficulties did you run in to?

Content Outline

Direction is the path of an object. Objects can move in a straight line, zig-zag, back and forth, round and round, fast and slow. The way to change how something is moving is to give it a push or a pull. A push uses force to move something away, and a pull uses force to move something towards you.

Larger STEM Challenge

This quick challenge could launch into an investigation unit on push, pull, strength, and direction. Students could experiment with objects of different weights, observe/describe the strength it took to move them, and rank them in order from heavies/hardest to move too lightest/easiest to move.

Eleanor Jahant
STEM 4033

In Class Quick Challenge

2nd Grade

Quick challenge to focus on science standard.

Learning Standard: **ESS.8.2.8** *Demonstrate and apply knowledge of Earth's structure and properties using appropriate safety procedures, equipment, and technology. Predict weather based on cloud type.*

1. Students will each be given cotton balls.
2. Students will take the cotton balls and build different types of clouds based on their own observations.
3. They will create their different cloud models and the students will paste their clouds on the given diagrams.

Quick challenge used as a hook.

Students will be introduced to a new unit on weather based on the different cloud types.

Students will use their knowledge of clouds that they have observed overtime. With this knowledge they will create models of clouds with cotton balls based on different types of weather.

<u>Content Information</u>:
Clouds play a big role in weather. There are different types of clouds according to what the weather is like. Students will use their past knowledge of observations to determine what they think a clouds look like. Students will be given different weather scenarios that they will have to model clouds for. This activity introduces students to what they will be learning about next, and also allows the teacher to see what students already know about the topic.

<u>Challenge</u>:
Using the materials supplied, form different types of clouds that you have observed in the past. Remember that you can stretch, pull apart, and combined the cotton balls when forming the clouds.
STOP & THINK: Think about how clouds look different depending on the weather.

Essential Question:
What ways that you can model clouds depending on the type of weather outside, and also label the different types of clouds?

Supplies:
Cotton Balls
Grey Cotton Balls
Glue

Larger STEM Challenge:
This can lead into a lesson about looking at different types of clouds. By looking a different types of clouds you can determine the weather.

Name:

Directions: *Make clouds that you would see on a rainy day. Paste the clouds where you think they belong on the worksheet*

Name:

Directions: *Make clouds you think you would see on a snowy day. Paste the clouds where you think they belong on the worksheet and label the cloud.*

Name:

Directions: *Make clouds you think you would see on a snowy day. Paste the clouds where you think they belong on the*

Morgan Kazanovicz
Explore Gravity with Marbles!
Grade: Kindergarten

Standard:
PS.6.K.3 – Demonstrate the effects of the force of gravity on objects.

Quick challenge:
Students will work in pairs to create their own marble drop track. Tracks must allow dropped a marble to travel completely through the track, from the top of the poster board to the floor, and the marble must land safely in a cup at the bottom.

Methodology:

1. Encourage students to experiment with marbles by dropping them from different heights and dropping them through the different track building materials. (Provide a soft surface for dropping if working on a hard floor)
2. Explain how students will tape the track materials to the poster board in a way that will allow the marbles to travel from the top of the poster board to a cup at the bottom.
3. Require students to utilize as many track materials as they can, making the finished track as elaborate as possible.

Materials needed:

- An assortment of track building materials, such as toilet paper rolls, paper towel rolls, or coin wrapping cylinders. **Note:** I used coin wrapping cylinders because:
    - They are very inexpensive and can be purchased in large bags
    - They are easily cut to provide a variety of different track materials, long tracks, short tracks, tracks with holes, track with open tops, etc.
    - They take up little space and can create an intricate track on a relatively small surface, such as a poster board
- Small marbles **Note:** test the size of the marbles and make sure that they are able to travel through your chosen track material.
- Tape **Note:** I recommend using a tape that is removed easily, such as washi tape or painter's tape, to allow student to manipulate track and to avoid damaging walls if poster board is not used.
- (Optional) poster board **Note:** I recommend providing students with a poster board if there is limited wall space within a classroom or you are concerned with damaging the walls.

Student feedback:
Students will be asked to describe how gravity affects an object when it is dropped and how gravity helps the marbles move through the tracks from top to bottom.
Content outline:

- Gravity and its effect on objects
- Sequence of events as marbles move through track

- Trouble shooting when track designs fail

Larger STEM challenge:
A way to expand this quick challenge would be to create a larger version of a track where students could test how fast materials with different weights, such as pom-poms and rubber balls, compare with the marbles.

Quick Challenge Assignment

Science Standard for first grade:
PS.7.1.6
Classify materials as magnetic or nonmagnetic

Quick Challenge:
Without touching two of the magnets, the spoon, or the cereal, you and your partner must find a way to feed a spoonful of cereal to your very hungry teacher. You may touch one of the magnets, the string, the pipe cleaners, the paper clips, and the safety pins in order to connect these materials to the spoon. Brainstorm ideas to lift the spoon, scoop up a bite of cereal, and maneuver the spoon to feed the cereal to your teacher or friend.

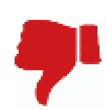
Methodology:
Two children are to be in each group.
You may only use the materials listed below:

- 3 magnets
- 1 spoon
- 12 inches of string
- 2 pipe cleaners
- 15 paper clips
- 15 safety pins

Student Feedback:
Students will be evaluated based on their ability to work as a team.

Student Evaluation Form (to be filled out by students)

Circle the thumbs up if you replied, “yes” to these statements.

My partner was a good friend to me during this activity.		
My partner tried her/his best during this activity.		
I was nice to my partner and helped him/her.		

We followed Ms. Keller's directions.		

Content Outline:

- Magnetic and nonmagnetic materials

STEM Challenge:
It would be a good idea to review magnetic materials by providing multiple items that are and are not magnetic. Provide a sheet for students to fill out or cut and paste images and words to the magnetic items side and the nonmagnetic items side.

STEM Quick Challenge
4th Grade

Standard: *PS. 6. 4. 2*

Investigate the relationship between force and mass.

Quick Challenge: The fire department needs your help! There has just been a report of a puppy stuck in a hole, 20 feet into the ground. You must create a rescue cranking device that will hook onto the rescue carrier, allowing Pete the Fireman to safely lower into the hole, rescue the puppy and return back up to the terrain. The device must be able to unwind and wind up the rope (string). It's getting late out, so your time is limited!

Methodology:

- Materials: Straws, Dixie cup, popsicle sticks, string or yarn, rubber bands, construction paper, tape, scissors, paper clips, and rocks (used as fireman and puppy)
- Preparation: Each group will get the following: 2 straws, 6 popsicle sticks, 36" of string or yarn, 2 rubber bands, 1 sheet of construction paper, 1 paper clip
- Instructions: The teacher will begin by displaying the rescue carrier that will be attached to the students' rescue cranking device. Students must build a device that is sturdy enough to withstand the fireman's weight, when being lowered, as well as the fireman and puppy's weight combined, when being rescued or pulled back up. Remind students that their device must have a hook or some sort of way to attach to and detach from the carrier.

Student Feedback:

Once the time is up, the students will test their devices in front of the class and explain why they chose the design of their rescue device. The class will hold a discussion about each device, offering ideas of what could have been done differently to enhance the performance of the device or simply what the group did well.

Content Outline:

- Force and mass

Larger STEM Challenge:

A way to expand this challenge would be to add more mass to the carrier and see how much each carrier is able to lift and lower with ease. Another way to include math would be to have the students measure the length of the distance between the starting point and the bottom of the hole and convert the measurement to different units of measurement.

Static Electricity Quick Challenge

Quick challenge to focus on science standard – Grade 1

Learning Standard: Demonstrate methods of producing static electricity (e.g., balloons, scuffling across carpet)

Quick Challenge:

1. Students will get in groups of two, and receive their materials.
2. Each water bottle will have a premade hole in the lid. When the students are ready to make their stream of water they will place the water bottle in the stand, and flip it upside down. Make sure the pan is under the bottle, so that the water that is pouring out is going into the pan. To make the water stop running, simply flip the bottle over.
3. Students will blow up their balloons, and create static electricity by rubbing them on multiple surfaces.
4. When the balloon becomes charged flip over the water bottle and get the balloon as close to the running water as possible without touching it to see if the water will bend (will lose its charge if water gets on it).
5. Try to find at least three different ways to create static electricity.

Essential Question: Using the supplies provided can you produce static electricity in at least three different ways that will bend a thin stream of running water?

Supplies	Tools
Water bottle 2 Balloons	Stand that will hold water bottle Pan to catch water Paper towels for clean up

(Ideal to do this quick challenge in a sink, but if a sink is not available these supplies and tools will work!)

Student Feedback: When students have completed their quick challenge have them share with the class the three different ways they created static electricity, and if each method caused the water to bend or not. The teacher can then discuss with them why the water did or did not bend.

Content Outline: The major aspects that will be talked about after the challenge is, attraction, repulsion, and positive and negative charges.

Larger STEM Challenge: After the students have completed the quick challenge the teacher can begin to talk about what static electricity is. She can also talk about how there is always a positive and a negative charge. Followed with what ends would attract, or repel each other. The teacher could then have the students create static electricity with objects in the room, besides a balloon, and together as a class discuss what made the most static electricity, and why.

Straw Tower Quick Challenge

Grade: 4th Grade

Standard: *PS.6.4.2*
Investigate the relationship between *force* and *mass*

Quick Challenge:

1. Students will work with partners to build a tower at least 10 inches tall made of straws and tape.
2. Students will be given 20 straws.
3. Students will be given no more than 12 inches of tape.
4. Students will have 10 minutes to complete the tower.
5. The tower must be built to hold and withstand the mass of a golf ball.

Materials:

- 20 straws
- 12 inches of tape
- Golf ball

Tools:

- Ruler

Student Feedback: Students will be assessed based on their abilities to work with a partner. Teacher will also provide verbal feedback on the student's creativity in building a tower.

Content Outline: The relationship and effects of force and mass on each other.

Larger STEM Challenge:
Students will be introduced to a unit dealing with the relationship between force and mass.

1. Students will make a tower made of blocks that can withstand 60 pounds.
2. Students will build a tower that is at least 10 inches tall.

The goal of this challenge should be to make the tower as strong as possible and will be tested by adding weight on the tower until it collapses.

Based off the larger STEM challenge, the teacher could discuss the tallest buildings in the world. They would learn that even though they are the tallest buildings in the world, they need to be able to support heavy weight.

Take Flight!

Grade: Kindergarten
Science standard:

- PS.6.K.3 Demonstrating the effects of the force of gravity on objects.

Scenario: Ladies and gentlemen, start your engines! It is time to take flight! Help us construct a paper airplane that will travel farther than all the other planes. You only have 15 minutes to complete the task. The clock is ticking!

Challenge: Follow the technical procedural instructions to construct a paper airplane that will travel the farthest distance.

Methods:

1. After reading the content provided, divide the students into groups of two.
2. Using the supplied materials and the technical procedural instructions, the students must construct a paper airplane that will fly the farthest. They may alter the weight of their planes by adding paperclips.
3. The teacher will need to create a runway by using masking tape. Use this runway to measure the distance traveled by each plane. Whichever plane glides the farthest wins the challenge.
4. Students will need to count/measure the amount of weight their plane carried. They will then need to discuss why the plane began to fall and if the weight affected the motion of the plane.

Materials:

(1) Construction paper	(1) Printer paper	5 inches of tape
Small &Large paperclips	Measuring Scale	Ruler

Content Outline: This challenge introduces the concepts of gravity, weight, balance, and distance. The students will need to understand the definition of gravity. They will also need to know how to measure weights using a scale and rulers. Students will need to have an understanding of how weight affects an object's balance. Additional Resources are provided below:
http://www.physics4kids.com/files/motion_gravity.html
http://idahoptv.org/sciencetrek/topics/gravity/facts.cfm

Student Feedback: After the students have tested their paper airplanes, they will then discuss the airplanes actions. The teacher may lead this discussion. They should discuss the motion and direction of the plane. Does the plane go up? How far did it travel? Does the plane come back down? Why did it come back down? What is gravity? How did weight affect the plane's motion?

Larger STEM Challenge: A larger STEM challenge that could be done is to have the students construct cars that vary in size and weight. Powered only by gravity, the cars will then be raced down different ramps. The students will be able to see how gravity affects a moving object on the ground. This will not only expand upon the knowledge they have gained from the quick challenge, but it will also introduce them to time, graphing, force, and friction. Another challenge could be dropping objects of different weights at the same time. This will show the students that regardless of the objects mass, they will fall at the same time. Then the teacher can introduce the students to the concept of air resistance.

Catch a Cloud!

Grade: 2nd
Standard:

ESS.8.2.8 Demonstrate and apply knowledge of Earth's structure and properties using appropriate safety procures equipment, and technology

- **Predict weather based on cloud type**

Introduction to Activity: *Little Cloud* by Eric Carle

Content Information: What makes a cloud? You see them almost every day, but have ever wondered what makes a cloud? In a nutshell, clouds are formed through the collection of tiny water droplets, when warm air is heated up by the sun rays while damp air from the ground come together. Thus, little water drops form into clouds. The water drops are so small and light that they can float in the air. When enough water droplets have gathered together, they can get too heavy to float, which causes rain.

Challenge: Using the provide materials, can you create a cloud? Follow the directions below to create a cloud in a jar.

Essential Question: What could you do to increase the strength of your cloud? What could you do to decrease the strength of your cloud? What does your cloud look like, is it thin, thick, or something else? Do you think there is a scientific name for your type of cloud?

Student Feedback: The teacher will be walking around to determine if students could follow directions, listen to students' discoveries or exploring conversations, and group discussion over essential questions.

Next Step: The students will be paired into groups to conduct a wild weather research. Students will be exploring different weather conditions that occur within local location. The challenge is students will have design their very own meteorologist instruments to help predict and measure the weather that could arise in our area.

Teacher Copy

Standard:
ESS.8.2.8
Demonstrate and apply knowledge of Earth's structure and properties using appropriate safety procedures, equipment, and technology

Quick Challenge:
A giant windstorm is coming and you need to build a structure that is going to withstand the wind.

Methodology:
Students will be given 20 toothpicks and the option of choosing either dots candy or mini marshmallows as their connectors. They will have 10 minutes to create a structure that is at least 6 inches tall that can withstand the winds (hairdryer). You also must cover your structure with either tissue paper or printer paper so that your house is enclosed.

Student feedback:

1. How well do you think you utilized your resources? Where you able to be innovative with them?

2. What would you have done differently, given five more minutes?

3. If you could be given one more material, what would it be?

Content outline:

After doing this quick challenge, students will be introduced to different structures that are built in regions with extreme weather.

The importance for us to build safe structures so that can withstand the properties of our earth

Ex: houses with stilts that are by oceans

Larger STEM challenge:

My follow up challenge would be for students to create a sturdier house that can withstand an earthquake. They will need it to have a certain number of sides and be able to hold a family of four people. This will be tested by placing the house in gelatin and shaking it, along with a leaf blower.

Student copy

Content: Our earth is always changing! Natural disasters happen and it is important that we use our skills to build the smartest, safest structures to withstand the properties that our Earth may throw at us.

Challenge:
A giant windstorm is coming and you need to build a structure that is going to withstand the wind.

What YOU need to do:
Using the materials provided, create a structure that is at least 6 inches tall that can withstand the hairdryer on a "high" setting. You will have 10 minutes for this challenge. You also will work with one other person on this challenge.

Materials
- 20 toothpicks
- Choose one kind of connector:
    - Marshmallows (15 pieces)
    - Dots candy (10 pieces)

Student copy

Quick Challenge

What do you see when you look at the moon?

You have maybe seen that the moon does not look the same every time you look at it. Is it a full circle, a half circle, or just a small crescent? What do you think?

Your challenge:

1. On a piece of paper you are to draw as correct as you can what you see when you look at the moon.
2. After you are done with the drawing you are to make a model of the moon using the salt dough provided.
3. Use your markers to color your model of the moon.

Do you think your model is correct?

How do you know it is correct or incorrect?

Materials:

Material	Tools
Salt Dough	N/A
Markers	

Teacher Copy

Standards: ESS.10.3.2 Demonstrate the orbit of Earth and its moon around the sun

Quick Challenge

What do you see when you look at the moon?

You have maybe seen that the moon does not look the same every time you look at it. Is it a full circle, a half circle, or just a small crescent? What do you think?

Your challenge:

4. On a piece of paper you are to draw as correct as you can what you see when you look at the moon.

5. After you are done with the drawing you are to make a model of the moon using the salt dough provided.

6. Use your markers to color your model of the moon.

Do you think your model is correct?

How do you know it is correct or incorrect?

Material

Material	**Tools**
Salt Dough	N/A
Markers	

Quick Challenge leads to:

- Discussion on what the moon actually look like.
- Discussion on lunar phases and the relation to time.
- Discussion on how the moon orbit the earth.

Larger stem challenge:

Students will make a correct model of the moon and earth and show how the lunar phases change as the moon orbits around the earth.

Basic Questions

- Is the moon flat?
- How do they know?

  Most of the student's original salt dough moons will be flat. Have the students try and show you how a flat moon can show all the phases of the moon. They will discover they cannot.
- Show close up images of the moon and ask what shape the moon is?

  You can see from close images that the moon is spherical due to the craters at the edges turning elliptical instead of circles in the middle of the moon.

Large challenge:

Make a spherical model that will show all of the lunar phases

Leslie Pervere

Quick Challenge: Personal Measurement Challenge

Grade: 2nd

Learning standard: CCSS.MATH.CONTENT.2.MD.A.2

- Measure the length of an object twice, using length units of different lengths for the two measurements; describe how the two measurements relate to the size of the unit chosen

Methodology

- Take the students into a large space and partner them up. Ask the students to lie on the ground and mark how tall they are on the floor. This can be done with post-it notes or some sort of marker. Then ask students measure the marked area with each of the provided materials. Tell them that their goal is to see how many of each item it takes to fill the length of the area they marked. At the end, hold a vote to see which item is the best for measuring how tall they are!

Materials/Tools:

- Ruler
- Unsharpened Pencils
- 8 ½ X 11 in. paper
- Dollar bills (true to size but fake)
- Paper clips that are the same size

Student Feedback:

- The teacher will host a vote to determine which tool of measurement was the easiest to measure how tall a person was.
- Students will fill out a simple chart that shows how many of each item it took to be the same length as the length they marked on the floor

Item of measurement	How many did it take?
• Ruler	•
• Pencils	•
• Paper	•

• Dollars	•
• Paper clips	•

Content outline:

- We use <u>units</u> of measurement to measure things.
  - There are many different units of measurement that we use to measure things.
- A ruler is equal to one foot. A foot is made up of twelve inches.

Larger STEM challenge:

- This challenge can be extended so that the students will move on to build their own large measuring device that can measure lengths using multiple units of measurement. The device should be able to measure things both large and small, using units other than just feet and inches.

Picture This Quick Challenge

Standard:

CSS.Math.Content.2.G.A.1 Recognize and draw shapes having specified attributes, such as a given number of angles or a given number of equal faces. Identify triangles, quadrilaterals, pentagons, hexagons, and cubes.

Quick Challenge:

To introduce the concept of shape identification, angles, and vertices, students will create a creature using a combination of cut out triangles, quadrilaterals, pentagons, and hexagons. Students will have 5 minutes to create their picture; when time is up, they will draw their figure on a sheet of notebook paper exactly as they see it on their desk. Students will make a note of how many of each shape they used on the paper as well.

Methodology:

Teachers will provide each student with a bag filled with the shapes listed above and instructions with content information on classifying shapes. Students will use their own sheet of notebook paper and a pencil to draw their final picture. As students are creating and copying their creatures, the teacher will walk around to check that students are classifying each shape correctly on their paper when they are listing how many of each shape they used to make their creature. Teachers are encouraged to stop and talk to students while walking around to discuss that the reason we classify triangles as such is because they have 3 angles (ex. "I love your creature Timmy! I see that you used 5 triangles. How do you know they are triangles?" "Because there are three points!" "That's right! Another way to say that is 'There are 3 angles!" because those points represent an angle!")

Student Feedback:

Teachers can provide feedback by checking each student's paper to see if their classification/quantity of each shape is correct. For example, if Jimmy has classified a rhombus-looking shape as a pentagon, you would explain to him that even though it is shaped differently than a square or rectangle, it is still a quadrilateral because there are 4 angles.

Content:

Content students would need to know before this quick challenge include basic knowledge/exposure to shapes and their classifications, the definition of a vertices, and the ability to count. Content that will be included in the student instructions should be an articulate review of information they know (a triangle has three sides, a quadrilateral has four sides, etc.) and new information on how to classify shapes by their angles.

Larger STEM Challenge:

Since this activity is introducing students to classifying shapes by their angles, a larger STEM lesson and challenge that could build off of this is to have students collaborate to design a creature with larger block shapes. Students would try to build the creature with the largest combined angle measurements of the class. The lesson to preface this larger STEM challenge would involve teaching students that each shape has a specific total degree of angles (ex. Triangles have 180 degrees, and quadrilaterals have 360 degrees, and students should use this information to consider using more squares than triangles to build their creature so the angle sum of their creature is larger). The STEM design loop can be used more precisely during this larger challenge, because students can collaborate, use research/prior learned knowledge of angles, design, and re-design their creatures with a longer amount of time.

Quick Challenge

Standard: *ESS.10.3.2*
Demonstrate the orbit of Earth and its moon around the sun

Content Information: The Sun is the largest star in our Solar System! It is almost 100x BIGGER than our Earth! The Earth rotates around the sun in a circular path. This is known as Earth's "orbit". It takes about 1 year for the Earth to orbit the sun completely.
The Moon moves in an orbit around the Earth, too! The Earth is about 4 times bigger than our moon!

Challenge: Using the given materials, build a model that will assist in explaining how the Earth and Moon move around our sun. Once you have built your model, raise your hand and explain to the Teacher the orbit of the sun, and its moon.

Materials:
1 Large Styrofoam Ball (sun)
2 Small Styrofoam Balls (Earth and Moon)
1 Toothpick
1 Paperclip
1 Plastic Cup

Student Feedback: Teacher will receive verbal feedback from the students. Additionally, the teacher will see how well students can follow explicit instruction.

Methodology: Students will use the materials provided above. The teacher should explain that this model is not to scale, however, students should still be able demonstrate the orbits.

Larger STEM Challenge: As a classroom, we will build a model closer to scale and that is mobile in showing Earth and Moon's orbit.

Quick Challenge: Pendulum Game

Grade Level: Kindergarten

Standard:

PS.6.K.3: Demonstrate the effects of the force of gravity on objects

Quick Challenge:

Using the materials provided, build a simple pendulum design like the one in the picture provided. Then, see if you can get the washer on the end of the pendulum to be caught by the magnet. You cannot touch the washer. Hint: experiment with how far the pendulum will swing if you pull it back at various lengths.

Methodology:

Students will be given a set of materials that include:

- 1 ruler
- 12 inches of masking tape
- 16 inches of string
- 1 washer

Students will be given 15 minutes to follow the instructions below and to play the magnet game.

Step one: Tie one end of the string to the hole in the ruler and the other end to the washer (leave some extra string to be able to pull the pendulum back).

Step two: Tape the ruler to the table.

Step three: Tape the magnet underneath the table, where the washer will be able to catch the magnet.




The teacher will visit pairs of students after they have had 15 minutes to complete the challenge. The teacher can give the student feedback on their design involving how they could get the pendulum to swing up to the magnet if they have not already completed the challenge.

Content Outline:

- Gravity is a force that attracts mass to the center of the earth.
- A pendulum is a weight hung from a fixed point so that it swings back and forth.

Larger STEM Challenge:

This activity could be used as part of a unit on gravity by experimenting with larger pendulum designs with Tinker Toys.

In Class Quick Challenge: Up, Up, and Away

Grade level: 1

Quick challenge to focus on transportation technologies (specifically airplanes)

Benchmarks:
In order to select, use, and understand transportation technologies, students should learn that:

a) A transportation system has many parts that work together to help people travel.
b) Vehicles move people or goods from one place to another in water, air or space, and on land.

Challenge: Make a paper airplane that can glide the furthest using provided materials. Students will be provided with some different ways to fold a paper airplane for reference, because they may not have previous experience.

Parameters:

- Students must build a plane that glides, not one that can just be thrown ten feet.
- Students must only use materials given by the teacher.

Content information:

- Air resistance: the frictional force air exerts against a moving object. As an object moves, air resistance slows it down. The faster the object's motion, the greater the air resistance exerted against it.
- Gravity/weight: The weight of the paper plane also affects its flight, as gravity pulls it down toward Earth.

Materials:

- Construction paper
- Straws
- Popsicle sticks
- Tape
- Paper clips

Instructions:

1. Students will get into pairs.
2. Students will be given options of materials (construction paper, straws, Popsicle sticks, paper clips, and tape) to use to build the paper airplane that will go the furthest.
3. Students will then have a few minutes with partner to discuss their strategy.
4. Students will build airplanes and we will test them in the hallway.
5. The airplanes should be able to glide at least ten feet.

Assessment: Students will be assessed by how far their airplane glides (at least ten Feet).

Quick challenge used as a hook:
After completing this activity students will be introduced to a new unit about the Wright Brothers and airplanes. At this point we will add the factor of weight to the planes by adding little weights gradually and observing the impact. Students will observe that the weight affects its flight, as gravity pulls it down toward earth.

Charging to the Finish Line

Grade Level: 1st grade

Standards:

Science

PS.7.1.5 Demonstrate methods of producing static electricity (e.g., balloons, shuffling across carpet)

Content Information:

Static electricity is a stationary electric charge, typically produced by friction that causes sparks or crackling or the attraction of dust or hair. Static electricity can be seen by scooting your feet across the carpet and then touching a metal object. It can also be seen by rubbing a balloon on your hair.

Challenge: Oral Instructions:

Using the materials supplied, work with your table (groups of 4) to pick the best medium to rub your balloon on to charge it. Try to get the soda can to make it across the finish line. Think about the properties of static electricity that we just learned. Brainstorm with your table and decide which medium you think will create the strongest static electricity. You should be able to describe your reasoning to the class. Once you have figured out what to use to charge the balloon to make the aluminum can roll, we will have a series of races to see who can get their aluminum can to the finish line the fastest.

Time:

10-15 minutes allowed unless expanded

Essential Question:

Using the ideas of static electricity, how can you charge the balloon to make the aluminum can roll to the finish line the quickest?

Materials:

- Aluminum Can
- Balloon
- Tape for the beginning and finishing line (teacher use)
- Things around the room you can use to charge the balloon: hair, carpet, pants, etc.

Expansion Activity:

Students will make a chart of how long it took each can to make it across the finish line. This will allow them to visualize that some mediums (carpet, hair, pants etc.) create more static electricity than others. This will also allow for a graphing lesson connecting to the following math standard.

AR.Math.Content.1.MD.C.6

• Organize, represent, and interpret data with up to three categories, using tally tables, picture graphs and bar graphs

• Ask and answer questions about the total number represented, how many in each category, and how many more or less are in one category than in another.

Find the Magnetic Object

Standard:
1st grade, PS.7.1.6 Classify materials as magnetic or nonmagnetic

Quick Challenge:
You will be given a mystery bag of items and it is your job to decide which object is magnetic without touching it to the magnet, you will determine what height is best for observing this. We are going to put objects under the magnet and look at the reaction the objects have with a partner.

Methodology:
As a class we would discuss different types of magnetic materials and how we go about finding out which is which. As well as the different ways magnets can be used, maybe to classify materials or if the material is unknown, give us more information about that material. Then further expanding the knowledge of magnets and their poles, leading into attraction and repulsion.

Materials:
- magnet attached to a piece of string
- small piece of tape
- index card
- washer
- piece of wood
- ping pong ball
- pencil

Testing procedure:
Students will hang the magnet off of a table or some other surface so that it is "free hanging". Students will use the shorter end of the index card to know where to hang their magnet from. Students will fold paper in half "hot dog" style once and check and then in half again the same way and then determine at which height they will observe how the materials react Students will then take the objects in their "mystery" bag of items, put them under the magnet and observe the reactions of the objects with the magnet. Once students think they have determined which object is magnetic with their partner they will write it on the index card with any justification they have for their findings.

Concepts to Reinforce:
An understanding of how magnets react to other magnetic objects and how they react to nonmagnetic objects.

Student Feedback:
There will only be one magnetic object in the bag for them to find in the quick challenge and students will answer the questions on the chart that will be printed out and provided to them. After the quick challenge has been complete we will come together for a class discussion on why the washer was the magnetic object and what that looks like.

Content Outline:

What makes a material magnetic?	What is a magnet?
Which object is magnetic?	**Why do you think that?**

Larger STEM challenge:
Would further go into magnetic objects and then lead into attraction and repulsion and the poles of a magnet and then discuss ferrous and nonferrous metals. Could move into building something that could be propelled by a magnet or more simplistically, building a car or other object that could be pulled forward by a magnet or propelled by a magnet.

Quick Challenge: Can You Catch It?

Science Standard: PS.6.4.2 Investigate the relationship between force and mass.

Challenge: Using the materials supplied, build something that can catch and hold three different objects without breaking. The objects will be: (1) colorful die(dice), (2) battery, and (3) nickel. The objects will be dropped one at a time from a distance of one foot above the catching device that you create. You will need to be able to hold your device while each object is dropped by the teacher. Your device can be no longer than 8 inches; and it can't be taller than 3 inches. You will have 15 minutes to build your device.

Supplies:

- 2 sheets of paper
- Tape
- 2 small rubber bands
- 1 big rubber band
- 2 feet of string
- 5 paper clips

Tools:

- Ruler
- Nickel
- Battery
- Die
- Scissors

Methodology/Content: The teacher can use this quick challenge to introduce the force of gravity. The teacher could also introduce mass by having the students consider whether each object falls differently because of its mass. As mentioned in the larger stem challenge, the teacher could discuss the idea of mass not affecting the speed of a falling object when gravity is the only force acting on it.

Student Feedback: The teacher can give each student feedback after their device is tested. The teacher can use a checklist as a tool for evaluation as the students are building their devices and while they test their devices. The teacher can also address the whole class and ask the class questions about how they built their catching devices. Example question: Was one object harder for your device to successfully catch?

Larger STEM Challenge: The teacher could extend this challenge by having the students weigh each object used in the challenge plus more objects. Then have the students test the objects to see if they fall and hit the ground at the same time. This could be used to teach that mass does not affect the speed of falling objects, assuming there is only gravity acting on it. The teacher could then have the students build a larger scale of what they built for the quick challenge.

Natural Resources: Wind Energy

Standard:

Strand 4: Earth and Space Science

Standard 8: Earth Systems: Structure and Properties

- Students shall demonstrate and apply knowledge of Earth's structure and properties using appropriate safety procedures, equipment, and technology

2nd grade: ESS.8.2.4

Identify products derived from *natural resources*

Challenge:

You will use the natural resource of wind to power your own windmill. Find a way to create a moving windmill out of the materials provided:

**You will not need everything provided, these are just options. Remember the goal is for the windmill to move when the fan blows on it.

- 6 index cards
- 2 straws
- 1 dowel rod
- 2 dowel rod stoppers
- Scissors
- Masking tape
- Paper plate
- Hole puncher

You will now test your windmill to see if you can make it spin as a windmill does outside. If you find that it doesn't spin, go back and make adjustments to your model.

Feedback:

While they are testing their windmills, I will be giving them verbal feedback on their design. They will explain to me their though process on how they used their materials, test it and then explain how it worked or why it didn't. We would discuss modifications they could do to their windmills to make it spin and then the student would go back a make their improvements.

Content Outline:

We will discuss what natural resources are and how we can take advantage of resources that are not exhaustible, such as wind energy. We will discuss how we use to use natural resources every day (depending on weather in this case) and where you might put windmills that would be more efficient. Why is it important to conserve natural resources? And also take advantage of those resources that we will always have?

Larger STEM Challenge:

The students will create their own way of taking advantage of natural resources by creating a device that we can use in our cities powered by natural resources. The goal will be to make sure you are efficient and not using up exhaustible resources.

Ant Potato Sack Race Path Quick Challenge

Standard

CCSS.MATH.CONTENT.2.MD.A.1

Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.

Challenge

You will complete this challenge in pairs or teams of three! The ants are having their annual Olympics in two weeks. One of the most popular events is the potato sack race. Each year, the ants try to create bigger and better potato sack race paths. This year they want to have "the world's longest potato sack race path." The ants place your team in charge of creating this path! In order to complete this challenge, you must use the provided materials make a path which is at least one inch wide so that the largest number of ant partners can race together. The catch: you cannot make the track go off of your table! When you are finished, you will need to measure your track to see how long is. You can use either a tape measure or a ruler. You will have twenty minutes to complete this challenge! Ready, set, Go!

Methodology

Materials: fifteen index cards for each pair of students

Tools: Scissors (if needed), ruler and tape measure (one of each for each 4-6 students. "Test" the paths by comparing lengths to discover which pair of students made the longest!

Remind to students to think outside the box, it doesn't have to be a straight path. They can add in curves and turns too, but the "lanes" need to line up appropriately! This could take a little extra thinking for the students

Student Feedback

As the teacher walks around the room, he or she can give feedback to pairs of students. After the challenge is complete, the teacher could also discuss with the whole class what different groups did that worked and didn't work, offering feedback as to why the path design did or did not reach the level of "The World's Longest Ant Potato Sack Race Path."

Content Outline

Students will practice using different tools for measuring the length of the race track. They will look at the differences between using a ruler versus using a tape measure to determine length.

After this quick challenge, the teacher would begin a discussion on what is the most appropriate to tool to measure objects of different lengths. Why would you use a ruler to measure the width of your palm and not a yardstick? What would you use to measure a wall in the classroom? Why?

Larger STEM Challenge

Students will work in larger teams of four to create the longest ant potato sack race which goes around (or over) obstacles such as trees, buildings, and roads. The teacher will provide students with a map (either fictional or a map of a portion of a real city) showing the area the race path must go through. Students will use index cards, tape and items to give the track elevation if needed such as Popsicle sticks and small paper cups. The track will be built on top of the map, going around and over the obstacles presented. Students will then measure their tracks using. In the end, the team with the longest path wins the larger challenge.

Symmetry Study
Grade: 4th
Learning Standard: *CCSS.MATH.CONTENT.4.G.A.3*
Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry.

Materials:
- Two-dimensional pictures with and without lines of symmetry
- Ruler
- Pen or pencil
- Blank paper

Quick Challenge:
1. Determine if the pictures provided have lines of symmetry.
2. Use the ruler and pencil to draw lines of symmetry on the pictures provided.
3. Sort the pictures into stacks with and without lines of symmetry.
4. Using the blank paper, draw one object with a line of symmetry and one object without a line of symmetry.

Student Feedback:
Students could collaborate with a classmate and decide if they agree on their answers.

Content Outline:
- Lines of symmetry
- Two dimensional object

Methodology:
- Before giving students the challenge, briefly explain lines of symmetry.
- Give just enough information for them to complete the challenge.
- Leave room for self-discovery.

Larger STEM Challenge
To extend this challenge:
- Students could identify objects around the school and determine if they have lines of symmetry. (Examples: playground equipment, desk, door, white board, etc.)
- Students could build a structure out of Keva planks with no lines of symmetry, one line of symmetry, two lines of symmetry, etc.

Quick Challenge

Standard	*AR.Math.Content.1.G.A.2* Compose two-dimensional shapes (e.g., rectangles, squares, trapezoids, triangles, half-circles, and quarter circles) or three-dimensional shapes (e.g., cubes, right rectangular prisms, right circular cones, and right circular cylinders) to create a composite shape.
Content	Students are focusing on 3D shapes
Materials	Play Dough (1/4 container per student) Buttons (any shape or size, enough for each student to have 20-30) Paper torn into 2 inch strips
Quick Challenge	You have been trapped on an island and you are all alone. The night is closing in and you begin to hear some pretty scary noises in the thick jungle behind the beach. Luckily, the plane you crashed in on has an odd number of buttons and play dough! Create a 3D frame that will be covered in leaves (shredded paper) and shrubs for protection on your first night here on the island.
Methodology	Students will create a frame using buttons and play dough that will "protect" them for the night. They only have 10 minutes to complete this task individually. Students will each get 20-30 buttons and ¼ container of play dough. Students should each create any 3D shape they feel will protect them, once covered in leaves (paper). Their constructed frame has no specified measurements. (DESIGN LOOP: developing and creating a design)
Student Feedback	Once students have completed their structure and covered it in torn paper, have students gather in groups of 3 or 4 and discuss what shape their frame is made. They will explain why they think it will protect them the best. Teacher will walk around the classroom and listen and provide feedback to students. Using the feedback of their peers, they should use the remaining time in the allotted 20 minutes to readjust their design/frame. (DESIGN LOOP: communicating and redesigning)
Guiding Question	When walking around during feedback time, ask students these questions to probe ideas: • What shape did you make your frame? • Why did you make your frame this shape?

Next Step Afterwards, students will work in groups of two or three to create a more in depth shelter for their island dwelling. They will use popsicle sticks and glue to create a shelter that has at least three different types of 3D shapes.

Scientific Inquiry

Scientific Inquiry

Title: Cubs Win the World Series, How Eggciting!

Grade level: 4th grade

STEM standards:

<u>Science:</u>

- PS.6.4.1
  Investigate the relationship between force and direction
- PS.6.4.2
  Investigate the relationship between *force* and *mass*

<u>Math:</u>

- Understand division as an unknown-factor problem

<u>Technology</u>**:**

- Standard 11: Students will develop the abilities to apply the design process
- Brainstorm people's needs and wants and pick some problems that can be solved through the design process
- Build or construct an object using the design process

Essential Question: How can you protect an egg from busting while being hit with different objects?

Scenario: The Cubs just won the World Series and it's time for a little bit of celebration. The head coach has come up with a little fun challenge. The players are to be tossed an egg and using three different objects the players are going to hit the egg without breaking it. Can you help them come up with a way to protect the egg without breaking it? You do not know the size, or mass of the object that is being used to hit the egg.

Challenge: Design an object that will protect the egg and can be adapted to withstand busting. The object must be capable of adapting for varying circumstances such as large, small, light, or heavy weight.

Materials
- Scissors
- Tape
- Bubble wrap – 2ft
- Paper – 10 pieces
- 1 shoe box

- 1 pack of tissue paper
- 1 bottle of water
- 10 packing peanuts
- 12 inches duct tape

Content Information:

During this STEM lesson students will need to have background knowledge related to motion and forces so that they will be able to accurately create a workable solution.

Motion- The process of continual change in the physical position of the object,
Distance- The extent of space between two objects or places.
Force- Strength or energy as an attribute of physical actions or movement.
Velocity- The rate of speed of action. Distance/time

Teacher Preparation:

After discussing content above, practicing division problems that involve time and distance, place the students into teams of two. The students will have to use engineering design and scientific inquiry to design a device that can adapt to given situations. During testing, each team will be presented with three different objects, a noodle, tennis racquet, and whiffle ball bat. During testing each team will have five minutes to arrange their object to withstand the force of the bat.

Parameters:

During testing, the egg must be hit with one of the objects drawn from a hat without breaking.
Teams must complete the worksheet of their trials with the solutions to their velocity equation.

Worksheet

Plan: Draw Sketches

1. What materials did you use?

2. What modifications were made in between trials?

3. What do you feel is creative for your design?

Trials:

Trial 1 Yes/No

Velocity

Trial 2 Yes/No

Velocity

Trial 3 Yes/No

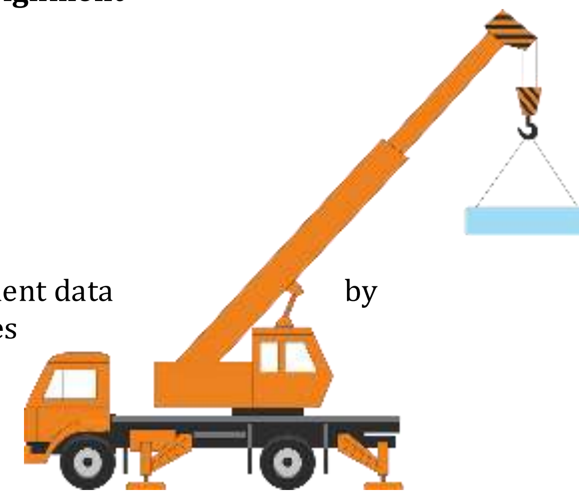
Velocity

Trial 4 Yes/No

Velocity

Weathering the Storm

Scientific Inquiry: Curriculum Brief Assignment



Grade Level: 4th Grade

STEM Standards:

Math:

Common Core Mathematics Standards

- Represent and interpret data: generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch
- Express the length of an object as a whole number of length units

Science:

PS.9.4.1

- Analyze changes to Earth's surface: *erosion*, glaciations, weathering, earthquakes, volcanic activity

ESS.8.4.1

- Locate natural divisions of Arkansas: Ozark Plateau, Ouachita Mountains, Crowley's Ridge, Mississippi Alluvial Plain (Delta), Coastal Plain, Arkansas River Valley

Engineering:

Standard 9: Students will develop an understanding of engineering design.

- C. The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.
- D. When designing an object, it is important to be creative and consider all ideas.

Essential Question:

How can you build a crane that can be adapted to easily pick up and transfer storm debris into a debris removal bin and out of civilian's way?

Scenario:

A terrible storm hit the edges of the Ozark Mountains, causing many broken tree limbs, rocks, and debris to gather at the bottom of the mountain. The aftereffects of the storm have become inconvenient for people living in the area. The large particles of the storm debris need to be gathered and removed from the area, but how? The boulders and trees are too large to lift and move with manpower. Build a construction crane to move the different sized debris from the bottom of the mountain, into a debris removal bin, to be removed from the bottom of the mountain and out of civilian's way.

Challenge:
Design and create a construction crane that can be adapted to grab and pick up objects and place them into a debris removal bin. Your crane must be adaptable to account for different sized objects, different weights of objects, and different lengths of objects away from the designated debris disposal bin.

Teacher Guidelines:
In order for students to be prepared for this assignment, they first need to be familiar with the concepts covered by the standards provided. Students should learn about the different changes to the earth's surface. This includes erosion, weathering, glaziers, volcanic activity, earthquakes, etc. Through this knowledge students will understand how and why natural debris is created, the hazards it can create, and when it is appropriate to remove. This assignment is specific to the Ozark Mountains located in Arkansas. This would be a great opportunity to bring some geography into the lesson and discuss characteristics of mountains specific to Arkansas. Students should review measurement in preparation for measuring and cutting their own materials. Measurement will also be a key skill in this STEM project in order to create their crane. Make sure the students are familiar and comfortable measuring at halves and fourths of an inch.

Students will be placed into small groups (2 to 3 students) to design a crane. Students will use the design loop and scientific inquiry to develop their crane to solve the given problem. When it is time for the final test, the instructor will create a scene that is the same for every group. This scene should include a designated spot student's crane. Upon starting their final test, the students will draw from 2 piles. One pile will contain the the object they will pick up and the other pile will contain the length away from their crane. Student will have a few moments to adjust their crane to fit the variable they have drawn and then conduct their final experiment for evaluation.

Tools, Materials, and Resources:
The more variety of materials offered to the children the better. All the students must be creative in their design with little restrictions on materials used.
<u>**Per Team:</u>

- 3 objects of different sizes, weights, and shapes to be storm debris (Teacher may decide what these objects are… can vary depending on classroom)
- 12"x12" piece of cardboard
- 2 plastic cups
- Cardstock paper
- 3 feet of String
- Popsicle sticks
- 12 pipe cleaners
- 12" flexible wire
- Misc. materials: paperclips, rubber bands, close pins, paper, paper plate, clothespins, other recycled/repurposed materials
- Misc. tools: duct tape, scissors, hot glue, wire cutters

<u>**Scenario Model provided by instructor</u>

- 3 objects of different sizes, weights, and shapes to be storm debris (Teacher may decide what these objects are… can vary depending on classroom)
- Clamp to hold students crane in place

Parameters:
The Crane must remain stationary and placed on the X that the teacher provides. The crane must be at least 10 inches tall. Students must control their crane with some type of lever or crank system.

Evaluation:
Students will be evaluated on:
- The functionality of their crane
- Creativity
- Team work
- Following the Parameters
- Completing the Challenge
- Completion of Engineering Design Journal

Bonus points can be rewarded for a crane that is able to pick up every object at any distance.

Not-So-Simple Machines

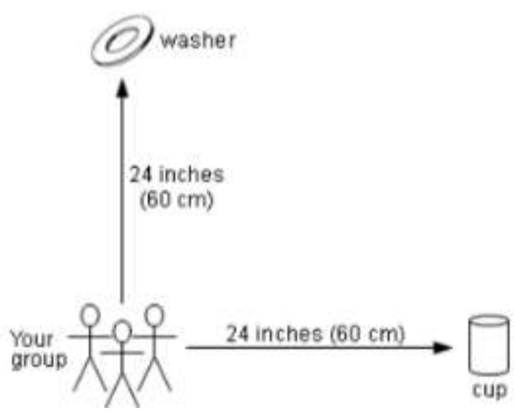
Grade Level: 5^{th}

STEM Standards: PS.6.5.1Classify *simple machines* PS.6.5.3 Relate *simple machines* to inventions and discoveries Standard 8: Students will develop an understanding of the attributes of design*. Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.*

Essential Questions: What is a simple machine? What mechanical advantages can become of simple machines?

Scenario: Sanitary workers are trying to clean up a junk yard. The workers need to design a simple machine that will move light, medium, and heavy weighted objects to the junk bin.

Challenge: Using at least one simple machine, design and construct a device that can move 1, 2, and 3 washers that is placed 24 inches (60 cm) away from your group, 90 degrees, to a cup that is also placed 24 inches (60 cm) away. See diagram below:



Design Requirements:

- Each group must use at least one simple machine in the device they build.
- The washers must be moved from its location to the fixed location of the cup without direct contact from any student.

Materials:

Brads	Plastic bags
Clay or play-dough	Plastic spoons
Clothespins	Plastic/paper cups
Craft glue	Pulleys
Craft sticks	Rope
Dowels	Rubber bands
Drinking straws	Scissors
Foam pieces	Spools
Gears	Springs
Hot glue	String
Magnets	Tape
Paper clips	Wire
Pipe cleaners	

Teacher Evaluation Questions:

- What simple machines did you use?
- Was your device made up of more than one machine?
- How did using a simple machine give you a mechanical advantage?
- How did the use of simple machines make the work easier to complete?
- Were you able to move 1, 2, and 3 washers?

Title: Baby Proof Latch
Grade Level: 3rd grade
STEM Standards:
Science-
3-PS2-4 Define a simple design problem that can be solved by applying scientific ideas about magnets.

Technology-
Standard 8: Students will develop an understanding of the attributes of design.
In order to comprehend the attributes of design, students should learn that:
3-5 Benchmarks
D. The design process is a purposeful method of planning practical solution to problems.
E. Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.

Standard 9: Students will develop an understanding of engineering design.
In order to comprehend engineering design, students should learn that:
3-5 Benchmarks
A. The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.
B. When designing an object, it is important to be creative and consider all ideas.
C. Models are used to communicate and test design ideas and processes.

Essential Question:
How do magnets interact with each other and with other objects?
How can magnets be used to help create useful devices?

Scenario:
My little cousin is one-year-old. He is at the age where he is trying to crawl around and get into everything. He is trying to open kitchen cabinets and drawers. I need you to create a device that uses magnets to prevent my cousin from getting into the kitchen drawers and cabinets. The device should be easy for me to maneuver but prevents my cousin from getting into the cabinets.

Challenge:
Students will work in groups of three. Students will be given a variety of different items to see how those items interact with certain magnets. The students will record their findings in a table. Students will also be able to research different types of magnets and discover why certain magnets are stronger than others. Then, based on their research and observations, the students will a build a device that can be used to keep babies and toddlers out of kitchen cabinets and drawers.

Tools:
Scissors
Wire cutters
Hot glue gun

Materials (per group):
- Various sizes and types of magnets
- Tape (any type)
- 6 inch by 6 inch square piece of cardboard
- Paper
- Construction paper
- 3 paper clips
- 1 foot of wire
- 1 foot of string
- 3 rubber bands
- 1 paper plate
- 3 tongue depressors

Resources:
- computer
- books and article about magnets (provided by the teacher)

Teacher Guidelines:
Students will be able to discover the different types of magnets and the different materials that are attracted to magnets. Students will have a better understanding of why magnets work the way they do. The teacher might need to facilitate some of the discovery about why magnets are only attracted to certain items. But the students need to make their own predictions and discoveries. The teacher will instruct the students that their device must fit on a cabinet door and a drawer (in the classroom or in a different room the in school).

Parameters:
- Device must weigh no more than 35 grams
- Device must fit on the drawer and cabinet in the classroom used to test the devices.

Title: Commotion in the Ocean

Grade Level: 4^{th} Grade

STEM Standards:

Science Standard:
ESS.8.4.4 Evaluate the impact of water pollution.

Math Standards:
AR.Math.Content.4.MD.A.1 Within a single system of measurement, express measurements in the form of a larger unit in terms of a smaller unit. Record measurement equivalents.
AR.Math.Content.4.MD.A.2
Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money including the ability to make change; including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit

Technology:
Standard 5: Students will develop an understanding of the effects of technology on the environment. Benchmark: Waste must be appropriately recycled or disposed of to prevent unnecessary harm to the environment.

Essential Questions:
How is ocean pollution negatively impacting our environment and what difficulties arise when trying to remove the pollutants?
How much water (written as a fraction) was conserved using my device?

Scenario:
ATTENTION STUDENTS!!!
Here at the Ocean Conservancy Agency we are fighting hard to save our oceans from pollutants, but we need your help!! Unfortunately, our oceans are being threatened by pollution from people on land and natural causes. Marine life is dying and the entire oceanic ecosystem is being threatened by the various sources of pollution. Some of the common pollutants include plastic, oil spills and toxic chemicals. We need to take action before our oceans are completely inhabitable.

Challenge:
Conduct research on the negative impact of pollution on the ocean ecosystem. Then, create some sort of filtration system that will remove the pollutants from the ocean while conserving as much of the water as possible. Your device must separate the pollutants (oil, sand, dirt and plastic beads) out and then be disposed of properly in the “pollution pan” resulting in clean unpolluted water. The filter must be able to stand-alone over the 4.5 inches X 2.5 inches baking pan where the clean water should be collected. Then measure the amount of unpolluted water to see how much was conserved in the filtration process.

Answer the following question:
I began the experiment with _____ ounces of water total. After filtering the water I had _____ ounces left. Written as a fraction I conserved ______ ounces of water. That is equal to ______ tablespoons of water. (1 ounce= 2 tablespoons)

Materials and Resources:

Available for students:
iPads or computers for researching ocean pollution
Scissors
Tape
Printing Paper
Cups
Paper Towels
Tissue Paper
Coffee Filters
Small Rocks
Tulle/Netting
Gauze

For testing:
16 ounces of water:
4 ounces mixed with sand
4 ounces mixed with dirt
4 ounces mixed with oil
4 ounces mixed with plastic beads
A 4.5 in X 2.5 inches baking pan
"Pollution Pan" to collect pollution filtered from water

Teacher Guidelines:

- Introduce the idea of ocean pollution
- Allow students to research how ocean pollution is impacting the ecosystem
- Introduce the different variables they will have to test (each of the four water and pollution mixtures)
- Students will brainstorm and then draw a sketch of their filter system before they create it
- Students will realize that some materials absorb a lot of water as it is filtering the pollutants instead of conserving water
- Students will learn that some materials are harder to separate from the water

Title: Swimming in Your Own Backyard

Grade Level: 3

STEM Standards:

Science: 3-ESS3-1 Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard. * [Clarification Statement: Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind resistant roofs, and lightning rods.]

Math: AR.Math.Content.3.MD.B.3

Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories (e.g., Draw a bar graph in which each square in the bar graph might represent 5 pets)

Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled picture graphs and scaled bar graphs

Engineering:
3-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

English Language Arts:
W.3.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly

Essential Question:

How do you create a levee/barrier that can withstand different heights/levels of water and different forces of waves?

Scenario:

Recently, the state of Louisiana has had some of the worst flooding the country has seen since hurricane Sandy. More than 31 inches of rain fell in less than 15 hours causing flooding in the streets and the flooding of rivers. Louisiana is also susceptible to hurricanes on its southern border.

Challenge:

To help the state be prepared if anything like this should happen again, do research on the disaster in Louisiana and effective levee systems, and design levees that can withstand varying levels of water, and extreme force of waves for the southern part of the state.

Tools, Materials, Resources:

Gravel
Dirt
Clay
Sand
Straws
A plastic/Tupperware container to build the levee in

Teacher Guidelines:

1) Show the students a video of the flooding in Louisiana to peak their interest
2) Describe briefly what happened to cause the flooding
3) Present the challenge
4) Present them with resources to do further research on the disaster and research on how to build a levee (Science in the News for Students is a great website with age appropriate reading levels); by having them research the disaster itself they are relating their design back to specific needs of people they have seen and heard of
5) Have them complete a design worksheet or journal with different ideas and how each would solve or could be adapted to solve different forces and heights of water (these are the variables); here they will be designing multiple possible solutions to the problem
6) Let them start building! Encourage continued use of the design journal as they run tests and adjust their designs; each adjustment and test should be documented
7) Conduct tests. Different heights can be tested by adding water to their tubs, and different forces can be tested by using spray bottles, water guns, and a hose.
8) Have the groups present their work. Before the presentation they should write an informational paragraph about why their design was successful; specifically, in what ways it was successful. What portions of their design worked best? Why? Is it research based? This portion of the assignment incorporates the ELA standards and part of the science standard (make a claim about the merit of a design solution).

*When giving out materials make sure that the students don't have so much that they can make their design out of just one material (clay). There should also be time constraints. When they start building they end up balancing out height and width for the levee to stand, but they also shouldn't have so many materials that the levee can be more than an inch or two out of the tub.

Title: Save Grandma's Garden!
Grade Level: 3rd

STEM Content Standards:
Arkansas K-4 Science Standards
3-ESS3-1 Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.

Arkansas Math Standards
AR. Math.Content.3.MD.A.2
• Measure and estimate liquid volumes and masses of objects using standard units such as: grams(g), kilograms(kg), liters(l), gallons(gal), quarts(qt.), pints(pt.), and cups(c)

Big Ideas:
- Impact of weather on environment
- Drought
- Water conservation

Essential Question: How can you create a portable structure that will protect Grandma's garden from being flooded by rain water and scorched by the sun AND help to gather the rain water for later use?

Scenario: In Arkansas, the weather can catch you by surprise. Unfortunately, Grandma's garden is not doing well this year because the weather has been switching rapidly between periods of heavy flooding rain and harsh drought, either drowning her plants or drying them out! Grandma really needs a special water gathering device that she can quickly place over her garden to protect it from both the heavy rain and intense sunlight.

Challenge: Using the materials provided, work with a partner to design and create a device that will:
- Protect Grandma's garden from heavy rains and intense sunlight
- Gather rain water to water Grandma's garden during the next drought

Tools and Materials

Tools	Materials (Per Pair)
• scissors • electronic scale • colander • measuring cup (1 cup) • green construction paper, cut into multiple pieces 4"X6" • thermometer • heat lamp	• 1 kitchen sponge • 5 straws • 4 Dixie cups • 6 in. aluminum foil • 6 in. cellophane • ½ plastic egg carton • 6 in. duct tape • 12 in. yarn

Content information:

- Portable- able to be easily carried or moved, especially because of being a lighter and smaller version than usual
- Absorbent- able to soak up liquid easily
- Drought- a prolonged period of abnormally low rainfall; a shortage of water resulting from this
- Flood- an overflowing of a large amount of water beyond its normal confines, especially over what is normally dry land
- Water conservation refers to any beneficial reduction of water usage, loss, or waste. It also includes the strategies and activities to manage and protect water resources to meet the demand for human consumption.

Deliverables:

- Working device that fits all parameters

Parameters or constraints:

- Students will work in pairs
- Students will only use materials provided
- Teams will be given 90 minutes to complete and test their design
- Device will weigh no more than 40g when dry
- Device will protect a garden represented by 4"X6" piece of construction paper
- Device will collect and hold at least one cup of water
-

Variables to consider:

Each device will be tested in one of two ways (pairs will be assigned a test randomly after completing their device):

- Device protects garden from rain while holding at least 1 cup of water
- Device protects garden from the heat of the sun (direct exposure to heat lamp)

Students are encouraged to create a device that can pass both tests.

Evaluation:

Students will be evaluated through:

- Function of devise
- Willingness to work with group member and equal division of duties

Transportation Tirade

Grade Level: 3rd grade

STEM Standards:
Next Generation Science Standards
3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

3-ESS2-2 Obtain and combine information to describe climates in different regions of the world.

Standards for Technological Literacy
Standard 2: Students will develop an understanding of the core concepts of technology.
K. Tools and machines extend human capabilities, such as holding, lifting, carrying, fastening, separating, and computing.

Standard 10; Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
E. The process of experimentation, which is common in science, can also be used to solve technological problems.

Essential Question:
How can you construct a lightweight machine that can lift and transport animals of many sizes and weights down the overhanging trolley cord?

Scenario:
The elephants within Zootopia have organized a protest because they cannot fit on the trolley system!! Zootopia needs your help creating a new trolley system that can support the weight of animals of all shapes and sizes.

Challenge:
Conduct research and then build a machine that connects to the trolley cord that can withstand the weight of a (toy) elephant, a (toy) giraffe, and a (toy) lion. Zootopia has asked your team to build this device, but within some parameters. In order to save money, the government has asked your team to use as little of the suggested materials as possible in order to create the lightest mechanism. The lightest yet sturdiest trolley will be chosen! Don't forget to brainstorm ideas to attach the trolley cart to the "cable" or string to allow it to slide down to reach the animal's destination.

Tools, Materials, and Resources:

- Paper
- Cardboard
- Wood
- Cups
- Pencils
- Tape (of any kind)
- Hole protectors
- Recycled Materials
- Scissors
- Ruler
- Hole punch
- String (to represent trolley cable)
- Weighted items or toy animals of varying weights

Teacher guidelines:
Teachers can use the standards after watching or reading a book about Zootopia by discussing the factors of this movie that are not likely to occur (although we are pretending that animals have evolved into very intelligent beings that do not attack and eat each other. May want to explicitly discuss this as well). For example, Zootopia is a wonderfully magical city with various climates situated near opposite climates, such as the snowy and cold climates located near the tropical and warm climates. Students can work in pairs to research information about different climates within the world and the animals that live within these habitats. Then, they can present to the class about why these animals survive well in the particular climate.

The teacher may want to explicitly clarify that within this lesson, only animals that live in the safari are asking to board the trolley.

The teacher should introduce the varying weights and allow students to feel the difference in order to brainstorm ideas to create a lightweight and sturdy mechanism. She/he will want to show how paper can be strong when pulled in the correct direction. One can represent this by asking a student to pull on the opposite 8" end of a sheet of printing paper. The teacher should explicitly reveal that the paper is stronger due to the direction of the fibers.

Students will be expected to fill out a worksheet to reveal their knowledge of the resources/materials they used to describe how their device was able to withstand the most amount of weight. Students need to defend the reason they chose certain materials.

Parameters: Students can only use the materials listed and other recycled materials. The lightest device that can lift all three weights wins. Students should try to use a minimal amount of resources to create a light device. The device should also be able to attach to the "cable" or string and slide down it.

The Speedy Turtle Sled

4th Grade

STEM Standards:

Science:

Arkansas K-4 Science Standards

- NS.1.4.2: Refine questions that guide scientific inquiry.

Technology:

Standards for Technological Literacy Content Standards and Benchmarks K-5

- Standard 10: Students will develop and understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
  E. The process of experimentation, which is common in science, can also be used to solve technological problems.

Engineering:

Standards for Technological Literacy Content Standards and Benchmarks K-5

- Standard 9: Students will develop an understanding of engineering design.
  A. The engineering process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.

Essential Question:

How can you design the fastest sled that will make sure Franklin makes it to the bottom without falling out?

Variables to Consider:

1. Size of the passenger

Scenario:

There has just been a big snowstorm! Franklin the Turtle wants to go sledding to finally see what it feels like to go fast, but all of the stores are out of sleds. Help Franklin build a sled to make his wish come true.

Challenge:

Develop a design for the sled. Use what you know about force, motion, gravity, and friction to build the sled. Make sure your sled is secure enough so that the passenger will not fall out. Measure how far your sled will travel on the slope. In order to get your sled to go all the way to the bottom of the slope, continue to revise and improve your sled to decrease the amount of time it takes to travel the entire slope.

Tools, Materials, and Resources:

- Plastic cardboard (used as the slope)
- Marbles (small, medium, large- to serve as passenger size)
- Stopwatch
- Cardboard squares (5 per group)
- 12 inches of duct tape (per group)
- Pennies (to provide weight)
- Pipe cleaners (6 per group)
- Scissors

Teacher Guidelines:

For this challenge, students are to use what they know about using the engineering design loop and connect it when undergoing experimentation to solve the technological problem. The engineering design loop should be used to brainstorm ideas of how to construct their sled and ways to improve it. To test their designs, students will be allowed to come up and let their sled slide down the slope (plastic cardboard) while timing it. Once receiving the time, they are to go back and make changes to make their sled faster and decrease their time. They will need to adjust and test their design three times, using each passenger (marble), before presenting the final product. The goal is to have the fastest sled go down the slope at the shortest amount of time.

Parameters:

- Students must only receive 5 pieces of cardboard squares, and are not allowed to receive extra materials other than the amount provided to each group.
- Students must construct a sled that can withstand the weight of the passenger they will randomly be given (small, medium, large)

Animal Cage

Grade: 3rd

Standards:

Next Generation Science Standards:

3-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

ETS1.A: Defining and Delimiting Engineering Problems: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-ETS1-1).

Arkansas Math Standards:

Measurement and Data: AR.Math.Content.3.MD.B.4

Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch.

Standards for Technological Literacy:

Standard 18: Students will develop an understanding of and be able to select and use transportation technologies.
3-5 Benchmarks
D. The use of transportation allows people and goods to be moved from place to place.
E. A transportation system may lose efficiency or fail if one part is missing or malfunctions or if a subsystem is not working.

Essential Question: How can you build a cage that can be adapted to accommodate the different sizes of animals you may find in Africa to transport them to a new location?

Scenario: A section of Africa is now being developed into a small town. This new construction will take away habitats for thousands of animals, including the main watering hole. This is detrimental to the animals, so they need to be moved to a new location where they can thrive and have the environmental resources they need to survive.

Challenge: Your team will design a scale model of a cage that can be adapted to accommodate different sizes of animals you would find in Africa. There will only be one animal per cage. The cage will need to be able to change in length and height, but the width will be 6 and half inches (the width our model trailer). Your goal is to select a section of Africa and see what types of animals live there. You will then create a cage to accommodate them, and tell where you will move them to. The trailer needs to be loaded to be efficient in getting as many animals loaded on it at once as possible. This is a scale model (1'=1").

Tools	Materials	Resources
• Scissors • Tape • Glue	• 6 Cardboard • 1 ½ Foot of String • 8 Fuzzy Sticks • 6 Rubber Bands • 1 Tissue Box • 4 Construction Paper • 4 Tongue Depressors	• Internet • Books on African Animals

Teacher Guidelines: The teacher will start the lesson by letting the students do research on what animals live in different parts of Africa, they can use computers and books for information. They will then select three animals their cage will accommodate and build the cage. They will practice their measuring skills by making the measurements of the cage contain half and forth inches. From this lesson the students will be expected to learn about what animals live in specific parts of Africa and thrive together. They will also work with measurements and be able to measure the cage using half's and fourths of an inch. They will build a cage that can become taller and longer, such as for a giraffe it would be taller, longer for a crocodile, and small for things such as a birds. They will create this cage to fit the most animals on to a truck to haul to a new location. The teacher will test the cages by selecting one of the animals from each group's work sheet, and seeing how the cage is adapted for that animal.

Parameters:

- The cages width must be six and a half inches
- Measurements must include one half and one fourth inch
- Can only use the given materials
- Only one animal per cage.

Animal Cage Worksheet

Directions: Fill out the information in the graph below. Your length and height measurements must be done in inches and include half inches, and one forth inches.

- You will only build one cage, but change it 3 ways.

	Cage 1	**Cage 2**	**Cage 3**
Animal			
Length of Cage			
Height of Cage			

I selected my animals from the ____________________ section of Africa, and they will be transported to the _______________ section of Africa.

Sections: North, South, East, West

Santa's Parachute

Grade Level: 3rd

STEM Standards:

Science: 3-PS2-1 Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

Math: AR.Math.Content.3.MD.B.4 • Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch

Technological Literacy: Standard 1: Students will develop an understanding of the characteristics and scope of technology. Tools, materials, and skills are used to make things and carry out tasks.

Essential Question: How can you build a parachute for Santa that can be adapted to carry him and his bag of presents safely to the ground?

Scenario: Santa's reindeers get very tired during his last few trips, and sometimes they stop flying and land quickly to rest which is not safe for Santa. Santa needs you to create a parachute he can use to carry him and his bag of presents safely to the ground without being hurt or breaking any presents or letting any fall out. This way he can continue to give all the children of the world presents once his reindeer are ready to fly again.

Design Challenge: Design a scale model of a parachute for Santa that can be adapted to hold different weights and still land safely. The parachute must be capable of being adapted fore varying circumstances (i.e., Santa's bag of presents can weigh heavier or lighter depending on where he is on his Christmas route)

Teacher Preparation: After discussing balanced and unbalanced forces, practice using rulers and measuring in halves and fourth of an inch. Place the students in small design teams and hand out all materials. The students will have to use engineering design and scientific inquiry to design a parachute that can adapt to given situations presented by the teacher. Design teams should utilize the engineering design loop to design the parachute, and then use scientific inquiry to plan for different potential scenarios. During testing, each team will be presented with three different samples of different weights that they must use and still land safely without hurting Santa or breaking the weights or letting them fall out of the cup. During testing, teams will have five minutes to fix their parachute if needed before showing the class it can hold all three weights without hurting Santa or the presents. The team that successfully lands Santa and the different weights all three times will be successful.

Materials:

Quantity	Description
2 per team	Small Dixie paper cups
1 per team	20 inches of string
3 per team	Small coffee filters
1 per team	Styrofoam plate
1 per team	Small Santa Clause
6 per team	Different size washers(2 per try)
1 per team	12 inches of scotch tape
3 per team	6 inch pipe cleaners
1 per team	Additional materials: Empty plastic water bottle, paper clips, tissue paper, construction paper, large coffee filters, sandwich zip lock bag
1 per team	Miscellaneous tools: Scissors, hot glue gun, glue stick, liquid glue, ruler

Parameters:

1. When cutting the string, you must measure using half or fourths of an inch.
2. The parachute must be able to hold three different weights and safely land Santa and his presents on the ground.
3. Teams must complete the "team evaluation" worksheet of the Parachute Evaluation Checklist/Scoring Guide before submitting their completed device for evaluation.

Criteria	Team Evaluation (Place a check mark next to each item completed)	Teacher Evaluation
Completed parachute creatively		______/5
Used materials and tools correctly		______/5
Stayed within parameters of the challenge		______/10
Parachute safely landed lightest amount of weight		________/10
Parachute safely landed medium amount of weight		________/10
Parachute safely landed heaviest amount of weight		________/10
TOTAL:		_______/50

High Rise

Level: 5th grade
Unit: Scientific Inquiry and Engineering Design
Paired Text: *A Year at a Construction Site* by Nicholas Harris

STEM Standards:
Next Generation Science Standards:
Standard 6: Motion and Forces

- PS.6.5.2 Conduct investigations using: Levers, pulleys, inclined planes/ramps, wedges, screws, wheels and axles
- PS.6.5.3 Relate simple machines to inventions and discoveries
- PS.6.5.6 Conduct investigations using potential energy and kinetic energy

Standards for Technological Literacy:
Standard 6: Students will develop an understanding of the role of society in the development and use of technology.

- 3-5 Benchmarks: Because people's needs and wants change, new technologies are developed, and current ones are improved to meet those changes.

Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

- Asking questions and making observations helps a person to figure out how things work.
- All products and systems are subject to failure. Many products and systems, however, can be fixed.

Common Core Mathematics Standards**:**
Measurement and Data: Convert like measurement units within a given measurement system

- Convert among different-sized standard measurement units within the customary system.

Big Ideas:

- Understanding how simple machines, such as pulleys and ramps work
- Understanding the different types of energy and energy transfers
- Ability to use scientific inquiry to adapt to potential solutions for differing circumstances
- Ability to measure lengths and covert measurements
- Ability to use the engineering design loop to solve technological challenges

Essential Question: How can you build a lifting device that can be adapted so that it can easily transport various weighted items to different levels of a skyscraper?

Scenario:
Welcome to our construction team! We are building a skyscraper that will be 70 stories high and we need your help! Our team is having a difficult time transporting the construction materials to the different levels of the skyscraper. Help us create a lifting device that is able to support the different shapes and weights of our construction materials and that can be altered so that it can reach the 20th, 30th, and 40th floor. Let's get started!

Materials, Resources, and Tools: (Groups of 2)

9ft. Rope/String	Glue	(4) Cups	Cardboard	Scissors
(4) Axels	(2) Pencils	Ruler	(4) Spools	(4) Wheels

*During the testing period, each group will be provided with the construction material. The testing material includes 2 pencils, 30 paperclips, and 3 large pink erasers. *

Teacher Guidelines: The teacher should begin this lesson by reading the book *A Year at a Construction Site* by Nicholas Harris. This book will introduce the students to the construction process and to the different tools and resources used during construction. After reading the book, the teacher will educate the students about how to measure and convert different measurements. Then the students will be introduced to the different types of energy and energy transfers. Once the students have a basic understanding of these concepts, they will split into groups of two and then be introduced to the challenge. The students will be instructed to build a lifting system such as a pulley system, conveyor belt, or an elevator that will transport different materials to different levels of the skyscraper. The teacher will need to provide three different platforms that are 2 (floor 20), 3 (floor 30), and 4 (floor 40) feet high. The lifting device must be controlled by a switch, lever, or crank. The students will use the design loop and the listed materials to complete this challenge. Once the students have constructed their lifting devices, they will then put it to the test. The teacher should provide two different cups; one cup will contain a list of the objects (2 pencils, 30 paperclips, and 3 large erasers) that can be transported and the other cup will contain a list of the three different levels. Once the groups have drawn from both cups, they will have five to ten minutes to alter their devices so that it will be able to successfully transport the chosen item to the chosen level. The teacher will assess the students using the evaluation form provided.

In order to complete this challenge, students will need to have an understanding of how to measure different lengths and they must be able to covert the lengths measured from centimeters to inches to feet. They will apply this information to ensure that their structure is the correct height. Students will need to understand what energy is and how it can be transferred from one object to another. This will allow them to understand how their devices work. Links are provided below to help the children understand the different types of lifting systems as well as how the different lifts can be used. The teacher will also need to discuss the importance of lifting systems and the importance of safety procedures when working with these machines. The students should apply this information when they are constructing their devices.

Energy	The ability to do work
Potential Energy	The stored energy an object has because of its position or state.
Kinetic Energy	The energy an object has due to its motion.
Motion	The process of continual change in the physical position of an object.
Direction	The extent of space between to objects or places.

Additional Resources:

- http://www.eia.gov/kids/energy.cfm?page=about_home-basics
- http://www.kids.esdb.bg/basic.html
- https://www.teachengineering.org/lessons/view/cub_simple_lesson05
- http://www.constructionknowledge.net/general_technical_knowledge/general_tech_basic_six_simple_machines.php

High Rise

Essential Question: How can you build a lifting device that can be adapted so that it can easily transport various weighted items to different floors of a skyscraper?

Scenario: Welcome to our construction team! We are building a skyscraper that will be 70 stories high and we need your help! Our team is having a difficult time transporting the construction materials to the different levels of the skyscraper. Help us create a lifting device that is able to support the different shapes and weights of our construction materials and that can be altered so that it can reach the 20th, 30th, and 40th floor. Let's get started!

Deliverables: Each group must present a lifting system to the teacher. Each group member will need to submit a completed design loop journal and peer evaluation form to the teacher.

Parameters: The lift must:
- Be able to successfully transport the different materials.
- Be adjustable so that it can reach all three floors.
- Be completed in the assigned time.
- Be created using the design loop.
- Be able to be altered to fit the given situation.
- Move only using a lever, switch, or crank.

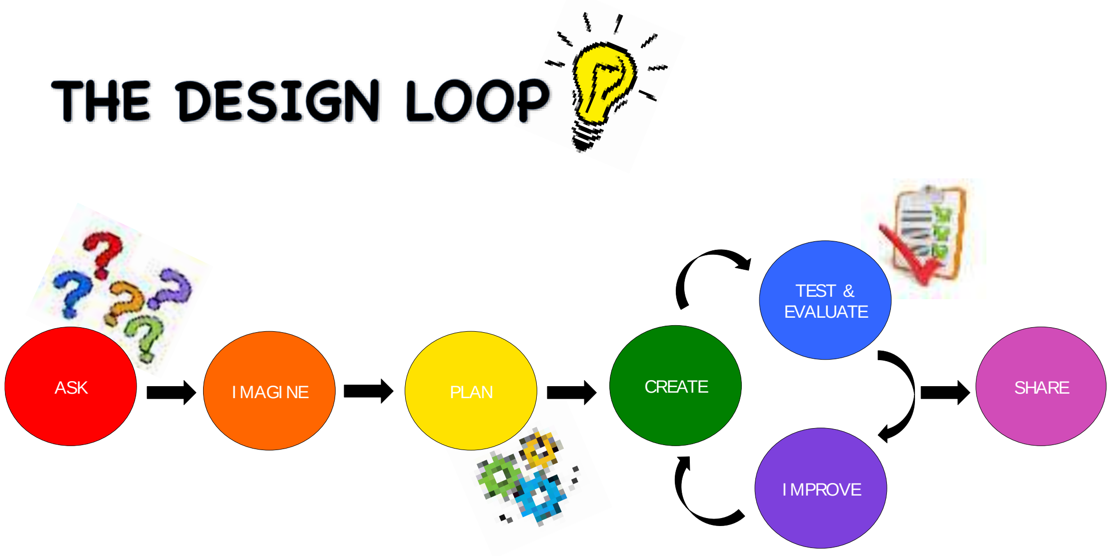
Materials, Resources, and Tools: (groups of 2)

9ft. Rope/String	Glue	(4) Cups	Cardboard	Scissors
(4) Axels	(2) Pencils	Ruler	(4) Spools	(4) Wheels

*During the testing period, each group will be provided with the construction material. The testing material includes 2 pencils, 30 paperclips, and 3 large pink erasers. *

Testing:
1. Each group will use the design loop to construct a lifting system that will transport construction materials to the different levels of a skyscraper. Your group will need to conduct research on different types of lifts and the importance of lifts.
2. Once your group has finalized their lifting system, they will then determine their scenario by drawing from two different cups. The scenarios include: level 20 (2 feet), level 30 (3 feet), and level 40 (4 feet), 2 pencils, 30 paperclips, and 3 large erasers. Each group will choose a "level" and a "construction material."
3. Your group will have five to ten minutes to alter the lifting device so that it will be able to successfully transport the material to the chosen floor.
4. After your group has successfully completed the challenge, each member will need to finish their design loop journal and peer evaluation forms provided.

Documentation: Each team must create lifting system using the design loop. Remember to document every step your team makes while completing the assignment.



My problem is:

My goal is:

What do I know?

What do I need to research?

What did I discover?

My device will look like:

Or this….

Or this….

The best solution is:

The materials needed are:

I will test my device by:

My group member's duties are:

Results:

Collected Data:

Adjustments Needed:

Test 2 Results:

Does my model work? Could it transport the different materials?

Describe how the lifting device could be adapted to operate effectively?

How can you improve your model?

Retest your model. Was it successful? Why or Why now?

What do you need to prepare before you present your design to others?

Peer Evaluation

Name: ______________________

Group Number _____________

Rate your group members 1-5
1 = did not participate and 5 = took the lead/extremely helpful

Group Members Name	Brain Storming (1-5)	Creating Model (1-5)	Collecting Data/Testing/ Presenting (1-5)

Additional comments:

Teacher Evaluation:

Student's name ______________________

Group Number: ___________

The lifting device was submitted on time	/10
The lifting device successfully transported each material	/25
The lifting device demonstrated uniqueness and creativity	/10
The lifting device adjusted so that it reached all three levels	/15
The group demonstrated their understanding of the design loop and scientific inquiry processes.	/20
Documentation of the design loop and peer evaluation	/20
Total	**/100**

Additional comments:

Calling all Innovators!

Grade Level: Third

STEM Standards:

Science

3-PS2-2: Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

Math

AR.Math.Content.3.MD.B.4 Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch

Technological literacy

Standard 6: Students will develop an understanding of the role of society in the development and use of technology.

- Benchmark: Because people's needs and wants change, new technologies are developed, and bid ones are improved to meet those changes.

Essential Question: What kind of device can you create that will hold someone's phone in their hand for them, but not let them drop it?

Scenario: People are always carrying their phone in their hands, but they are also always dropping them. Apple is calling on you to create a device that will allow people to hold their phones in their hands without dropping it.

Challenge: Students will use any typical household materials to construct a device that fits around an average sized hand (mannequin provided) and holds multiple sizes of phone. The phone must stay in the device when turned upside down and shook in all directions.

Tools:

- Cardboard
- Card stock
- Elastic
- Sand paper
- Fabric scraps
- Glue (different types)
- Tape (different types)
- Scissors
- Rubber bands
- Aluminum foil

Teacher guidelines:

- Teachers will pass out a letter from the technology company, Apple. This letter asks the students to form the device that will help all of the iPhone owners out. They will be rewarded by Apple if they are able to create a device that fits their needs.
- Students will be expected to record measurements (to the fourth/ eighth inch) and created detailed pictures of how they created the device so that Apple can manufacture it.
- Students will discover that they will need to use materials that are going to keep the phone from slipping and note the pattern in motion of a falling phone. They will also discover that they need to use materials that are going to allow them to adjust the device for different sizes of phones.
- Students will learn how new technology is always forming and we must keep up with people's needs
- Students will be asked to present their devices and explain how their device fits the changing needs of today's phone owners. They also will show how their device takes into account all of the possible motions. There is a pattern in how the phone could fall out of the device, and students must show that they have thought this through.
- Students will be given a mannequin hand that is representative of an average sized hand. They will use this to create their device. They also will be given 3 different models that represent the different sizes of phones. Their device must fit all three of these phones with none of them slipping out.

Letter from Apple-

Innovators,

Hello! We have been given your contact information as someone that we can go to solve a problem that we have.

Every one of our customers loves our iPhone product, but we are having a challenge. People feel the need to always have their phone in hand- however, this is a problem when people drop and crack their phone.

We want to make life for our customers easier and create an innovative device that will allow our customers to hold their phone in their hand, but not allow them to drop it.

You have shown to have experience with creating detailed, measurable, plans and would like to tackle our idea. For the proto type that you are creating, it will fit an average sized hand (model included) and will also be able to fit our three different sized phones we sell. Please provide a detailed plan and sketch so that we can manufacture your product if it fulfills our needs.

Detailed instructions have been provided to your supervisor and we look forward to see what ground-breaking technology you create.

Thank you,

Apple, INC.

Defend Your Land

Grade Level: 9-12

Stem Standards:

Standard 11. Students will develop the abilities to apply the design process.

Standard 12. Students will develop the abilities to use and maintain technological products and systems.

Standard 13. Students will develop the abilities to assess the impact of products and systems.

Essential Questions:

What are the factors that need to be collected and analyzed to make an accurate devise?

What is the relationship between mass, force, gravity, angle of launch etc.?

You are a defender of the lands to the west. Your scouts have found invaders from the east advancing on your location. You have five days to prepare a device that will launch a projectile through the air and strike the invaders at 10 feet, 15, feet, and 20 feet from the borders of your land. This should deter the opposing forces to return to their lands.

Tools & Material:

Hand saw, scissors, and other tools in class room.

1 Mouse traps, 4 rubber bands, 12" x 12" card board, 6 paper clips, 1 6" dowel rod, 6 popsicle sticks, 24" duct tape, hot glue, 24" string, three sheets of computer paper, and 1lnft. Of tin foil.

Teacher Guidelines:

The students should come to a realization of what factors can be manipulated to accomplish the greatest effect. The factors they discover should documented by them and as they test their device the students should record the specifics of each factor. Examples mass of projectile, angle of launch, force the device puts on projectile, and the known distances of 10', 15',and 20'. If the invaders are maybe 10 or twenty plastic army men lined up in a row the larger the projectile the better chance of knocking down more invaders. Students could have a chance to knock down all of the invaders. One shot at each distance. If some are knocked over they do not advance to the next distance. Another option if there is not enough time is to have the students draw from a hat the distance in which they are to fire.

This challenge should help the students develop a better understanding of a design process. The teacher should help the students remember the design loop and make sure they are using it. This will help students stay organized.

Students should develop skills required in using tools. Also they should be able to break down their device into different systems. Students should be able to repair and improve their device.

Students will learn how to organize, analyze, and use data to improve their device.

Surviving the Storm

Grade Level: 4th grade
STEM Standards:
Science Standards

- NS.1.4.2 Refine questions that guide scientific inquiry
- ESS.8.4.10 Describe weather related natural disasters
- ESS.8.4.9 Demonstrate safety procedures related to severe weather

Technological Literacy Standards:

- Standard 7: Students will develop an understanding of the influence of technology on history.
  - B. People have made tools to provide food, the make clothing, and to protect themselves.

  Standard 8: Students will develop an understanding of the attributes of design.
    - 3-5 Benchmarks
  - The design process is a purposeful method of planning practical solution to problems.
  - Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.

Math Standards

- AR.Math.Content.4.MD.A.3
- AR.Math.Content.4.MD.A.1

Essential Question: How can I construct a structure that will protect people and survive the weather conditions associated with a tsunami?

Scenario: You are vacationing in Thailand, just like in the book Eli the Elephant. Something in the air seems not quite right. You know from your studies that this strange feeling you feel is very possibly an oncoming natural disaster! You also know that the current place you are staying in probably won't survive any kind of extreme weather. You don't have much material and you don't have much time, but you need to figure out what kind of weather conditions are coming and build a structure for you and your friends to stay in and stay safe through the different weather conditions that are associated with a tsunami.

Challenge: Conduct research to identify what weather conditions come with a tsunami and then build a structure that is capable of withstanding the oncoming weather conditions to keep you safe. Your structure must be able to adapt to the changing weather conditions associated with this natural disaster and remain standing.

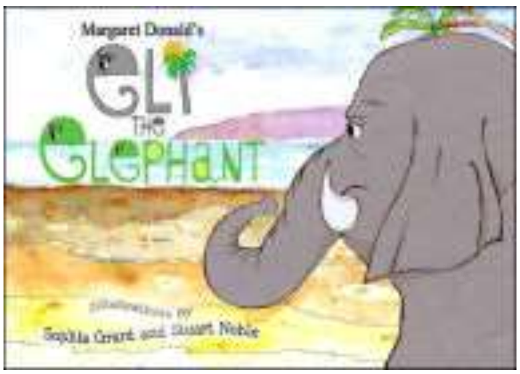
Tools

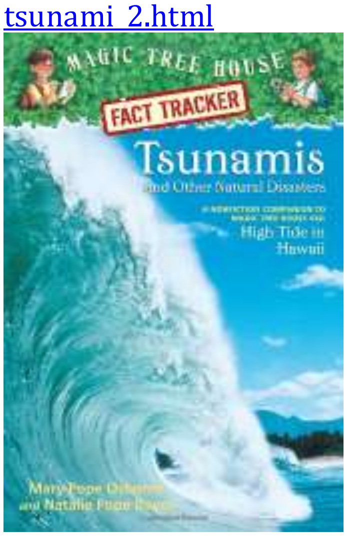
- Scissors
- Twine
- Rubber bands

Materials

- 6 Wooden dowels
- 1 sheet of 8 ½ by 11 in. Paper
- 1 Plastic Cup
- 2 Straws
- 1 sheet of Cardboard
- 1 sheet of Aluminum foil
- ½ sheet of poster paper

Resources

- 

- National Geographic article about warning signs and safety tips during tsunamis: http://news.nationalgeographic.com/news/2007/04/070402-tsunami_2.html


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Teacher guidelines: Start by reading the book Eli the Elephant to your class. Ask them to imagine themselves being in a foreign place where they know dangerous weather is coming. This lesson activity will drive the students to better understand the weather conditions that come with a tsunami, safety during natural disasters, design principles and process, and measurement. Once they build their structures, their structures need to be tested. Their structure needs to be able to survive strong wind (tested with a leaf blower), heavy rain (tested with a hose), and the earthquakes (tested with earthquake simulator) that come with a tsunami. A cotton ball wrapped in tissue paper (to show moisture) will be representative of a person and placed in the safety of their structure. The cotton ball must remain dry and in the structure to show that they can build a structure to help people survive a tsunami. They need to be able to identify the shape of the base of their structure. Their structure must be no shorter than 5 ½ inches tall. Students are only allowed to use the given materials remembering that tools are not materials.

Deliverable to show design process and understanding of standards:

What different weather conditions must your structure survive?

Sketch three possible designs for your structure

Pick your best design. Draw it here including materials and construct it.

Test your Design. What needs to be revised so that it is more effective? Sketch revised idea.

After questions:

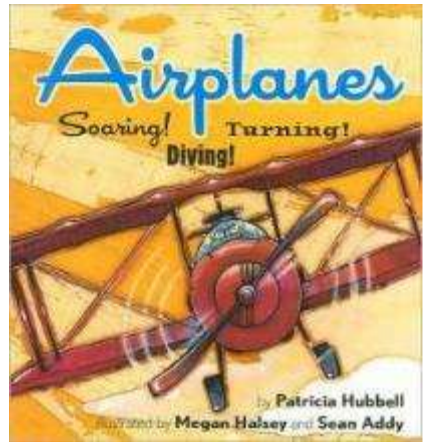
1. If you were to do this project again, what would you do differently?

2. What signs helped you to know that it was a tsunami that was coming? Name the warning signs.

3. Why is this project important?

4. What types of shapes were most effective in your design? Draw the shapes and explain how they helped your structure.

5. What is the shape of your base? Calculate the perimeter of your base.



Grade Level: 3rd-5th Grade

Unit: Scientific Inquiry and Engineering Design

Literacy: *Airplanes* by Patricia Hubbell

STEM Standards:

Next Generation Science Standards:

3-ESS3-1 Earth and Human Activity:

- Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.*

Arkansas Math Standards

AR.Math.Content.3.MD.B.4

• Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch

Standards for Technological Literacy:

Standard 9: Students will develop an understanding of engineering design.

- The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.
- When designing an object, it is important to be creative and consider all ideas.
- Models are used to communicate and test design ideas and processes.

Standard 10; Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

- Troubleshooting is a way of finding out why something does not work so that it 4an be fixed.
- Invention and innovation are creative ways to turn ideas into real things.
- The process of experimentation, which is common in science, can also be used to solve technological problems.

Big Ideas:

- Understanding that certain materials can withstand weather related hazard better than others.
- Use scientific inquiry to adapt potential solutions for differing circumstances
- Use engineering design to solve technological problems

Essential Question: How can you build an airplane that can be adapted to easily withstand weather related hazards such as rain, wind, and abrupt landings?

Scenario: During a routine flight you and your team suddenly are suddenly expected to make an emergency landing. During the landing your airplane is destroyed. Using the debris from the wreck you must build a new airplane that can withstand weather related hazards better than your first airplane did so your team can fly safely home.

Content Information:

During this STEM lesson, students will be expected to have background knowledge related to measurement so that they can create a workable device. The students will also be practicing the engineering design process and scientific inquiry. There will also be a varied of terms used that will need to be covered prior to the lesson if the students are unfamiliar with them.

Terms:

Aerodynamics-the study of the properties of moving air, and especially of the interaction between the air and solid bodies moving through it.

Drag-pull (someone or something) along forcefully, roughly, or with difficulty.

Gravity-the force that attracts a body toward the center of the earth, or toward any other physical body having mass. For most purposes Newton's laws of gravity apply, with minor modifications to take the general theory of relativity into account

Thrust-push (something or someone) suddenly or violently in the specified direction.

Lift-is the force that directly opposes the weight of an airplane and holds the airplane in the air.

Design Challenge:

Design a scale model of an experimental airplane that can withstand weather related hazards such as rain, wind and abrupt landings. The device must travel down the hallway for a minimum of 2 yards and not be destroyed by rain or wind. We will test the rain with a strainer and water and the wind with a hair dryer. Your device must still fly after weathering these elements. Your device must also stay intact when landing abruptly in the hallway from your toss.

Teacher Preparation:

After discussing the content (above), and reading *Airplanes* by Patricia Hubbell, place the students in small design teams. The students will have to use engineering design and scientific inquiry to design a device that can withstand the weather related hazards presented by the teacher. Design teams should utilize the engineering design loop to design the airplane, and the scientific inquiry plan for deferent potential solutions. During testing, each team will be presented with the three different weather related hazards that their airplane must withstand. The team whose airplane withstands all three elements will be successful.

Materials & Equipment:

Unlimited Supply of

- Paper
- Aluminum Foil
- Straws
- Plastic Wrap
- Cups
- Pipe Cleaners
- Rubber bands
- Plastic Water Bottles
- Tape, Glue, Scissors,
- Any material found in the classroom may be used

Parameters:

1. The airplane may be no larger than 12" in length
2. The airplane must fly a minimum of 2 yards down the hallway.
3. During testing the airplane must withstand ALL elements and be intact and able to fly the minimum 2 yards to be considered successful.
4. Teams must complete the "team evaluation" column of the Check List/ Scoring Guide before submitting their completed device for evaluation.
5. Teams must complete the engineering design worksheet to record research and activities while completing this challenge.

<u>Using an Engineering Journal</u>

Having students use an engineering journal or portfolio is a great tool to help them stay on task, keep their research and planning ideas organized in one area, and provide a place for them to reflect on and evaluate their work. The components of an engineering journal would vary according to the teacher's preferences, the grade level of the student and the complexity of the project. Listed below are possible components of an engineering journal for design and engineering projects.

1. State problem, criteria, constraints
2. Space for research/investigation notes

3. List of tools and materials
4. Outline of steps to follow
5. Brainstorming space
6. Final design sketch
7. Special worksheets (data collection)
8. Presentation organizer
9. Personal reflections
10. Redesign space and time
11. Assessment (teacher, student)

Name: ________________________

Date Started: ___/____/____

Date Completed: ___/_____/____

Design Brief Title: ______________________________

7. What is the problem?

What do I need to do?

2. Brainstorm solutions –

What do I already know?

____

____

____

What do I need to find out?

____

____

____

What did I find out?

____

____

____

My First Ideas:

____

____

____

Draw 4 examples of a design you might use.

Choose your solution:

My best idea is ……

The steps I will use:

The tools and materials I will use:

NOTES:

4. Test your solution

Thinking About My Idea

Name _____________

Design Title: ___________________

How did you test your solution?

____
____
____

How do you know if your idea works?

____
____
____

5. Evaluate your solution

How would you change your idea?

What did you learn?

What did you like about this project?

What did you not like about this project?

Airplane System Evaluation Checklist/Scoring Guide

Criteria	**Team-Evaluation** (Place check mark next to each item completed)	**Teacher Evaluation**
Completed airplane creatively		**_____/15**
Completed Engineering Design Journal		**_____/15**
Used materials and tools wisely and correctly.		**_____/ 10**
Stayed within the parameters of the challenge.		**_____/ 20**
Device withstood the rain effectively.		**_____ / 10**
Device withstood the wind effectively		**_____ / 10**
Device withstood an abrupt landing.		**_____ / 10**
Device withstood all weather related hazards and flew down the hallway successfully.		**_____ / 10**
Team presentation provided high-quality details concerning the process used to solve the challenge and defended their research		**_____/ 10**
TOTAL:		**____/ 100**

Up to 5 Points	Up to 10 Points	Up to 15 Points	Up to 20 Points
Team showed little understanding of concepts from lesson and were unable to build device	Team shows some understanding of concepts from the lesson and were able to build a device	Team applied concepts from the lesson and created a device that withstood 2 samples	Team effectively applied concepts from the lesson and created a device that withstood 3 samples
Team completed one or two aspects of the engineering design journal	Team completed many aspects of the engineering design journal	Team completed most aspects of the engineering design journal	Team completed every aspect of the engineering design journal
Team demonstrated little understanding of lesson content and scientific inquiry	Team demonstrated some understanding of lesson content, but little ability to utilize scientific inquiry to modify initial design ideas	Team applied many concepts from the lesson content and made some modification to their initial device	Team demonstrated the ability to use content and scientific inquiry to adapt their device to perform different functions
Team was unable to apply concepts related to aerodynamics, lift and gravity.	Team applied some concepts related to aerodynamics, lift and gravity.	Team applied many concepts related to aerodynamics, lift, and gravity.	Team applied most concepts related to aerodynamics, lift, and gravity.
Students did not collaborate as a team. Communication was lacking and conflicts were not resolved	Students worked together, but did not share work equally. Conflicts were not resolved on the team	Students worked equally as a cohesive group, may have shown some signs of conflict without resolution	Students worked equally as a cohesive group and communicated well with each other as a team

Title: Helmet Impact

Grade Level: 4th

STEM Standards:

Standard 1:

D. Tools, materials, and skills are used to make things and carry out tasks.]

Standard 2:

I. Tools are used to design, make, use, and assess technology.

K. Tools and machines extend human capabilities, such as holding, lifting, carrying, fastening, separating, and computing.

Standard 8:

D. The design process is a purposeful method of planning practical solution to problems.

Standard 9:

C. The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.

D. When designing an object, it is important to be creative and consider all ideas.

Science Standards:

6.4.1 Investigate the relationship between force and direction
PS.6.4.2 Investigate the relationship between force and mass

Math Standards:

AR.Math.Content.4.MD.A.1 • Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb., oz.; l, ml; hr., min, sec; yd., ft., in; gal, qt., pt., c

Essential Question:
How can you build a device that can be adapted to protect the varying sizes, weights, and shapes of human heads during impact? What physical properties are important when working with shock absorption?

Scenario:
Imagine you are newly hired at a sports company. A brand of their helmets has been recalled due to inadequate protection during impact. This particular helmet comes in all sizes ranging from children, teen, and adult sizes. Adult customers say the helmet cracks upon impact and is not sufficient to protect a larger, adult head. Come up with a helmet that can protect heads of a larger mass.

Design Challenge:
Design a model of an experimental helmet that can be adapted to protect heads of different masses and diameters. The device must be capable of being adapted for varying

circumstances (i.e. Small, medium, large heads) In teams of 3, conduct research then build a helmet that that is able to absorb shock when a force is applied opposite its direction.

Tools:
Scissors
Sling Shot
Cart

Materials:
12" X 12" of foam
5 Rubber bands
12"v String
½ Egg carton
1 Plastic bowl
4 Pipe Cleaners
15 Cotton Balls
1 Egg
1 Melon
20" Tape
Glue

Resources:
Design Loop
IPad

Teacher Guidelines:
Teachers should discuss the importance of helmets and the effect of force and mass when a helmet is put to use. What are important qualities in a helmet and why? Students will have to use scientific inquiry to design a helmet that can protect both small and large heads when the same force is applied. Teams should apply the design loop to create a helmet and use scientific inquiry to plan for contrasting scenarios such as a child or adult sized head. During testing, each team will need to prove that their device can be used to protect both small and large heads. The two "heads" will vary in size, shape, and mass just as real heads do. Testing will require the students to place their "head", with helmet intact, on a cart which we will slingshot into the wall at different speeds. The team that can create a helmet that can protect all sizes and speeds will be outstanding!
Parameters:
Students will have 1.5 class periods to create. Half a class period will be used to test and redesign.

Title: Saving Our Oceans
Grade Level: 4th
STEM Standards:

Arkansas Science Frameworks:
ESS.8.4.4 Evaluate the impact of water pollution

Common Core Mathematics Standards
Measuring & Data

- Represent and interpret data: generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch.
- Express the length of an object as a whole number of length units.

Standards for Technological Literacy
Standard 5. Students will develop an understanding of the effects of technology on the environment. 3-5

- B. Waste must be appropriately recycled or disposed of to prevent unnecessary harm to the environment.
- C. The use of technology affects the environment in good and bad ways.

Essential Question: How can you build a waterproof device that can reach into up to two feet of water to capture different sized objects?
Scenario: Water pollution is a big issue in our bodies of water on earth today. We need your help to make a contraption that can go under water and capture this trash. Your problem is, you don't know what all trash you may come across (shape, size, weight, etc.). Your device must also be able to reach up to two feet of water without any of your body parts touching the water, only the device.
Challenge: Design a device that can capture different kinds of trash from up to two feet deep of water. The trash can be all shapes and sizes, so be prepared.
Materials:

- Plastic forks
- Plastic spoons
- Popsicle sticks
- Plastic baggies
- Tape
- Scissors
- Construction paper
- Wax paper

Teacher guidelines: We will begin this lesson by discussing the impact of pollution on our environment, specifically in our water. The students will need to be familiar with waterproof materials to use. They will also need to be familiar with measurement so that they can have a device that reaches the correct length. The teacher needs to demonstrate different types of trash the students could be expected to pick up so they understand they cannot build a device that would only work for one size and shape.

Scientific Inquiry
Grade Level: 5th

Standards:

Arkansas Science Frameworks:

NS.1.5.1
Make accurate observations

NS.1.5.2
Identify and define components of experimental design used to produce empirical evidence:
• Hypothesis
• Replication
• Sample size
• Appropriate use of control
• Use of standardized variables

ESS.8.5.12
Conduct investigations on sedimentation

Arkansas Math Frameworks:

AR.Math.Content.5.MD.A.1
Convert among different-sized standard measurement units within the metric system

Essential Questions:

- Which material was best for water to pass through?
- Which material held water best?
- Which material will be best for my habitat for the organisms to live in?

Scenario:

We have lots of mystery materials available but we aren't sure what they are. We need to find out which material will hold water the best and which will hold the least amount of water. This information can then be used to build a habitat for different animals.

Challenge:

Students will fill their containers with different materials (.10 lb.) and pour 30mL of water over it and then measure how much water makes it into the "capture device" and record their findings. They will then conduct research and determine which animals will be in their habitat and what materials they will use to create this habitat

Tools, Materials, Resources:

- Water capturing device, 2 liter bottle cut about 2/3 of the way down, end with the cap on it will be turned upside down and placed in the bottom half of the bottle. The cap will have holes in it to filter the water through.
- Sand
- Pebbles
- Scraps of paper
- Scraps of rubber
- Record sheet
- Water
- Graduated cylinder
- Scale

Teacher Guidelines:

This lesson will provide students with practice in accurately measuring and observing a variety of different variables. Students will have to initially hypothesize which materials will retain the least and most amount of water and then reflect on their hypothesis after they have recorded their findings. Student will then have to determine which material retains the most water and releases the most water. They will then choose which material they would use to build a habitat for certain organisms. They should have one day to collect data and measure the water and the next day to research habitats and come to a conclusion on the materials that they would use.

Save the Space!

Grade level: 4th grade
Unit: STEM Scientific Inquiry

STEM Content Standards:

Next Generation Science Standards:
Engineering Design in a 3-5 developmental learning progression:
ETS1

- **Optimizing the engineering design** involves a process in which solutions are systematically tested and refined and the final design is improved by trading off less important features for those that are more important. In this grade range students build and test models or prototypes using controlled experiments in which only one variable is changed from trial to trial while all other variables are kept the same.

Standards for Technological Literacy:
Standard 7: Students will develop an understanding of the influence of technology on history.

- 3-5 Benchmarks: People have made tools to provide food, to make clothing, and to protect themselves.

Common Core State Standards:
AR.Math.Content.4.MD.A.2

- Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money including the ability to make change; including problems involving simple *fractions* or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit.

Big Ideas:

- Constructing a large object out of a series of smaller objects
- Scientific Inquiry usage
- Role of brain storming to problem solve
- Applied creative thinking for innovation
- Ability to measure size, distances and mass
- Understanding the importance of measurements when constructing
- Understanding the importance of space and earth
- Understand the properties of different surfaces (liquids, gas, ground)
- Ability to work with peers

Essential Question: How can you construct a landing device in space so that the landing is smooth on different surfaces?

Scenario:
A ship is flying in space, it has caught a bombing device, left by the aliens to destroy the space! Suddenly, it got wrecked and the astronauts have less than 2 hours to design a landing device to escape, without the bomb exploding. Oh no! They do not know where they will land. Please, help the astronauts to save the space and themselves by designing a safe landing device.

Instructions: For the hook assignment, the teacher will supply the students with a variety of materials like ground, water, oil, pebbles and nothing (to simulate the air). Provide each student with boxes with these materials and make them discuss in groups their properties. Then, the teacher and the students will discuss about the properties of the materials together and the teacher will make a general conclusion on space and earth properties. The teacher, at the same time, will show a video about space to make the students get more involved in the next stage of the activity. After the hook activity, the teacher will divide the students into groups of two and then review the instructions and expectations of the activity. Once the children have an understanding of the assignment, they will begin to design the landing device. When the brainstorming is finished, the students select the materials. All the teams are supplied the same materials. When the challenge is solved, each group tests the device. The teacher uses the first variable – different surfaces for landing (water in a bucket, a box with pebbles, a box with ground, a bucket with oil and an empty bucket). Then they must repeat the testing process and make general conclusions. After having conducted this experiment, the students will complete the worksheets and peer evaluation form provided.

Materials & Resources:

cardboard	2 gums	String	Foil
4 straws	2 plastic bags	water	Scissors
Tape	oil	pebbles	
ground	Measuring tape	Measuring scale	

Parameters: The device has to be:
- Be 150 grams in weight
- Be constructed using the proposed materials (no other materials are allowed to be used)
- Land smoothly on different surfaces
- Be documented by each group member
- Be able to transport different weight

Content Information:
The students will need to have background knowledge of surface and earth properties. They must also know what a landing device is. Students will need to be able to measure mass in grams. The teacher will need to provide additional materials on different surfaces and space crafts. To deepen the students' understanding of different types of surfaces, the teacher will bring different surface materials and discuss their properties**. The teacher will make the students use the design loop to make the process mostly clear and**

effective. The scientific inquiry can be expanded on, using different variables (length and weight of the aircraft).
Additional resources:
https://www.youtube.com/watch?v=bWrxe_jxjR8
https://www.youtube.com/watch?v=f8LWLLu8eME
https://www.youtube.com/watch?v=f7mf1Qvswtw

Different Surface Worksheet

Instructions: Analyze the provided materials properties and correct the following sentences (if necessary).

1. The ground is hard material that can be found only in space.

Yes ___________ No____________________

Comments:

2. Oil is not liquid. It does not have color.

Yes ___________ No___________________

Comments:

3. Water resembles oil in some properties. It is not so consistent as oil.

Yes ___________ No____________________

Comments:

4. Pebbles are not hard materials. They can be found both on earth and in space.

Yes ___________ No____________________

Comments:

5. Air is gas. It has a dark color.

Yes ___________ No____________________

Comments:

Choose the right picture for the materials provided

Save the Space!

Grade level: 4th grade
Unit: STEM Scientific Inquiry

Scenario:
A ship is flying in space, it has caught a bombing device, left by the aliens to destroy the space! Suddenly, it got wrecked and the astronauts have less than 2 hours to design a landing device to escape, without the bomb explo ding. Oh no! They do not know where they will land. Please, help the astronauts to save the space and themselves by designing a safe landing device.

Challenge: How can you construct a landing device in space so that the landing is smooth on different surfaces? Do not forget, there is a bomb on that should not explode, otherwise the space will be destroyed too.

Materials & Resources:

cardboard	2 gums	String	Foil
4 straws	2 plastic bags		tape

Each team will have access to a pair of scissors, measuring tape, and a measuring scale

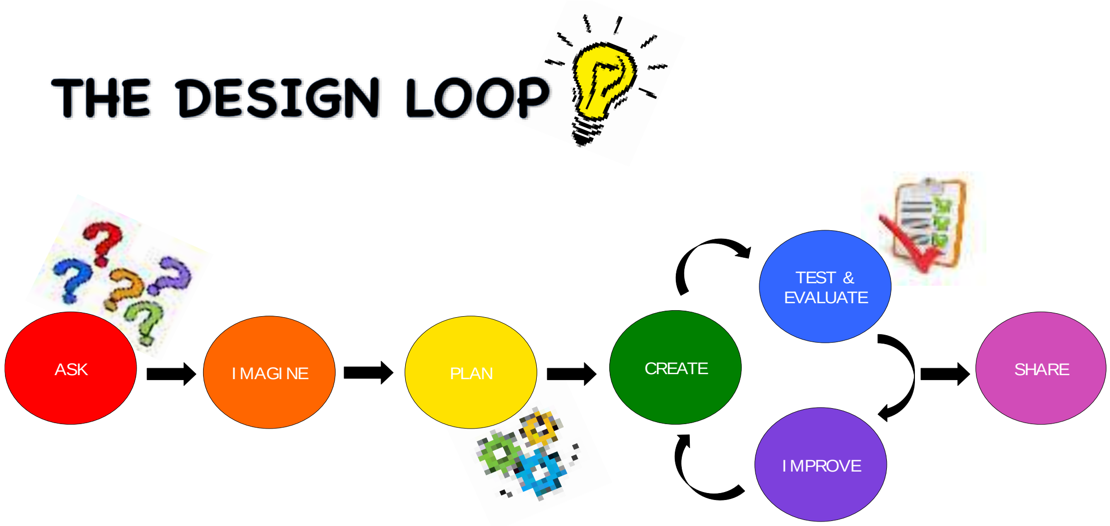
Parameters: The device has to be:
- Be 150 grams in weight
- Be constructed using the proposed materials (no other materials are allowed to be used)
- Land smoothly on different surfaces
- Be documented by each group member
- Be able to transport different weight

Deliverables: At the end of this challenge, each group will need to present their landing device. Each group member will also need to turn in his worksheets and peer evaluation form.

Test: (remember to document the process and findings in your design loop journal)

8. After constructing the device, you will need to measure the weight to make sure it is 150 grams.
9. Each team will test out their solution by landing the device on different surfaces.
10. Have one team member add a ping-pong ball to the device to simulate the bomb.
11. If your bomb "exploded", redesign the device. Make sure each member documents these changes.
12. After conducting the experiment and calculating the results, the students will evaluate each member of the group.
13. Each group will share their findings and design loop process with the class.

Documentation: Each team member will complete the engineering design loop that is provided below.



My problem is:

My goal is:

My model will look like:

Or this…

Or this…

The materials I need are:

The best solution is:

My group member's duties are:

My results are:

The adjustments needed:

The final results are:

Peer Evaluation:

Name: ____________________

Group Number: _______________

Rate your group member and yourself from 1-5.
1 = did not participate and 5 = took the lead/extremely helpful

Group Members' Name	Brain Storming (1-5)	Creating Model (1-5)	Collecting Data/Testing/ Presenting (1-5)

Additional Comments:

Teacher Evaluation

Student's name: ___________________

Group Number: ____________________

Landing device was submitted on time	/5
The group demonstrated their understanding of the design loop	/20
The landing device is unique and creatively made	/10
The group presented their findings clearly to the class	/15
The device landed successfully on different surfaces	/25
Documentation of the design loop, worksheets, and peer evaluation	/25
The device was created using only the provided materials	/10
The group demonstrated their understanding of measuring weight	/10
Total	**/120**

Additional Comments:

STEM 4033
Scientific Inquiry: Curriculum Brief Assignment

Arkansas Digging

Grade: 4th grade

Standards:

- Math: AR.Math.Content.4.MD.A.1 • Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb., oz.; l, ml; hr., min, sec; yd., ft., in; gal, qt., pt., c • within a single system of measurement, express measurements in the form of a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table
- Science: Strand 4: Earth and Space Science Standard 8: Earth Systems: Structure and Properties Students shall demonstrate and apply knowledge of Earth's structure and properties using appropriate safety procedures, equipment, and technology.
  ESS.8.4.1 Locate natural divisions of Arkansas: • Ozark Plateau • Ouachita Mountains • Crowley's Ridge • Mississippi Alluvial Plain (Delta) • Coastal Plain • Arkansas River Valley
- Technology: Standard 2. Students will develop an understanding of the core concepts of technology. Resources are the things needed to get a job done, such as tools and machines, materials, information, energy, people, capital, and time.

Essential Question(s):
The students will be able to answer the question(s):

- What area of Arkansas do we live in? What makes it said area?
- What materials are needed to lift different weights of rock?
- What tool will you design to lift and move the rocky soil of Arkansas?

Scenario:
You are a construction worker that is needing to move and adjust the land to get it ready to build an amusement park here in Northwest Arkansas, which is part of the Ozark Plateau. The problem is that the soil is very rocky. You will need to find a solution to being able to lift different weights of rock into the truck (tub/ bucket) to be moved.

Challenge:
In groups of 2, you will need to find a way that will lift (without you touching the rock), carry 3 different weights of rocks and also move the rock to the truck (bucket). Your device needs to be able to lift the 3 weights of rocks and dump the rocks into the tub/ bucket. The tub will be 10 feet away from the table your rocks will be on. You and your team mate must choose 3 rocks each with a different weight. You will use a scale to weigh the 3 rocks of your choice (but they each must be different in weight by at least 1 gram).
Tools:

- Scissors
- Ruler
- Hot glue gun
- Box cutters
- Scale

May use approved tools you already have readily available
Materials:

- Card Stock (2)
- 1 Milk jug
- Paper (3)
- Duct Tape (15in per group)
- Bucket of rocks (students must weigh and pick 3 different weights)
- Pipe Cleaners (3)
- 1 paper cup (you may not just use a cup)
- 1 plastic cup
- 1 empty water bottle
- 2 tongue depressors
- 3 Large rubber bands
- 12in x 12in piece of card board (1 per group)
- 12in of string (1 per group)
- Masking tape
- Tub/ bucket to put rocks in (1 per group)

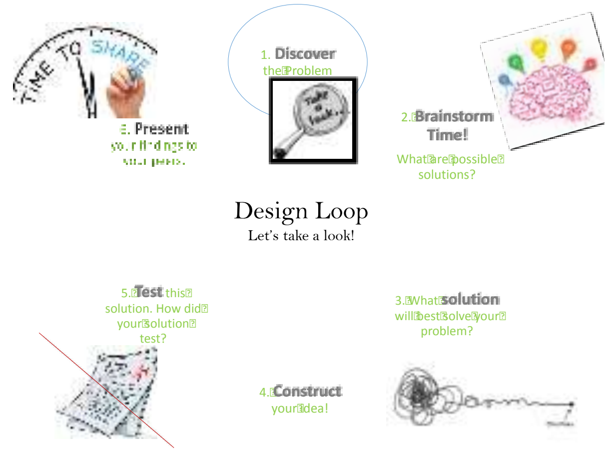
Teacher guidelines:
This inquiry lesson will be carried out by discussing the science standards first. The teacher will introduce the topic of the 6 regions of Arkansas, what makes them natural barriers between each other and what characteristics each region contain. The teacher will then narrow in on Northwest Arkansas and our region being known for having rocky soil. This will carry into our STEM challenge. Students will have the above materials available for them to create a device that will pick up 3 different weights of rock and used to move them to the bucket. While they are designing and testing their device they will complete their design packet to keep track of their work and designs and if needed, adaptations. They will also record their trials when testing their device to see if it can pick up all 3. The students will gain an understanding that we use resources like our devices we made to get important jobs done. You wouldn't think the ground would be an issue, but Arkansas's soil is very rocky and hard to excavate to create level ground for new construction. In their design packets, they will also record their math conversions when measuring their

supplies. They are provided inches, but they must show the math to convert the inches into centimeters and also feet, showing they are able to convert measurements into smaller and larger units such as the string and cardboard. They must also be able to weigh their 3 rocks they choose making sure they all are differing in weight by at least 1 gram. They must convert grams into milligrams practicing conversions. Once students have tested their device, modified for improvements and recorded their data, each group will share their ideas and models to the class.
Extension: Students can figure out how to pick up multiple rocks with your device. What would you change?
Parameters:

- The 3 rocks must different in weight by at least 1 gram
- The device must be less than or equal to 12 inches
- The device must weigh under 35 grams
- The device must pick up all 3 weights
- The device must be able to pick up and hold the 3 different rocks as you carry it to the tub (the tub will be 10 ft away).
- Students may not use their hands to pick rock up into device.

Design Challenge Journal

Team:



Identify the Challenge:

What are the parameters?

Weight of your 3 rocks (grams):

Rock 1	Rock 2	Rock 3

Convert grams to milligram:

Remember: 1 gram=1000 milligram

Show work below

Materials that require you to measure them such as the string or cardboard, you will convert them here: (inches to centimeters) or (inches to feet) Choose one.

When you construct your model, to make sure it falls within the parameters, measure your device with a ruler in inches and convert it to centimeters. Show work below:

Now it's time to plan! Brainstorm some ideas and sketch them below:

Design Ideas Room to sketch your ideas	

With your team mate, choose the best solution to the challenge. Sketch below.

List the materials you used:

May use to draw your device closer up:

Construct your model and Collect your data. Don't forget to go back a measure your device and convert!

	Rock 1 Weight:	Rock 2 Weight:	Rock 3 Weight:
Trial 1			
Trial 2			
Trial 3			

Does your device work?

Which rocks does the device lift and carry to the tub?

How might you adapt the device to work with the different weights of rocks?

Adapt and improve your device:

How did you change your device to lift all 3 rocks?

Retest your modified design with all 3 rocks. Did your device work this time? Explain why.

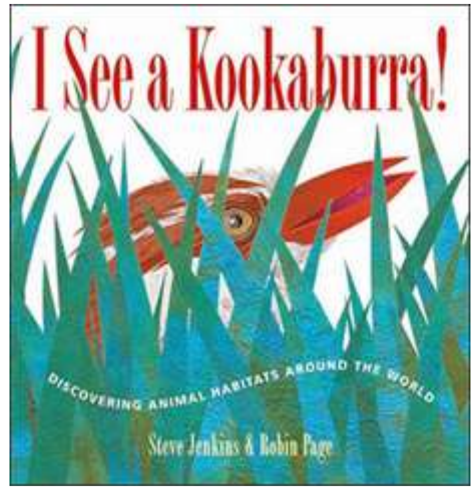
Bonus Challenge!
How could you modify your design to lift multiple rocks?

Prepare to share with other teams. What do you like about your design? What modifications did you make? Why did it work?

Title: The Mystery Guest Arrival

Grade Level: 3rd

STEM Standards:



Science:

Interdependent Relationships in Ecosystems

3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all

Technology:

Standard 8: Students will develop an understanding of the attributes of design.

C. The design process is a purposeful method of planning practical salutation to problems.

D. Requirements for a design include such factors as the desired elements and features of a product or system of the limits that are placed on the design.

Standard 9: Students will develop and understand the engineering design.

C. The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.

D. When designing an object, it is important to be creative and consider all ideas.

E. Models are used to communicate and test design ideas and processes.

Standard 11: Students will develop abilities to apply the design process.

E. The process of designing involves presenting some possible solutions in visual form & then selecting the best solution(s) from many.

F. Test & evaluate the solutions for the design process.

G. Improve the design solutions.

Mathematics:

Measurement and Data Represent and interpret data

AR.Math.Content.3.MD.B.4 • Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch • Express the length of an object as a whole number of length units.

Essential Question: How can your group design and create the ultimate habitat that is suitable for anytime of organism to survive and thrive in?

Scenario: You are a wildlife animal rescuer, on (due date of the assignment) a new organism will arrive to your facility. However, the instruction form, containing all the information about the organism is missing. Your job is to design a habitat that will be suitable for anytime of organism (mainly ones depicted in *I See a Kookaburra!).*

Challenge: Construct a habitat that is adaptable for a variety of organisms.

Parameters:

- Habitat fits within a shoe box (12 x 7 x 4")-mini version of exhibit
  - Height- outside shoe box cannot exceed 6" from top of side
- The habitat design needs to be acceptable for the following organism:
  - Desert
  - Pond
  - Rainforest
  - Coast
  - Grassland
  - Wood forest
- Each group member will select a job
- Each group member will complete their own design journal
- All teams will complete the "team evaluation" sheet prior to submitting their complete habitat design
- On the last day, students will test their design by completing a survival evaluation activity sheet

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Tools, Materials, and Resources:

- Resources:
  - Graphic organizer
    - Contents from read-aloud
- Materials: (per group)
  - 1 Shoe box with lid
  - Reusable/recycled materials (material ideas)
    - Colored paper
    - Pipe cleaners
    - Pom-poms
    - 1 plastic bottle
    - 12" of tape
    - 18" of string
    - 4 rubber bands
- Tools:
  - Scissors
  - Glue stick
  - Rulers
  - Markers/crayons

- Writing tool (pen or pencil)

Teacher guidelines: After reading the literacy read aloud. As a class construct a graphic organizer that can be referred to often. The graphic organizer needs to contain the habitats (visual image/word list about the environment) and the list of organisms that are found in those habitats. The students will use the engineer design & scientific inquiry to design a habitat environment that is adaptable for a variety of organisms to live. Students will be divided into groups to utilize the engineering design loop to design the prefect habitat, and use the scientific inquiry to plan for deferent potential scenarios. Each group will random select an organism that was illustrated in the read-aloud to test their design (last day). A survival evaluation activity sheet needs to be create to accurately evaluated (test) the design layout of the habitat for the drawled organism.

Other: *I See a Kookaburra!* Steve Jenkins & Robin Page
This title introduces six different habitats--desert, pond, rainforest, coast, grassland, and forest--in clearly written descriptions and cut paper illustrations. The habitat's plants and wildlife hidden throughout, making this seek-and-find book not only great fun. Grade Level: k-4th

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STEM 4033
Scientific Inquiry: Curriculum Brief Assignment

Title: Hot Rod Collision

Grade Level: 4th

STEM Standards:
Science:

- 4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object. [Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.]

- 4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide. [Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.] [Assessment Boundary: Assessment does not include quantitative measurements of energy.]

Math:
AR.Math.Content.4.MD.A.2: Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale

Essential Question:
Students, after completing the STEM scientific inquiry challenge, should be able to understand that once the car was released at a height of ten centimeters and then again at a height of fifteen centimeters there is an increase in potential energy of the car and if so is there is also an increase in kinetic energy.

Scenario:
Imagine that you and some of your friends are exploring at the base of a cliff. While you are looking at the cliff wall, you hear one of your friends yell that rocks are falling. You look up to see your large friend Sam (a huge 180 pound boy) is directly beneath a large rock coming straight for his head. Only you or your best friend (who weighs exactly the same as you) are near enough to push Sam toward the base of the cliff and away from the falling rocks. Your friend is standing next to Sam and you are positioned slightly higher up so that you can run some downhill and shove Sam away from the approaching rocks. Who is more likely to move Sam farther away from the danger?

Challenge:
Students, as a class, will assemble a twenty foot track that is provided by the physics department from the University of Arkansas ensuring that the height of the track can be manipulated from ten centimeters to fifteen centimeters. Students, in groups of 2-3, will determine if an increase in the height of the track will increase the speed of a 10 gram car

and generate enough force to more a ten gram block of wood that is positioned ten feet from the top of the track. Students will after be determining if an increase in height of the track from ten centimeters to fifteen centimeters would increase the speed of the car in order to generate enough force to more a ten-gram bock of wood. Students will perform the actual experiment in their individual groups with the car at ten centimeters and then again at fifteen centimeters. The goal is to determine if the 10 gram block positioned at the ten foot mark moves farther down the track if the potential energy of the car is increased. Students in their groups will repeat this experiment five times (at the ten and fifteen centimeter levels) and record their information on the worksheet/ checklist provided.

Tools, Materials, and Resources:

Tools:	Materials:
Tape measure of 30 feet or greater length	(1)10 gram car for each group
	20 feet of track
	10 gram block of wood

Resources:

https://www.enwin.com/kids/electricity/types_of_energy.cfm

Kinetic Energy

Kinetic Energy is energy that is in motion. Moving water and wind are good examples of kinetic energy. Electricity is also kinetic energy because even though you can't see it happen, electricity involves electrons moving in *conductors*.

Potential Energy

Energy is measured in the amount of "work" it does. Potential Energy is stored energy. Examples of potential energy are oil sitting in a barrel, or water in a lake in the mountains. This energy is referred to as potential energy, because if it were released, it would do a lot of work.

Energy can change from one form to another. A good example is a Roller Coaster. When it is on its way up, it is using kinetic energy since the energy is in motion. When it reaches the top it has potential (or stored) energy. When it goes down the hill it is using kinetic energy again

Teacher guidelines:
Describe to the teacher how this STEM scientific inquiry lesson activity will be carried out, what lessons the students will be expected to discover, how these discoveries relate back to the standards, and how the teacher should introduce the variables that will cause the students to prepare for varying circumstances (i.e., *various sizes and masses of space debris in the example above*). Also, identify the parameters that the teacher should establish for the student teams to keep them going in the correct direction.

1. After setting up a track of twenty feet, with the head at ten centimeters, the students will release a ten gram car to descend and push a ten gram block of wood. The goal is to determine how far the block moves.
2. Next, the students will again release the ten gram car with the track head set at fifteen minutes to descend and push the ten gram block of wood. The goal is to determine how far the block moves.
3. The goal of this experiment is to determine if the increase of potential energy by raising the head of the track by five centimeters makes a difference if how far the block of wood moves.
4. The students will learn that an increase of height affects the speed of the car and increases its energy.
5. The students will strictly control the height of the head of the track and record the distance the ten gram block of wood set on the track moves. The students will record the distances the block moves, and the experiment will be repeated five times to assure them of the results.

Worksheet:

Name: ___________________________ Group Name: _______________________

Checklist:

20 feet of track	
10 gram car	
10 gram block of wood	
Block of wood is placed 10 feet from the top of the track	
Track is ten centimeters high	
Track is fifteen centimeters high	

Experiment #1:

(Ten centimeters high)

How high is the track?

How far did the car travel?

How far did the car push the ten gram block of wood?

(Fifteen centimeters high)

How high is the track?

How far did the car travel?

How far did the car push the ten gram block of wood?

Experiment #2:

(Ten centimeters high)

How high is the track?

How far did the car travel?

How far did the car push the ten gram block of wood?

(Fifteen centimeters high)

How high is the track?

How far did the car travel?

How far did the car push the ten gram block of wood?

Experiment #3:

(Ten centimeters high)

How high is the track?

How far did the car travel?

How far did the car push the ten gram block of wood?

(Fifteen centimeters high)

How high is the track?

How far did the car travel?

How far did the car push the ten gram block of wood?

Experiment# 4:

(Ten centimeters high)

How high is the track?

How far did the car travel?

How far did the car push the ten gram block of wood?

(Fifteen centimeters high)

How high is the track?

How far did the car travel?

How far did the car push the ten gram block of wood?

Experiment #5:

(Ten centimeters high)

How high is the track?

How far did the car travel?

How far did the car push the ten gram block of wood?

(Fifteen centimeters high)

How high is the track?

How far did the car travel?

How far did the car push the ten gram block of wood?

Title: *Baby Proof Latch*

Literacy Connection:
A way that the teacher could include literacy in this lesson is by reading an informational text about magnets to the class. The teacher could explain why informational texts are useful and helpful when you want to learn about something.

Grade Level: 3rd grade

STEM Standards:
Science-
3-PS2-4 Define a simple design problem that can be solved by applying scientific ideas about magnets.

Technology-
Standard 8: Students will develop an understanding of the attributes of design.
In order to comprehend the attributes of design, students should learn that:
3-5 Benchmarks
F. The design process is a purposeful method of planning practical solution to problems.
G. Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.

Standard 9: Students will develop an understanding of engineering design.
In order to comprehend engineering design, students should learn that:
3-5 Benchmarks
E. The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.
F. When designing an object, it is important to be creative and consider all ideas.
G. Models are used to communicate and test design ideas and processes.

Big Ideas:
- Magnets have varying strength.
- Magnets can attract and repel.
- Magnets only attract to objects made of iron.
- Using the design loop can help you solve a problem and create/design a solution.

Essential Question:
How do magnets interact with each other and with other objects?
How can magnets be used to help create useful devices?

Scenario:
My little cousin is one-year-old. He is at the age where he is trying to crawl around and get into everything. He is trying to open kitchen cabinets and drawers. I need you to create a

device that uses magnets to prevent my cousin from getting into the kitchen drawers and cabinets. The device should be easy for me to maneuver but prevents my cousin from getting into the cabinets.

Challenge:
Students will work in groups of three. Students will be given a variety of different items to see how those items interact with certain magnets. The students will record their findings in a table. Students will also be able to research different types of magnets and discover why certain magnets are stronger than others. Then, based on their research and observations, the students will a build a device that can be used to keep babies and toddlers out of kitchen cabinets and drawers.

Tools:
Scissors
Wire cutters
Hot glue gun

Materials (per group):
- Various sizes and types of magnets
- Tape (any type)
- 6 inch by 6 inch square piece of cardboard
- Paper
- Construction paper
- 3 paper clips
- 1 foot of wire
- 1 foot of string
- 3 rubber bands
- 1 paper plate
- 3 tongue depressors

Resources:
- computer
- books and article about magnets (provided by the teacher)

Content Information:
Magnets attract objects made with iron. Magnets have two poles, a north pole and a south pole. The opposite poles of magnets will attract, or pull toward each other. The like poles will repel, or push away. Magnets can pull through gases, like air, but some can also pull through solids and liquids. A magnetic field is the area around the magnet where it can attract or repel things. A magnet will affect a magnetic object only when it enters its magnetic field.
(from: https://jr.brainpop.com/science/forces/magnets/preview.weml)

Parameters/Constraints:

- Device must weigh no more than 35 grams
- Device must fit on the drawer and cabinet in the classroom used to test the devices.

Deliverables:

Students will turn in:

- Their group's device (one per group)
- An engineering design loop worksheet (one per student)
- Peer evaluation (one per student)
- Magnet table (one per student)

Teacher guidelines:

Students will be able to discover the different types of magnets and the different materials that are attracted to magnets. Students will have a better understanding of why magnets work the way they do. The teacher might need to facilitate some of the discovery about why magnets are only attracted to certain items. But the students need to make their own predictions and discoveries. The teacher will instruct the students that their device must fit on a cabinet door and a drawer (in the classroom or in a different room the in school).

Evaluation:

Students will be evaluated using the attached rubric. Groups will also present their device to the class and demonstrate how it works. Each group member will submit a peer evaluation (attached) about their group members which the teacher will look at before giving each student a grade.

Rubric

1) Device (10pts), peer evaluation (6pts), design loop journal (7pts), and magnet table (7pts) were submitted on time	________/30
2) Device demonstrated creative, thoughtful and intentional use of material to carry out design	________/15
3) Students in group clearly and effectively presented their project to the class	________/15
4) Device successfully used magnets to keep drawer and cabinet closed.	________/10
5) Students worked well together and respected each other.	________/10
6) Demonstrated understanding of learning: specifically magnets and design loop	________/20
	Total__________/100

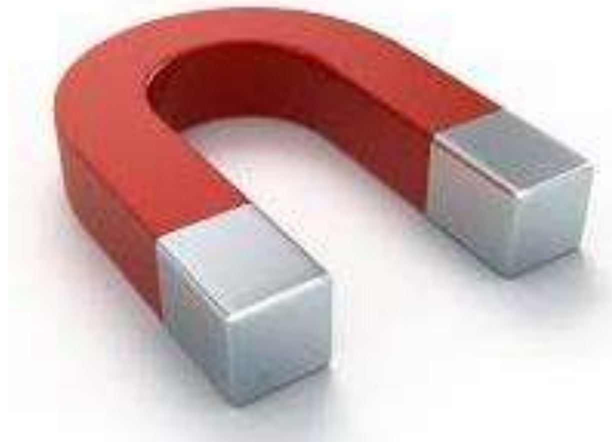
Peer Evaluation

Directions: Put a 3 in the box if your group did what the statements say on the left side. Put a 1 in the box if they did not do what the statement says. And put a 2 in the box if you are unsure if they did what the statement says.

	Group Member 1 name:	Group Member 2 name:	Your name
My group member helped create our device.			
My group member helped in the designing process of our device.			
My group member respected other people's ideas and listened to what they said.			

STUDENT GUIDE

Baby Proof
Latch Challenge



My little cousin is one-year-old. He is at the age where he is trying to crawl around and get into everything. He is trying to open kitchen cabinets and drawers. I need you to create a device that uses magnets to prevent my cousin from getting into the kitchen drawers and cabinets. The device should be easy for me to maneuver but prevents my cousin from getting into the cabinets.

Goal: In groups of three, design and create a device that can help me keep my baby cousin from getting into the kitchen cabinets and drawers.

Steps:

1. You have been given a variety of different items to see how those items interact with certain magnets. Record your findings in the attached table. You can research different types of magnets and discover why certain magnets are stronger than others. Then, based on your research and observations, you can build a device that can be used to keep babies and toddlers out of kitchen cabinets and drawers.
2. Use the Design Loop worksheet as a way to plan out your design/solution.
3. Take time to think of an idea on your own.
4. Then talk with your group about each person's idea.
5. Decide on one design/solution.
6. Gather materials.
7. Start building.

Once each group has built their device, the groups will present their latch devices to the class and demonstrate how it works. Then each group member will fill out a peer evaluation to turn in with the created product. Each group member will also turn in their design loop worksheet and their completed table.

Tools:
Scissors
Wire cutters
Hot glue gun

Materials (per group):

- Various sizes and types of magnets
- Tape (any type)

- 6 inch by 6 inch square piece of cardboard
- Paper
- Construction paper
- 3 paper clips
- 1 foot of wire
- 1 foot of string
- 3 rubber bands
- 1 paper plate
- 3 tongue depressors

Resources:
- computer
- books and articles about magnets (provided by the teacher)

Parameters/Constraints:
- Device must weigh no more than 35 grams
- Device must fit on the drawer and cabinet in the classroom used to test the devices.

Magnet Table

MAGNET USED	OBJECT TESTED	OBJECT MAGNETIC? YES OR NO? WHY?

What have you learned about magnets?

____

____

____.

Title: *It's Lit!*

Grade Level: 4th grade

STEM Standards:

- Arkansas Science Standard
  - 4-PS3-2 Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents
- Arkansas Math Framework
  - AR.Math.Content.4.NBT.A.3 Use place value understanding to round multi-digit whole numbers to any place
- Standards for Technological Literacy
  - Standard 3: Students will develop an understanding of the relationships among technologies and the connection between technology and other fields of study
    - B. Technologies are often combined
    - C. Various relationships exist between technology and other fields of study

Essential Question

Students will be able to understand that electric currents are used to produce light and that larger amounts of energy in an electric current is needed to produce more light.

Scenario

The scenario is, an estimated 79% of the world is without electricity in their homes. Students must construct a simple electric current that will be used with three different and increasingly large bulb sizes to be used in these homes to light them up.

Challenge

Students are required to conduct research on electric currents that will help them create a circuit that can light up 3 different light bulbs with 3 different watt amounts. Students will be given a set number of materials, which will be their parameters.

Tools, materials, and resources:

Students will be allowed access to computers for research.

- Tools include:
  - Wire stripper
  - Scissors
  - Wood cutters
  - Ruler

Materials include:

- 5 pennies
- 5 paper clips
- 2 red (positive) wires
- 2 black (negative) wires

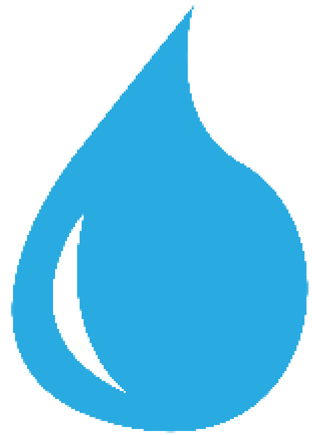
- 2 nails
- 2 12V batteries
- Large eraser
- Paper
- Pencils
- One miscellaneous item from the teacher (teacher's choice)

Teacher Guidelines

- Students can have minimal knowledge on electric currents (as little as simple understanding of a closed circuit and that positive and negative charges have to remain on opposite ends) before, and should be able to show you that they can create electric currents with increasing strengths using the materials given. Afterwards you would help them articulate how/why they were able to do this.
- Establish these parameters: 2 persons per team, only the materials given, must test their current on all three bulbs and be successful, must complete a drawing and class demonstration of what they made.

Title: Every Drop Counts

Grade Level: 5th grade



STEM Standards:

Science:

5-ESS2-2 Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

Technology and Engineering:

Standard 1: Students will develop an understanding of the characteristics and scope of technology.

> D. Tools, materials, and skills are used to make things and carry out tasks
>
> E. Creative thinking and economic and cultural influences shape technological development

Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology

> B. When using technology, results can be good or bad
>
> C. The use of technology can have unintended consequences

Standard 8: Students will develop an understanding of the attributes of design

> C. The design process is a purposeful method of planning practical solution to problems
>
> D. Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design

Standard 10: Students will develop an understanding of the role of troubleshooting, research, and development, invention and innovation, and experimentation in problem solving

> C. Troubleshooting is a way of finding out why sometimes does not work so that it can be fixed
>
> D. Invention and innovation are creative ways to turn ideas into real things
>
> E. The process of experimentation, which is common in science, can also be used to solve technological problems

Mathematics:

AR.Math.Content.5.MD.A.1

> Convert among different-sized standard measurement units within the metric system.

Essential Question:
How can we use common recycled materials to build a water filter to make water drinkable without a heat source?

Scenario:
You are a group of missionaries in a third world country digging wells for communities. But all of a sudden your group finds out that there was an unknown political process that is needed to build a well! The government is taking their sweet time with the documents, and the community needs fresh water. There is a clean water well that is a 10 mile hike from the small village, but there is a source of water within a mile of the village. There's only one problem, it isn't safe to drink. You and your group must design a filter from resources that you brought with you from home and are local to the village.

Challenge:
Design a *water filter* for an undrinkable water source so that it is drinkable. This filter must be able to filter three different levels of water cleanliness, as well as be lightweight and easily transportable. To achieve this challenge the students will need to research water filters and understand how they work. Then they will need to apply their research to a design that they create.

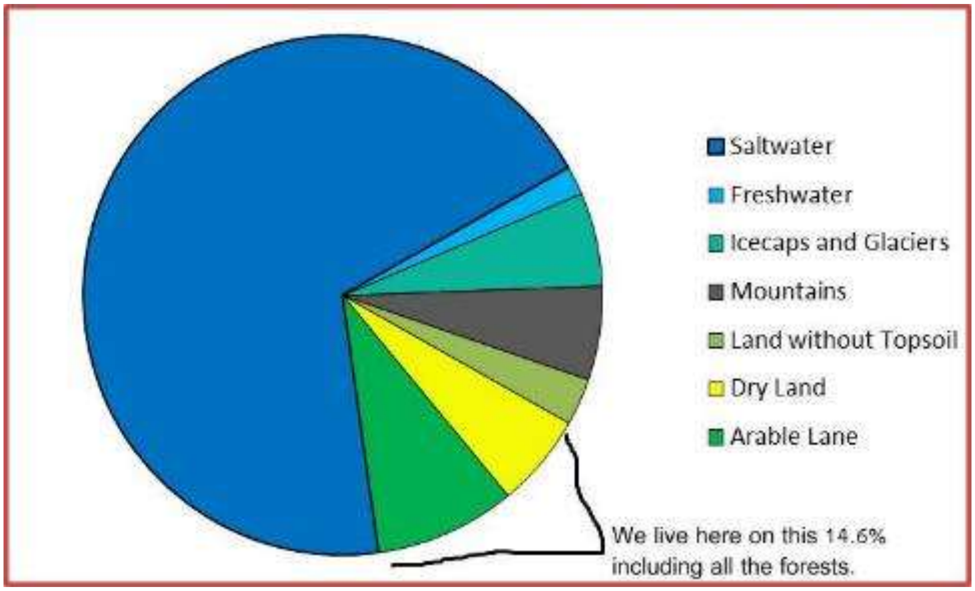
Tools, Materials, and Resources:
Per group of 3

Quantity	Description
1	16 oz. empty water bottle
1	1.9 Liters milk jug
1	4 oz. of fine sand
1	4 oz. of soil
1	4 oz. of pea sized gravel
1	4 oz. of marbles
1	4 oz. of larger sized rocks
1	1 paper towel square
1	1 scarf
1	½ meter of masking tape
1	Newspaper section (3 pages)
1	1 coffee filter

1	8 oz. of creek water
1	8 oz. of river water
1	8 oz. of pond water
1 set	Scissors, funnel, trowel, ruler, 1 set of water quality tests

Teacher guidelines:
Content
Prior to this lesson students will need to have a prior knowledge that not all water on the earth is drinkable, as well as have a firm understanding and know how to use the design loop for a problem.

Freshwater	Water we use in our everyday life (water fountains, water bottles)
Salt water	97% of the earth's water
Frozen	2% of the earth's water
Underground	0.7% of the earth's water
Surface	0.3% of the earth's water
How much of the earth's surface is covered in water?	70% of the earth's surface is covered in water
How much of that can we drink?	0.37% of the earth's surface water is drinkable



http://jbsfood4thought.com/water/

Procedures

Begin this lesson by discussing the different qualities of water and how different the different water sources found on and in the earth. After dividing the students into their groups pass out the design book where they will keep all of their ideas and their design processes. The students will then begin their design processes. They should be following the design loop that has been discussed. Once they have done their research and have created a detailed sketch on what they want to create, they should come to the teacher to get their supplies (listed above) in a tub. After receiving their tub of supplies they need to get to building and testing their design. When the prototypes have been built have the students test out their designs first on clean tap water to see if it does improve the quality of water. Then have the students test their designs on the lower qualities of water. After every group has designed and tested their prototypes, they will be given an additional 10 minutes to make minor adjustments before the final test. Each group will come up and draw out of a hat what location and water source that they will be getting their water from. After that, they will have 5 minutes to produce a decent quality of water that is drinkable, determined by the water quality test. (DO NOT DRINK THE WATER)

Parameters

The filter...

1. Must be shorter than half a meter
2. Must use at least 3 of the materials for the filter itself
3. Must produce clean water (remove visible contaminants)

The group…

1. Must fill out the participation rubric
2. Must complete the design journal

Title: *Super Siphon*

Grade Level: 5th

STEM Standards:

Science

Arkansas Science Frameworks
Strand 1: Characteristics and Processes of Science
NS.1.3.2 Develop questions that guide scientific inquiry
NS.1.3.3 Conduct scientific investigations individually and in teams:
- lab activities
- field studies

NS.1.3.8 Use simple equipment, age appropriate tools, technology, and mathematics in scientific investigations (e.g., balances, hand lenses, microscopes, rulers, thermometers, calculators, computers)

Technology and Engineering

Standards for Technological Literacy
Standard 1. Students will develop an understanding of the characteristics and scope of technology.
D. Tools, materials, and skills are used to make things and carry out tasks.

Standard 5. Students will develop an understanding of the effects of technology on the environment.
B. Waste must be appropriately recycled or disposed of to prevent unnecessary harm to the environment.
C. The use of technology affects the environment in good and bad ways.

Mathematics

Arkansas Mathematics Frameworks
Measurement and Data: Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses of objects.
AR.Math.Content.3.MD.A.2
- Measure and estimate liquid volumes and masses of objects using standard units such as: grams (g), kilograms (kg), liters (l), gallons (gal), quarts (qt.), pints (pt.), and cups (c)
- Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units (e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem)

Essential Questions:
Can you build a device that can siphon water out containers of varying height and into a container at ground level?

Scenario:
Three small, rural towns have been experiencing severe drought due to the depletion of natural resources caused by a certain bottled water manufacturer. In order to provide the towns with enough water to meet the residents' basic needs, local activists have devised a plan to create a device that can siphon water out of nearby elevated lakes and streams. The water will be siphoned into ground level reservoirs that will be purified and feed into each town's water supply.

Challenge:
Working in pairs, students will create a device that can siphon water out of an elevated source into a reservoir container. Because the elevation of these bodies of water will vary, the device must be able to successfully siphon water from varying heights of sources.

Tools, Materials, Resources:
- 10 straws
- 12-inch-long strip of duct tape
- Cardboard
- Paper plates
- Pipe cleaners
- Rubber bands
- 4 large plastic Tupperware containers
- Several thick books, to be used as elevation

Teacher Guidelines:

Procedures:
The teacher will present to students the scenario and challenge. With the given materials and working in pairs, students will have one class period to experiment with how a siphon works and to brainstorm ideas. The device must be able to siphon water out of a container that is sitting on a height of six books, four books, and two books, and into the empty container at ground level (the table). Students will be asked to record their observations, notes, and plans in their science notebooks. They will also be asked to record approximately what percentage of water from the elevated container was siphoned into the ground container in one try, draw pictures, and label to clarify. The next class period, the teacher will instruct the students to focus on building, finishing, and testing their siphoning devices. On the third class period, the students will present their device and will be asked to demonstrate how their device siphons water from the elevated container to the ground level container. Students will also be asked to share what they learned through inquiry about siphons.

Discovery:
Students will be expected to discover how a siphon works. Depending on the students' background knowledge on the topic, the teacher may need to present a short mini-lesson on the mechanics of a siphon before the inquiry activity begins. Students will be expected to learn that the height of the container of water will impact how strong the flow of the siphon is. They will also be expected to discover the most effective way of starting a siphon.

Content:

Science
Students will use scientific inquiry to build a device that will siphon water from varying heights. During the process, they will record their findings in their science journals and discover factors that affect a siphon's flow of water.

Technology and Engineering
Students will need to use tools and materials to create their siphon (a simple machine). This includes scissors, rulers, and tape.

Mathematics
Students will estimate the volume of water that was successfully siphoned into the ground level container in each try. They will draw pictures and label the volumes in their science journals.

Parameters
Students will be given limited materials, and will also be given a time restraint of three class periods. The variables are also constraining, because the procedures specify the three heights that the siphoning device must work from.

We Need Clean Water

Grade Level	4th grade
Standards	Arkansas Science Standards ESS.8.4.3 Evaluate the impact of water pollution NS.1.4.5 Communicate the designs, procedures, and results of scientific investigations Standards for Technological Literacy Standard 19 Students will develop an understanding of and can select and use manufacturing technologies
Essential Question	How can I create an economically efficient water filtration system?
Scenario	I work for the Great Water Supply Company, and I need to hire a team that comes up with the most economically efficient water filtration system. With the ongoing drought, not enough water has been available for our town's needs. I want to hire a team that develops a water filtration system that cleans water polluted by soil, sand, or oil.
Challenge	In teams of three, students create an economically effective water filtration system. The filtration system must be able to adapt to different levels of polluted water, while staying within their budget.
Resources	Plastic container (three per group) Spout Cardboard Empty liter bottles Tape Scissors Dirty water (1 gallon of: water/oil; water/sand; water/soil) Measuring cups Gravel rocks Cotton balls Coffee Filters Marbles 5 sq inch fabric squares Any other potential filtration items Money Worksheet

Preparation	• Have all materials (except water, scissors, and tape) on display • Label all materials with prices (found on worksheet)
Teacher guidelines	1. Split students up into groups of 3. 2. Hand out Money worksheet 3. Explain to students that they have $10 for their budget. With that imaginary money, they must buy the materials that they intend on using for their filtration system. 4. Students will record on their Money Worksheet what and how much they buy. 5. Explain to students that they can use any of the materials on the display table to create a filtration system. 6. Their system must be adaptable to filter the three different types of water: water/oil, water/sand, or water/soil 7. Once students have created their filtration systems, test each type of water separately. (1/2 of cup of each sample) 8. Have students lead a discussion about whether they think that their filtration system was effective and what they could have done differently. 9. Finally, choose a "hired" team. Have each team state how much they "spent" on their filtration system. 10. Choose the three with the lowest cost and compare their filtered water. 11. As a class, vote on which of the three should be hired.
Conclusion	To finish lesson, discuss with students the impact of water pollution. Ask students if they would drink the water before it was filtered? What about after? Point out to students that clean water is needed for many of society's needs. (Students can popcorn potential needs of clean water)
Potential Economic Connection	Relate to students that not all societies have the means to produce clean water. Ask students to consider if they had only been given $5.00. Would their filtration system had turned out the same? In other countries, clean water is scarce. They may not have the money, resources, etc. to filter their water.

Money Worksheet			
Materials	**Price**	**Amount**	**What You Paid**
Spout	$2.00		
Cardboard	$0.75		
Liter Bottle	$2.00		
Gravel Rocks	$1.00/ ½ cup		
Cotton Balls	$0.05		
Coffee Filters	$2.00		
Marbles	$2.00/ ½ cup		
Fabric squares	$2.00		
Additional Materials			
Total			
Remaining Balance (subtract Total from $10.00)			

Title: *Solar Cooker*

Grade Level: 4th Grade

STEM Standards:

Science Standards

- 4-PS-3-1 Energy can be transferred between objects.
- 4-PS3-2 Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents
- 4-PS3-3 Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Standards for Technological Literacy:

- Standard 10: Students will develop understanding for role of troubleshooting, research and development invention and innovation and experimentation in problem solving.
- Standard 11: Students will develop the abilities to apply the design process.

Essential Question:

Using the materials and tools provided, how can you build a solar powered marshmallow roaster that make your marshmallow burnt without fire?

Scenario:

This is a perfect season for bonfire! The perfect match of bonfire is s'more!! However, today we will use some simple materials and tools to make a marshmallow roaster which can burn our marshmallow under the sunshine! Now you're cooking!

Challenge:

Students are required to create a solar cooker which is a solar powered marshmallow roaster that make marshmallow burn under the sunshine.

Tools & Materials:

Materials:	Tools:
Cardboards	Glue
Aluminum foil	Tape
Marshmallows	scissor
Bamboo skewers	A page magnifier

Teacher Guidelines:

- A page magnifier, also known as a Fresnel lens. This is a piece of plastic almost the size of a notebook page that is used to magnify a page of a book to make it easier to read.
- Step 1: Use cardboards to make a roster box with tape.
  (The actual size will depend on the focal length of the magnifier. Guide students to adjust the size of their box.)
  http://hyperphysics.phy-astr.gsu.edu/hbase/geoopt/foclen.html
- Step 2: Tape the page magnifier inside of the box.
  (The lens has a smooth side and a grooved side. The grooved side should be facing out, away from the inside of the box.)
- Step 3: Glue aluminum foil to the inside of the box, on all sides except the side that has the lens.
  (Aluminum foil can reflect light so it protects the cardboard box not be burned.)
- Step 4: Cut two holes in the box that can get the marshmallows inside of the box and hang in with bamboo skewers.
- Test students' device at noon which is the strongest sunshine time in a day.

Technical Procedural

Racer Activity

Teacher Copy

Grade: 3

STEM Content Standards:

- **Science:** Forces and Interactions: 3-PS2-2 Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
- **Mathematics:** AR.Math.Content.3.MD.B.4- Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch
- **Technology:**

Big Ideas:

- Build a rubber band racer
- Construction Design
- Recognizing how adding weight can affect speed
- Teamwork

Essential Question:

How does weight affect the speed of the rubber band racer?

Scenario:

Jim works for FedEx and he is traveling across the United States to deliver heavy items. He is trying to figure out how much weight his truck can hold and still move fast enough so he can get to his destination on time.

Challenge:

After being introduced to the rubber band racer and all the parts that make up the racer, students will work together in pairs to build a car that is powered by rubber bands. Students will experiment with weight and see what affect it has on the speed of the rubber band racer.

Materials/Tools:

- 4 Skinny Rubber Bands
- **2** 12in Dowel Rods
- 4 connector strips
- 2 Hole plates
- 4 wheels
- 6 rubber bands
- 2 stop clips
- ___ stop cuts

- Dowel cutter
- Reamer
- String
- Washers

Content Information:

Introduce the rubber band racers to the class. Using the parts and a couple of rubber bands, demonstrate to your students how pulling the rubber band back as far as it will go will make the car go farther, faster. Explain that the higher number of times the rubber band is wrapped around, the farther distance it will be able to go. Let your students know it is okay for their cars to look different than their classmates because we all think differently!

Deliverables:

Each student will work in pairs to build a rubber band powered car to determine how the weight of the car effects the speed. Each pair of students will have one hour to work together to build their rubber band powered car and experiment with weight to determine how it effects the speed of the car. After the hour is over, each pair will bring their car to the front and explain the problem and demonstrate their findings. Each car will need to start the front of their car at the designated starting point, and will time (using a stopwatch) how long it takes for it to go 5 feet. Students will complete three different trials with a variations of weight that they choose that are increments of two. After each pair has looked at their trials, the class will look at their results to determine how the weight effects the speed of the car.

Parameters:

Your pair's car must:

- Be made of only the given materials
- Be made by only using the given tools
- Be powered by a rubber band

Evaluation:

After all of the pairs have presented their cars, students will complete a worksheet with assignment observations and follow up questions on it.

STEP-BY-STEP BUILD

1. Cut four (4in) pieces from the dowels
2. Cut four (6in) pieces from the dowels
3. Cut one (4 ½ in) piece from the dowels
4. Insert the four pieces of (4in) dowels in the corners of the hole plates to make the sides of the car
5. Insert one 6in dowel in the rear of the car, 3 holes from the back
6. Attach a wheel to each of the side of the dowel rod
7. Insert another 6in dowel rod 3 holes form the front on the bottom row
8. Attach one connecter strip on each side of the car horizontally 11 holes from the front
9. Attach stoppers on the outside of the center dowel rod on the outer side of the connecter strip
10. Ream out one hole on each connecter strip 5 holes from the front of the car
11. Insert another 6 in dowel rod through the holes from one side to another
12. Place a stopper on the outside of each front dowel rod
13. Attach wheels to each side of the dowel rod
14. On the very front of the connecter strips attach a 4 ½ in dowel road
15. Place rubber bands around each of the wheels to add more friction
16. On the back bottom 6 in dowel road attach two stop clips
17. Diagonal from that dowel rod, attach two rubber bands to the top right dowel rod
18. Loop one more rubber band connecting two rubber bands together linking them to the stop clips
19. Attach two connector strips parallel to each on vertically to the hole plates, one on each side
20. At the bottom of the connector strips insert a dowel rod all the way through one side to the other
21. Further up the connector strips insert another dowel rod through one side to the other connector strip
22. At the very top of the connector strip insert another dowel one from one connector strip to the other

23. Attach string to the top dowel rod and this is how you will add weight with your washers

24.. Pull your car backwards as far as it goes and let go, the car should spring forward

Racer Activity

Student copy

Essential Question:

How does weight effect the speed of the rubber band racer?

Scenario:

Jim works for FedEx and he is traveling across the United States to deliver heavy items. He is trying to figure out how much weight his truck can hold and still move fast enough so he can get to his destination on time.

Challenge:

After being introduced to the rubber band racer and all the parts that make up the racer, students will work together in pairs to build a car that is powered by rubber bands. Students will experiment with weight and see what affect it has on the speed of the rubber band racer.

Materials/Tools per Group:

- 4 Skinny Rubber Bands
- **2** 12in Dowel Rods
- 4 connector strips
- 2 Hole plates
- 4 wheels
- 6 rubber bands
- 2 stop clips
- ___ stop cuts
- Dowel cutter
- Reamer
- String
- Washers

Content Information:

How does weight effect force and motion?

STEP-BY-STEP BUILD:

1. Cut four (4in) pieces from the dowels
2. Cut four (6in) pieces from the dowels
3. Cut one (4 ½ in) piece from the dowels

4. Insert the four pieces of (4in) dowels in the corners of the hole plates to make the sides of the car

5. Insert one 6in dowel in the rear of the car, 3 holes from the back

6. Attach a wheel to each of the side of the dowel rod

7. Insert another 6in dowel rod 3 holes form the front on the bottom row

8. Attach one connecter strip on each side of the car horizontally 11 holes from the front

9. Attach stoppers on the outside of the center dowel rod on the outer side of the connecter strip

10. Ream out one hole on each connecter strip 5 holes from the front of the car

11. Insert another 6 in dowel rod through the holes from one side to another

12. Place a stopper on the outside of each front dowel rod

13. Attach wheels to each side of the dowel rod

14. On the very front of the connecter strips attach a 4 ½ in dowel road

15. Place rubber bands around each of the wheels to add more friction

16. On the back bottom 6 in dowel road attach two stop clips

17. Diagonal from that dowel rod, attach two rubber bands to the top right dowel rod

18. Loop one more rubber band connecting two rubber bands together linking them to the stop clips

19. Attach two connector strips parallel to each on vertically to the hole plates, one on each side

20. At the bottom of the connector strips insert a dowel rod all the way through one side to the other

21. Further up the connector strips insert another dowel rod through one side to the other connector strip

22. At the very top of the connector strip insert another dowel one from one connector strip to the other

23. Attach string to the top dowel rod and this is how you will add weight with your washers

24.. Pull your car backwards as far as it goes and let go, the car should spring forward

NAMES: ____

Trial 1:	**Trial 2:**	**Trial 3:**
# of Washers: Time:	# of Washers: Time:	# of Washers: Time:

Question 1: After completing all three trials, explain how you believe weight effects the speed of the rubber band powered car.

____
____
____

Evaluation

Grading Rubric

Student participates with other group member (0-25pts):__________

Student completes handout (0-25pts):__________

Student demonstrates knowledge of force and motion (0-25pts):__________

Student completes the building of their car (0-25pts):_______

Ms. Frizzle's Race to the Finish

TEACHER COPY

Unit: STEM Transportation Technologies
Grade Level: 3rd

STEM Content Standards:

Math**:**
Arkansas Mathematics Framework: AR.Math.Content.3.MD.B.4

- Generate measurement data by measuring lengths and using rulers marked with halves and fourths of an inch.

Technology and Engineering**:**
Standards for Technological Literacy: Standard 2. Students will develop an understanding of the ore concepts of technology

- Benchmark B. Systems have parts or components that work together to accomplish a goal

Standards for technological Literacy: Standard 18. Students will develop an understanding of and be able to select and use transportation technologies.

- Benchmark B. Vehicles move people or goods from one place to another in water, air or space, and on land.
- Benchmark E. A transportation system may lose efficiency or rail if one part is missing or malfunctioning or if a subsystem is not working.

Science**:**
Arkansas Science Framework: NS.1.3.4

- Communicate the results of *scientific investigations* (e.g., age- appropriate graphs, charts, and writings)

Big Ideas:

- Understanding how to follow step-by-step instructions
- Understanding the benefits of experimenting
- Understanding the concept of energy
- Understanding the concept of measurement in ½ and ¼ increments

Essential Question:
Will a rubber band powered car go further at a taller or shorter height ramp?

Scenario:
Ms. Frizzle's class has challenged another school to a magic school bus race and they need your help! They have already decided that they are going to have three different races on ramps at different heights, just to make sure the race is fair. The problem is, they are having trouble deciding on where to put the finish line! The finish line needs to be hard to reach, but still possible.

Challenge:
After discussing concepts of energy and measurement with the class, students will follow the written procedure to create a rubber band powered car with a partner. After a rubber band powered car is successfully constructed, students will conduct a series of experiments to determine at which length on the ramp, a finish line should be placed. This finish line should mark a spot that is the furthest the car will go consistently. Students will demonstrate their knowledge of measurement and energy by recording their observations on the worksheet provided. Following the experiment, students will record their observations and what they have learned in their science journal. At the end, the students will have a discussion and decide, as a class, where to place the finish lines for each ramp height. They will discuss the differences between the ramp heights and lengths as well as how the new vocabulary they learned applied to the experiment.

Parameters:
The students must follow the directions to build their rubber band car. They may not use any non-teacher Geek materials, or tools not listed in the materials and tools section. Students must follow all directions exactly.

Content:
The instructor will introduce to the class the two different types of energy: potential and kinetic. The following video describes the two energies very well through giving examples and visuals of kinetic and potential energies.
(https://www.youtube.com/watch?v=ASZv3tIK56k). Students will discuss the vocabulary introduced in the video. Students will also review concepts of measurement in ½ and ¼ increments. The instructor will next introduce the assignment and divide students into pairs to begin working on the assignment.

Vocabulary:
Energy: the strength required to sustain physical or mental activity
Potential Energy: energy that is stored in an object
Kinetic Energy: energy that an object has when in motion
Transportation: the action of transporting someone or something somewhere

Deliverables:
Students will turn in the following at the completion of the assignment:

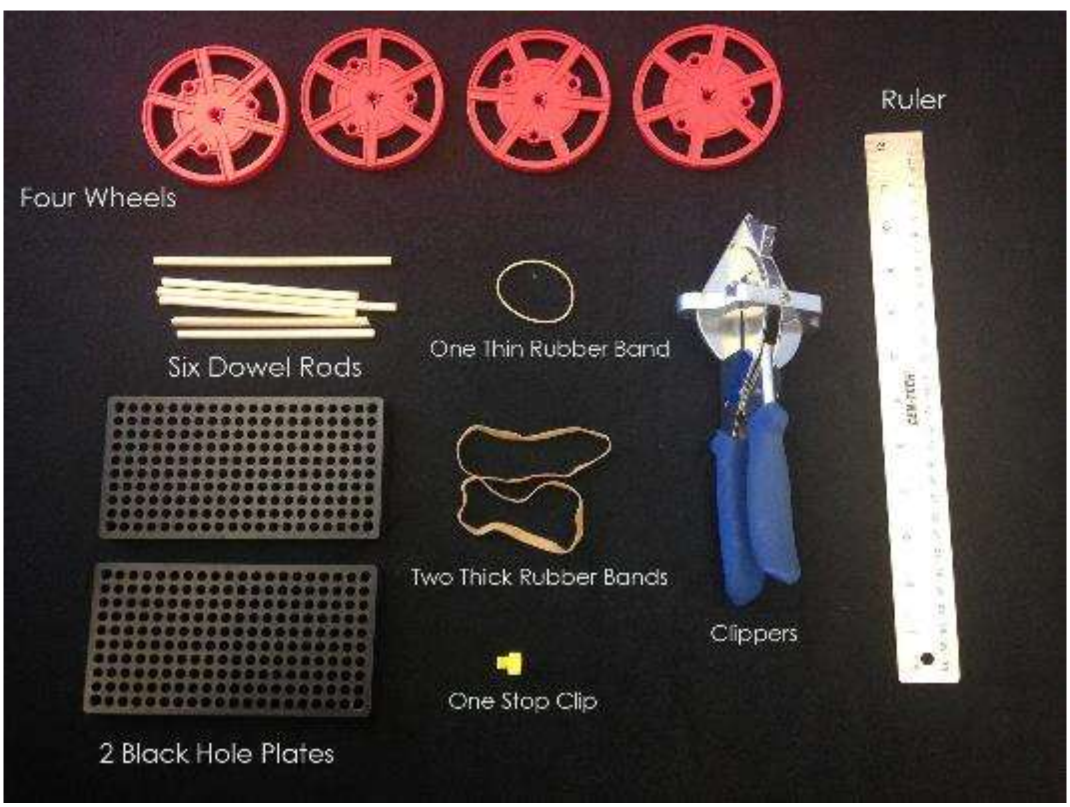
- Science Journal Entry and Results Chart
- Content Questions

Materials:

- 2 black hole plates
- 6 dowel rods
- 4 wheels
- 1 stop clip
- 1 thin rubber band
- 2 thick rubber bands

Tools:

- Clippers
- Ruler



Materials for Testing:

- Ramp
- Measuring Tape
- Masking Tape
- Data table for students to record results

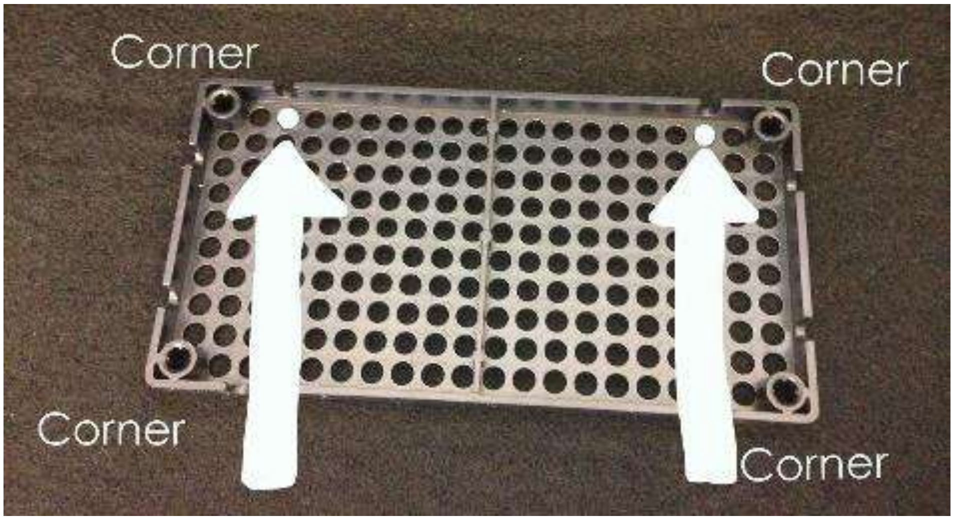
Student Directions:

1. Cut 4 dowel rods to 4 ½ inches
2. Cut 2 dowel rods to 5 ½ inches
3. Place thick rubber bands around the edges of two of the wheels

4. Attach 4 ½ inch dowel rods into the corners of 1 black hole plate
5. Attach the remaining black hole plate to the other ends of the 4 ½ inch dowel rods

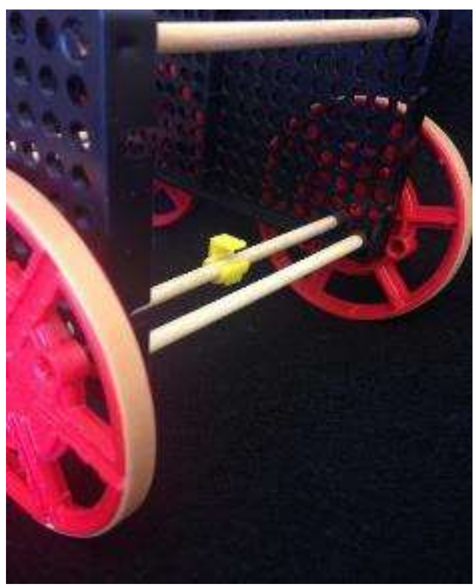
6. Attach a wheel to 5 ½ inch dowel rod to start creating an axle

7. Push the axle you are making through the second hole from the corner of the black hole plate



8. Attach second wheel to the end of the 5 ½ inch dowel rod and complete the axle

9. Repeat steps 5-8 with the remaining 5 ½ dowel rod and wheels to create the second axle

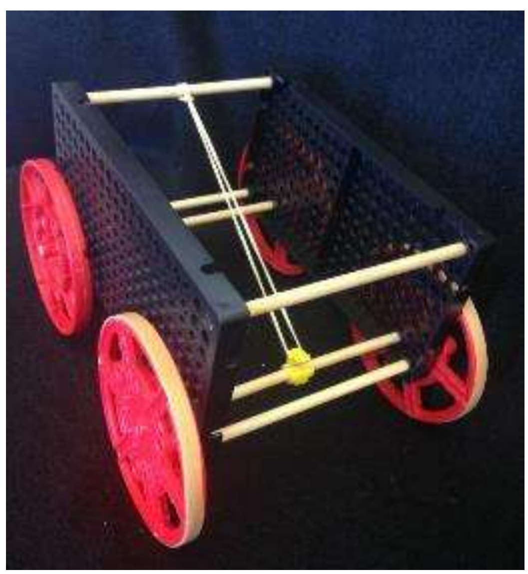


10. Attach stop clip on the 4 ½ inch dowel rod with the rubber banded wheels. Make sure the stop clip is facing the back of the car.

11. Attach the rubber band to the top of the 4 ½ inch dowel rod on the front of the car. (This is the side without the rubber banded wheels.)

   a. To tie the rubber band, first, set rubber band underneath the dowel rod.
   b. Then, pull the end of the rubber band through the loop of the other side of the rubber band.
   c. Pull tight!

12. Pull the rubber band and hook it on the stop clip.



Experiment Procedure:
Set up a ramp that can be adjusted to different heights. Tape down the measuring tape along the edges of the track for students to measure the distance their cars roll. Designate a starting point with masking tape for students to wind their car up from by rolling it backwards to the top of the ramp.

1. Set ramp to 5 ½ inches tall
2. Place car at the masking tape start up line and wind up the car by pulling it backwards until it reaches the top of the ramp.
3. Release the car and watch it roll down the ramp. DO NOT move the car when it stops rolling
4. Measure the distance the car rolled with the measuring tape. (If needed, round measurement to the nearest ¼ inch)
5. Record results on the worksheet
6. Repeat steps 1-5 at ramp measurements of 12 inches, 17 ½ inches, and 24 inches.

Evaluation:
Students will be evaluated on:

- Completion of the rubber band powered car
- Completion of the student worksheet
- Completion of the journal entry
- Teamwork with their partner

These evaluation components will be graded by the use of the following **rubric**:

Completion of Rubber Band Powered Car *(Evaluated by teacher when students begin experimenting)*

- Students followed written directions in creating the car
- The rubber band powered car is completed correctly

____ /20

Group Work *(evaluated by teacher observation and student "grading sheet")*

- Both partners participated
- Work distributed evenly
- Worked well with others when taking data

____ /20

Understanding of Energy *(Evaluated by teacher through journal entry and student worksheet)*

- Able to define the energies in their own words
- Understand how the energies work and their importance

____ /15

Understanding of Measurement *(Evaluated by teacher through observation during experimentation and student worksheet)*

- Able to accurately measure in ½ and ¼ increments

_____ */15*

Completion of Deliverables

- All handouts are completed with name on it and turned in
- Journal entry is completed

_____ /30

Total ____ / 100

Ms. Frizzle's Race to the Finish

Student Copy

Essential Question:

Will a rubber band powered car go further at a taller or shorter height ramp?

Scenario:

Ms. Frizzle's class has challenged another school to a magic school bus race and they need your help! They have already decided that they are going to have three different races on ramps at different heights, just to make sure the race is fair. The problem is, they are having trouble deciding on where to put the finish line! The finish line needs to be hard to reach, but still possible.

Challenge:

You will decide, for each ramp height, where the finish line should be so that it is difficult but still reachable. After discussing with the class concepts of energy and measurement, you will follow the written procedure to create a rubber band powered car with a partner to represent the magic school bus. After your rubber band powered car is successfully constructed, you will conduct a series of experiments to determine, at each height, where to put the finish line for the race. You will demonstrate your knowledge of measurement and energy by recording your observations on the worksheet provided. Following the experiment, you will record their observations and what they have learned in their science journal. At the end of the experiment, we will have a discussion where we share results and decide where to place the finish lines for each ramp height. We will discuss the differences between the ramp heights and lengths as well as how the new vocabulary we learned applies to the experiment.

Parameters:

You must follow the written directions to build your rubber band car. You may not use any non-teacher Geek materials, or tools not listed in the materials and tools section. You must follow all directions exactly as they are written!

Vocabulary:

- Energy: the strength required to sustain physical or mental activity
- Potential Energy: energy that is stored in an object
- Kinetic Energy: energy that an object has when in motion
- Transportation: the action of transporting someone or something somewhere

What do I turn in at the end?

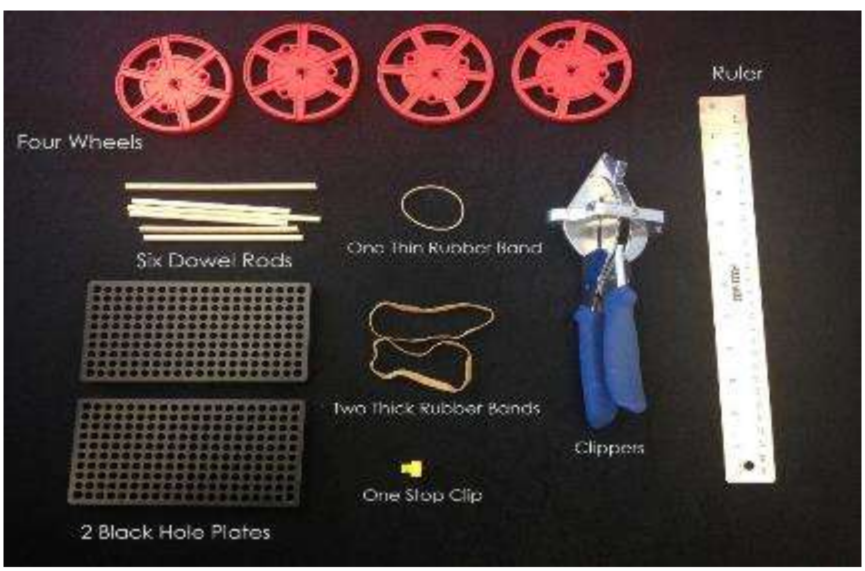
- Science Journal Entry and Experiment Results Sheet
- Content Questions Worksheet

Materials:

- 2 black hole plates
- 6 dowel rods
- 4 wheels
- 1 stop clip
- 1 thin rubber band
- 2 thick rubber bands

Tools:

- Clippers
- Ruler



Materials for Testing:

- Ramp
- Measuring Tape
- Masking Tape
- Data table for students to record results

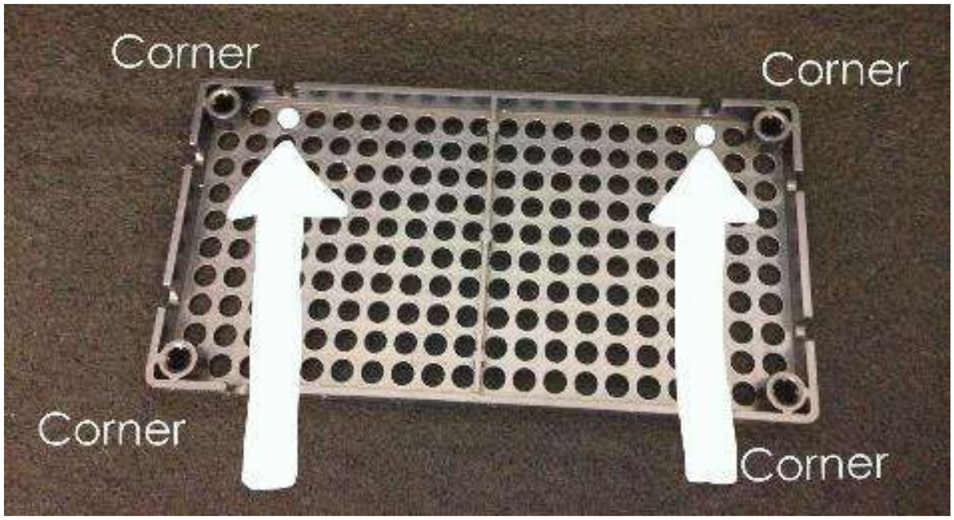
Student Directions:

13. Cut 4 dowel rods to 4 ½ inches
14. Cut 2 dowel rods to 5 ½ inches
15. Place thick rubber bands around the edges of two of the wheels

16. Attach 4 ½ inch dowel rods into the corners of 1 black hole plate
17. Attach the remaining black hole plate to the other ends of the 4 ½ inch dowel rods

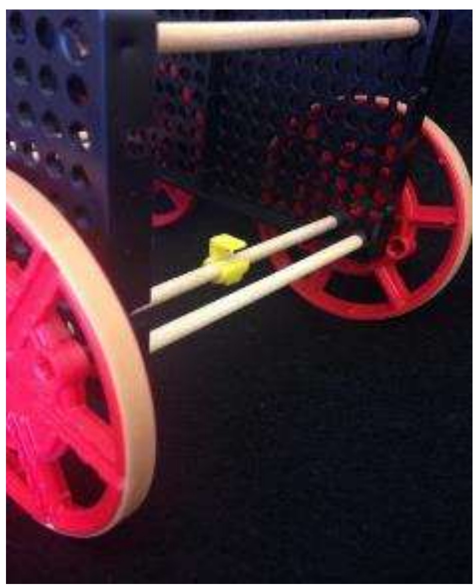
18. Attach a wheel to 5 ½ inch dowel rod to start creating an axle

19. Push the axle you are making through the second hole from the corner of the black hole plate



20. Attach second wheel to the end of the 5 ½ inch dowel rod and complete the axle

21. Repeat steps 5-8 with the remaining 5 ½ dowel rod and wheels to create the second axle



22. Attach stop clip on the 4 ½ inch dowel rod with the rubber banded wheels. Make sure the stop clip is facing the back of the car.

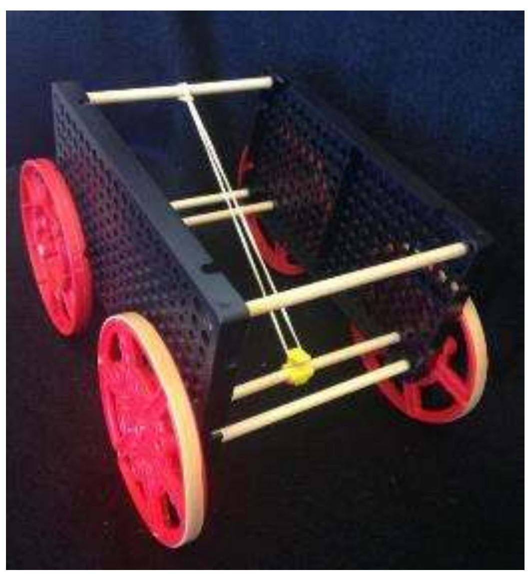
23. Attach the rubber band to the top of the 4 ½ inch dowel rod on the front of the car. (This is the side without the rubber banded wheels.)

a. To tie the rubber band, first, set rubber band underneath the dowel rod.

b. Then, pull the end of the rubber band through the loop of the other side of the rubber band.

c. Pull tight!

24. Pull the rubber band and hook it on the stop clip.



Experiment Procedure:

1. Set ramp to 5 ½ inches tall
2. Place car at the masking tape start up line and wind up the car by pulling it backwards until it reaches the top of the ramp.
3. Release the car and watch it roll down the ramp. DO NOT move the car when it stops rolling
4. Measure the distance the car rolled with the measuring tape. (If needed, round measurement to the nearest ¼ inch)
5. Record results on the data sheet
6. Repeat steps 1-5 at ramp measurements of 12 inches, 17 ½ inches, and 24 inches.

<u>Experiment Results Sheet</u>

Ramp Height	Car Distance	Finish Line Location
5 ½ inches		
12 inches		
17 inches		
24 inches		

<u>Scientific Journal Entry</u>

Consider answering these questions. Use your new vocabulary!

1. What challenges did you have in your experiment?
2. Did you recognize any of the concepts we talked about in the experiment? How?
3. Did you notice any patterns with how far your car went at different ramp heights?

Content Questions

1. How was potential energy used in the experiment?

2. How was kinetic energy used in this experiment?

3. Write your own definition for potential energy.

4. Write your own definition for kinetic energy.

5. What troubles did your group have in constructing your car? Why?

6. What gave your car the potential energy to go?

Title: *Rubber Band Racer*

Grade Level: 3rd

Standards:

Science:

3-PS2-2 Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. PS2.A: Forces and Motion Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) (3-PS2-1)

Math:

AR.Math.Content.3.MD.B.4 Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch

Technology:

Standard 12: Students will develop the abilities to use and maintain technological products and systems. Follow step-by-step directions to assemble a product.

Materials:

- 2 Hole plates
- 4 wheel hubs
- 2 connector strips
- 1 3in slide stop (cut into ¼ in.)
- 4 stretch tire
- 2 rubber bands
- 1 stop clip
- 4 12in dowel (use cutters to create 5 4in. and 4 5in.)
- tape
- cardboard
- 4 golf balls

Tools:

- 1 reamer
- 1 cutter
- Measuring tape

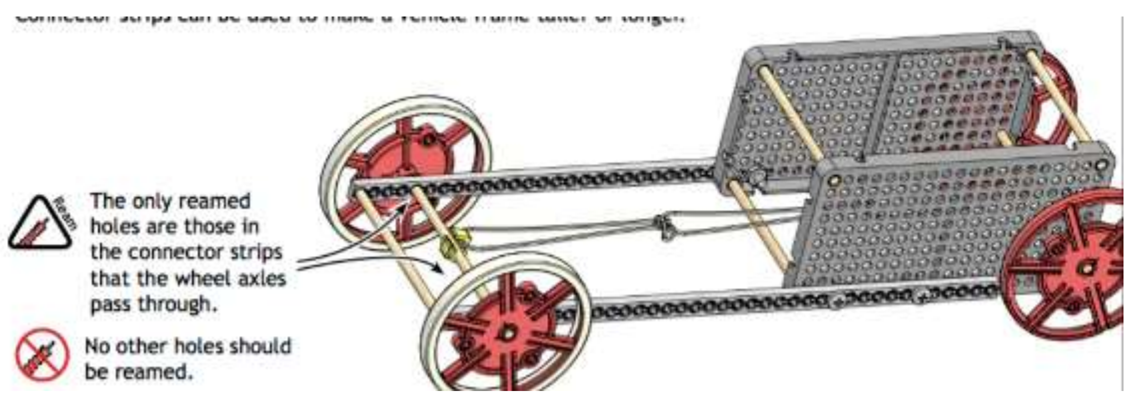
Assembly Directions:

1. Insert the 4 4in dowels into the 4 outside corners of the two hole plates (w/ bottom sides facing)
2. Insert the 2 5in dowels into the wheels. The dowels become axels
3. Place the wheel and axel through the frame
4. Place 1 side stop on the outside of each wheel
5. Let it roll

____________________ **(^^This is the basic racer design^^)**________________________

Additional Assembly Directions for Frame Extension

1. Remove the front wheels and axels, and set aside
2. Align the connector strips with the bottom row of holes on the hole plates, go in 10 holes
3. From the wheel go over three holes, ream the connector strip hole and insert a 5in dowel rod, put a yellow stopper on
4. From that dowel rod go over six holes and ream the connector hole and insert a 5in dowel rod, put a yellow stopper on the end
5. From the front of the connector strip count 2 holes back and insert a 4in dowel rod
6. From that dowel rod count 3 holes back and insert the 5in dowel rod with the wheels attached
7. On the back axel place a stop clip
8. Tie 2 rubber bands together and tie on the top 4in dowel on the hole plate structure
9. Place a stretch tire around each wheel
10. Tape a piece of cardboard on top of plates, w/a plastic cup to hold the balls
11. Wind the rubber band and let it roll

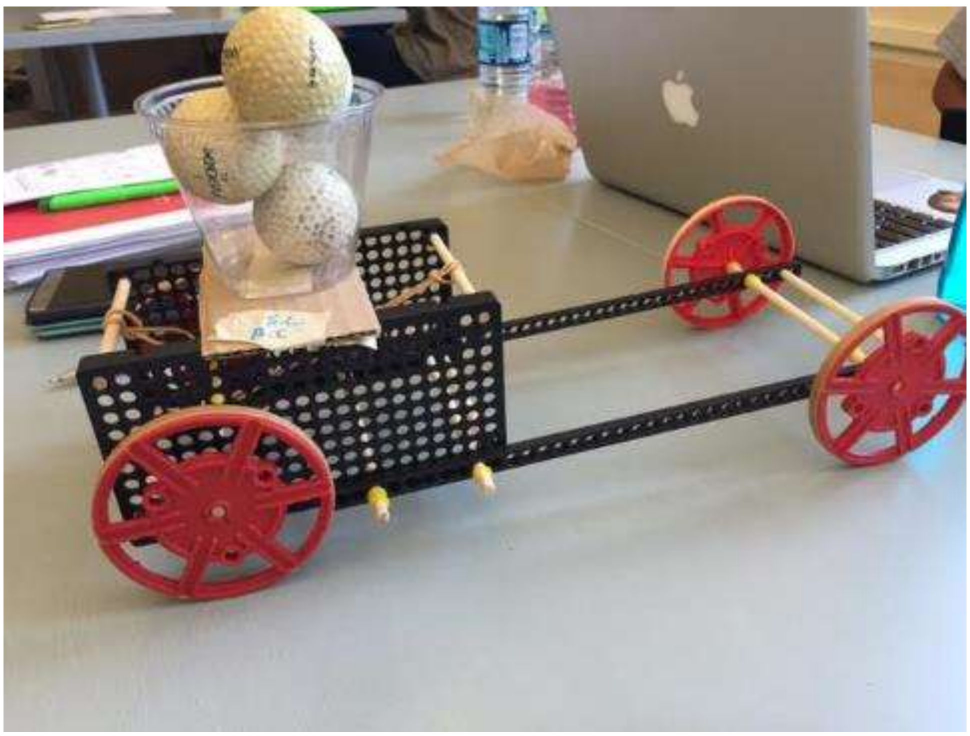


Challenge/Assessment of Racer

- Using different amounts of golf balls (testing weight), and placing the weight with the racer, determine the distance the racer travels with the different weights.

Check to see if they fill out their weight and distance table on their packet.

- The students need to start from a starting point and start with no golf ball in the cup, wind the rubber band and see how far the car travels. Repeat the same steps with 1, 2, 3, and 4 golf balls. They will be measuring the distance using whole, half and one-quarter measurements



Curriculum Development Rubber Band Racer

Student Copy

Name____________________

Challenge:

Using the materials and tools listed below follow the technical/procedural assembly directions to build a rubber band racer. After the racer is built test the distance the racer travels with different weight using golf balls. Record your observations in the table provided.

Materials:

- 2 Hole plates
- 4 wheel hubs
- 2 connector strips
- 1 3in slide stop (cut into ¼ in.)
- 4 stretch tire
- 2 rubber bands
- 1 stop clip
- 4 12in dowel (use cutters to create 5 4in. and 4 5in.)
- plastic cup
- tape
- cardboard
- 4 golf balls

Tools:

- 1 reamer
- 1 cutter
- measuring tape

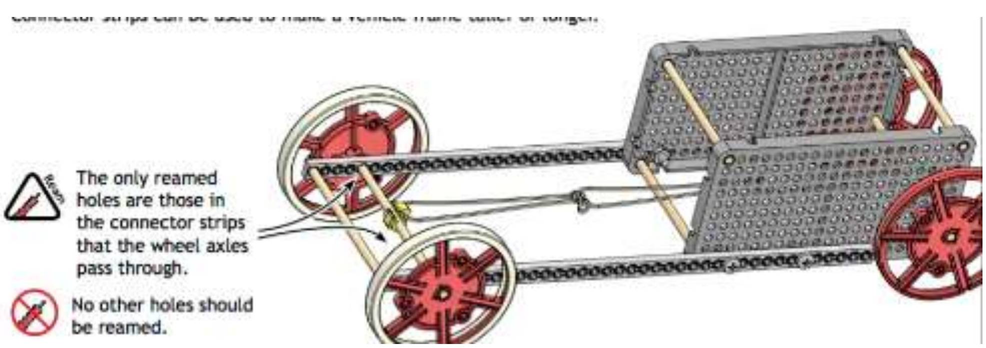
Assembly Directions:

1. Insert the 4 4in dowels into the 4 outside corners of the two hole plates (w/ bottom sides facing)
2. Insert the 2 5in dowels into the wheels. The dowels become axels
3. Place the wheel and axel through the frame
4. Place 1 side stop on the outside of each wheel to help keep them from falling off
5. Let it roll!

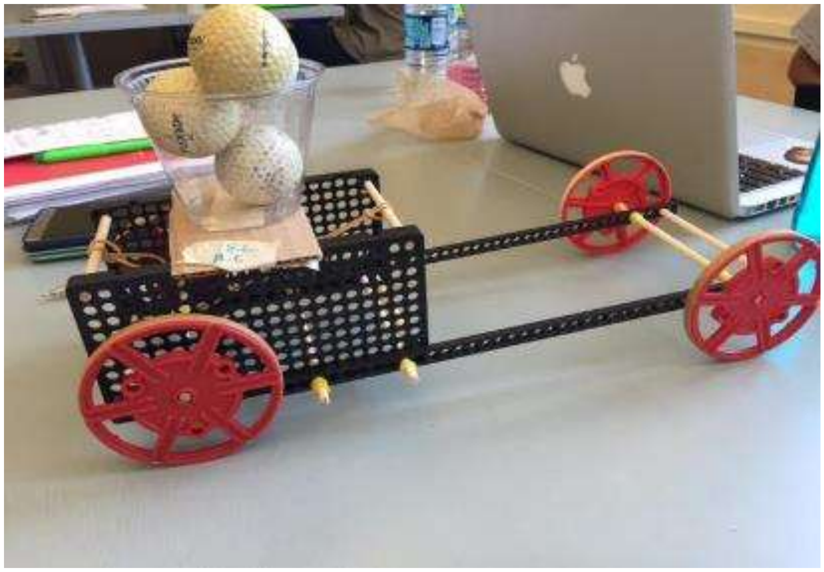
__________________ **(^^This is the basic racer design^^)**______________________

Additional Assembly Directions for Frame Extension

1. Remove the front wheels and axels, and set aside
2. Align the connector strips with the bottom row of holes on the hole plates, go in 10 holes
3. From the wheel go over three holes, ream the connector strip hole and insert a 5in dowel rod, put a yellow stopper on
4. From that dowel rod go over six holes and ream the connector hole and insert a 5in dowel rod, put a yellow stopper on the end
5. From the front of the connector strip count 2 holes back and insert a 4in dowel rod
6. From that dowel rod count 3 holes back and insert the 5in dowel rod with the wheels attached
7. On the back axel place a stop clip
8. Tie 2 rubber bands together and tie on the top 4in dowel on the hole plate structure
9. Place a stretch tire around each wheel
10. Tape a piece of cardboard on top of plates, w/a plastic cup to hold the balls
11. Wind the rubber band and let it roll



Testing the Racer: After you have built your racer, go to the starting point of the raceway. Starting with zero golf balls in the cup, wind the rubber band to the knot in and see how far it travels. Repeat these steps with 1,2,3, and 4 golf balls. Record your data.



Number of Golf Balls	**Distance Racer Traveled** *(inches)*
0	
1	
2	
3	
4	

After Thought: *What pattern have you noticed that weight has on your racer?*

____

Title: *Ecstatic about Elastic!*

Discipline unit: STEM

Unit standards:

- Science:
    - Grade 4
    - 4-PS3-1 Use evidence to construct an explanation relating the speed of an object to the energy of that object
- Mathematical:
    - Grade 4
    - AR.Math.Content.4.MD.A.1 Solve problems involving measurements and conversion of measurements from a larger unit to a smaller unit
    - (feet- inches, feet per second, inches per minute, etc.)
- Engineering/ Technology:
    - Standard 12: Students will develop the abilities to use and maintain technological products and systems
    - Benchmark:
        - Follow step by step instructions to assemble the product
        - Select and safely use tools, products, and systems for specific tasks

Big ideas:
Have an understanding of what makes the car go the furthest the fastest in terms of elasticity of the rubber band.

Essential questions:
How is the speed of the car affected by the elastic potential energy provided by the stretching of the rubber bands?

Scenario:
Students will be ask to build a rubber band racer based off of the instructions provided. At a certain point, they will be free to choose the numbers of stop clips and rubber bands that they would like to use. Their goal is to use the best combination of stop clips and rubber bands to create the most elastic potential energy to make the car go the furthest the fastest. Students will measure using inches, and then convert it to feet per second.

Materials/ resources:
- 2 hole plates
- 4, 4 inch dowel rods
- 2, 5 inch dowel rods
- 4 un-reamed wheels
- 4 stop cuts
- 4 wide rubber bands
- 1-3 stop clips

- 1-9 rubber bands
- Instructions provided

Content information:

- Science: Elastic energy (elasticity)
    - Describe elastic energy in these terms: Elastic potential energy is created when you are applying a force on an elastic object by stretching it. The energy is stored until the force is released off the object. The object will spring back to original shape, creating energy that will make something move.
    - In this case, the elastic object is the rubber band. They force is your hand pulling back the car to create tension of the rubber band. Once you remove the force of your hand, the car will move forward.
- Mathematical: measuring the distance in inches and convert it to feet per second
    - We will provide conversion factors and do practice with conversion prior to this activity.
    - 12 inches= 1 foot
    - Sample equation
    - 42 inches x 1 foot/ 12 inches
        - Cancel out the inches
        - Divide 43 by 12
        - Equals 3.5 feet
- Engineering/ Technology: follow step by step directions and use the correct materials in order to build the car and make it go the furthest the fastest
    - We will discuss of closely following instruction when building objects
    - We will walk through materials together and discuss how they are used and how they work

Deliverables:

-Students will present to us what combination they chose with a rationale (relating to the elastic potential energy)
-After their presentation, we will test their models

Parameters:

-Students will work in groups of two
-Instructions to build the car are provided
-They will have the option to decide on the number of stop clips and rubber bands to create the most elastic potential energy
-This project will be completed over 3 class periods

- 1st class: build car
- 2nd class: test possibilities
- 3rd class: present final ideas and test models

Assessment:

1- unsatisfactory
5- above and beyond

Follow directions of building car using correct materials 1 2 3 4 5

Time management 1 2 3 4 5

Understanding of concepts present during presentation (measuring concepts and elastic potential energy) 1 2 3 4 5

Active participation in group 1 2 3 4 5

Materials:

- 2 hole plates
- 4, 4 inch dowel rods
- 2, 5 inch dowel rods
- 4 un-reamed wheels
- 4 stop cuts
- 4 wide rubber bands
- 1-3 stop clips
- 1-9 rubber bands l

Directions:

1. Insert 4 inch rods into each corner of hole plates
2. Attach second hole plate to the open end of the dowel rods (both hole plates should now be attached by dowel rods and also be parallel)
3. Insert 5 inch rods into wheels and thread through third hole from each corner. Do not push through the other side
4. Slide 2 stop cuts onto each rod
5. Attach another wheel to the opposite side and slide stop cuts to be flush with the hole plate
6. Repeat for other set of wheels
7. Slide wide rubber bands around each wheel
8. Clip desired amount of stop clips (from 1-3) to back wheel dowel rod (make sure the hook of the clip is facing away from the car
9. Decide on amount of rubber bands desired to make the car go the furthest the fastest
10. Tie the band(s) to the front top dowel rod and attach to appropriate stop clips(s)

Ecstatic about Elastic!

What's the situation??

- You've come across a pile of car parts in your backyard. Lucky for you there are some instructions lying on top of them. It's your job to build the car according to the instructions. There is one tiny problem. The last page of the instructions got wet and you don't know how to finish the car. Working in groups of two, use the concepts we have learned about elastic potential energy to decide how many stop clips and rubber bands will create a car that goes the furthest the fastest.

Materials

- 2 hole plates
- 4, 4 inch dowel rods
- 2, 5 inch dowel rods
- 4 un-reamed wheels
- 4 stop cuts
- 4 wide rubber bands
- 1-3 stop clips
- 1-9 rubber bands

Directions:

1. Insert 4 inch rods into each corner of hole plates
2. Attach second hole plate to the open end of the dowel rods (both hole plates should now be attached by dowel rods and also be parallel)
3. Insert 5 inch rods into wheels and thread through third hole from each corner. Do not push through the other side
4. Slide 2 stop cuts onto each rod
5. Attach another wheel to the opposite side and slide stop cuts to be flush with the hole plate
6. Repeat for other set of wheels
7. Slide wide rubber bands around each wheel

** This is where the instructions got wet and your decision comes into play! You decide how many clips and rubber bands to use to make the car build up the most elastic potential energy so that it goes the furthest the fastest.

8. Clip desired amount of stop clips (from 1-3) to back wheel dowel rod (make sure the hook of the clip is facing away from the car
9. Decide on amount of rubber bands desired to make the car go the furthest the fastest
10. Tie the band(s) to the front top dowel rod and attach to appropriate stop clips(s)

What we are looking for:

- First period: use instructions to assemble your car

- Second period: test different combinations of stop clips and rubber bands to create the most elastic potential energy
- Third period: present to the class your findings and test cars
    - While presenting provide a reason for why you chose this combination (relate it to elastic potential energy)
    - While testing, you will need to record distance travelled by the car in both inches and feet using conversions that we discuss.

Title: *Rubber Band Racer*

Disciplinary Area: STEM

Unit: Rubber band Racer

Grade Level: 3

STEM Content Standards:

Science Standard**:**

NS.1.3.8 Nature of Science Strand 1

As part of learning how to use and maintain technological products and systems, students should be able to: Use simple equipment, age appropriate tools, technology, and mathematics in scientific investigations (e.g., balances, hand lenses, microscopes, rulers, thermometers, calculators, computers)

Standards for Technological Literacy:

3-5 Benchmarks:

Strand 12: Students will develop the abilities to use and maintain technological products and systems. As part of learning how to use and maintain technological products and systems, students should be able to:

D. Follow step-by-step directions to assemble a product.

Strand 18: **S**tudents will develop an understanding of and be able to select and use transportation technologies. In order to select, use, and understand transportation technologies, students should learn that:

E. A transportation system may lose efficiency or fail if one part is missing or malfunctions or if a subsystem is not working.

Math Standards:

Measurement and Data, Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses of objects.

AR.Math.Content.3.MD.B.4

- Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch.

Resource(s) used:

http://teachergeek.org/rubberbandracer.pdf

Deliverables:

Completed Rubber band Racer: Part 1 and Part 2 worksheets. Working rubber band racer. Proper use of materials are evident in racer and experiments.

Content Information:

The Teacher will first hook the students by racing the model rubber band racer and discussing how it works. Teacher may need to review how to accurately measure distance using a ruler, and tape measure. Teacher will also need to emphasize the importance of safety and using safety equipment and cutting tools properly. The classroom will need to know how to find the average (by adding all of the numbers in the set, and then dividing the sum by the number of numbers in the set). After answering any questions, allow a student to test the model racer, and then be introduced to the essential questions, and scenario. Go over the materials, tools, and safety equipment to be used. Tell students their parameters, and how they will be assessed. Pass out Rubber band Racer Part 1 worksheet. Observe students as they design their rubber band racer. The next class period the class will go over different factors that will affect the distance the racer travels depending on the amount of rubber bands used. Rubber band Racer Part 2 worksheet will be completed on the following day where students will continue to conduct experiments, and gather new information with the new factors they are given. Students are expected to use comparison and critical thinking during this experiment. Assess students based on worksheet, performance, and rubber band racer completion.

Big Ideas:

- Students will know how to accurately use a ruler, and measuring tape to measure the distance traveled by the rubber band racer.
- Students will follow a step-by-step instructions to build their rubber band racer.
- Students will learn that the rubber band racer must be constructed correctly in order to work properly, and will malfunction if something is missing.
- Students will use technology, tools, math, science, and engineering to carry out their experiments.
- Students will construct and improve their rubber band racer by interpreting their collection of data from running trails and experiments.
- Students will solve problems involving measurement.

Teacher and Student Guide:

Scenario: Dale Earnhardt is attempting to build a rubber band racer that will go the farthest distance possible. While experimenting with his racer, he found out that there are many factors that can cause the car to go a short distance, or go a long distance. He does not know how many rubber bands to use, or which factors to consider. He needs your help to go the farthest distance possible with his rubber band racer!

Essential Question 1: Construct a rubber band racer that goes the farthest distance. Complete 3 trials using one rubber band, two rubber bands, and three rubber bands. Measure, fill in the graph, and find the average for each trial. How did the number of rubber bands affect the distance traveled by the rubber band racer?

Essential Question 2: Many factors affect the rubber band racers ability to travel. Using what you have learned about those different factors, test three of the factors that you think make the biggest difference on the racers distance. How can you redesign your rubber band racer so that it goes the farther distance possible?

Parameters:

Only wind up the racer 5 times, (5 revolutions). Use the materials provided for part one, and follow the step-by-step instructions when building the racer. Redesign your racer using your own ideas on how to get the racer to go farther by using what you have learned from experiments, and the additional materials provided for part two.

Assessment:

Performance based, and worksheet based. Students should demonstrate how to accurately build a rubber band racer that works. They will then need to measure and average their results with 1, 2, and 3 rubber bands and continue to compare them. After, we will do a brief lesson on some outside factors that could affect the racers distance and speed. Once we do the lesson, students are given the opportunity to test out different factors and reflect on how those factors affected the racer.

Materials:

2 hole plate's

4 stop cuts (yellow)

2 long dowel rods

4 wheel hubs

3 thin rubber bands

1 stop clip

Tools:

Cutter

Calculator

Ruler

Hammer

Measuring tape

Safety Equipment:

Safety glasses

Additional Materials (for redesign):

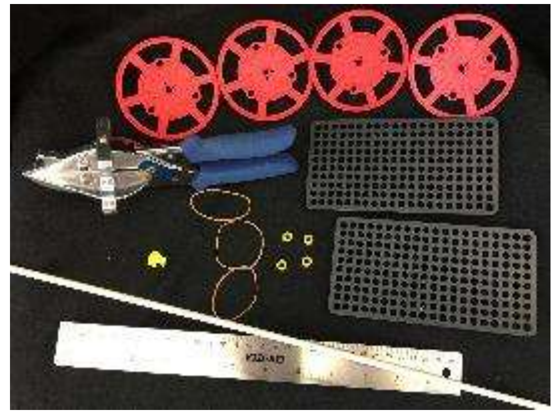
Thick rubber bands

Thin rubber bands

Weights

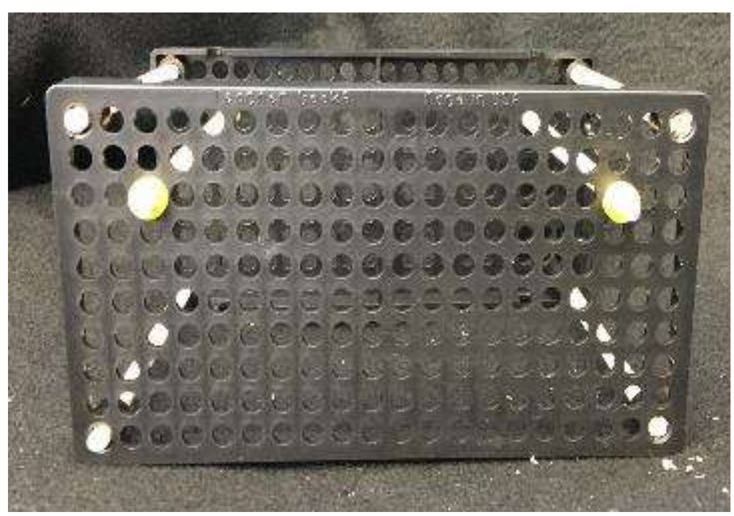
2 more materials of choice

Technical Directions:



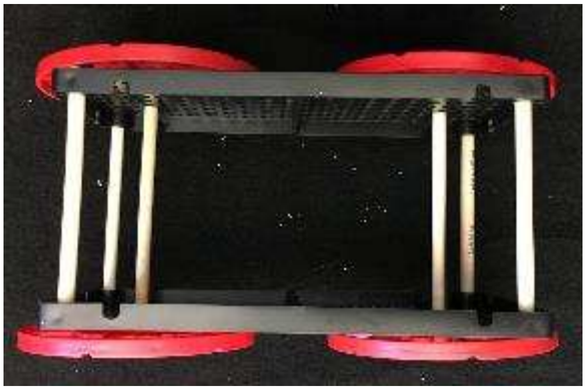
1. Gather all of the necessary materials and tools used to build the racer.
2. Take them to your desk.
3. Using the cutters, cut four 4 inch dowels out of the long dowel rod.
4. Place each dowel in the corner of one hole plate. (4 dowels, and 4 corners)
5. Lay the second hole plate on top of the four dowel rods, directly above the first hole plate.

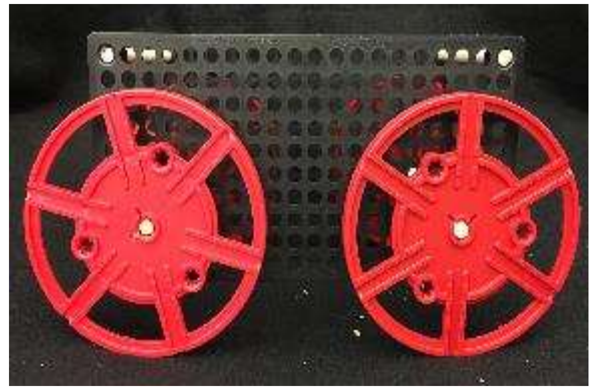
6. Using the cutters, cut two 5 inch dowels out of the long dowel rod. (they will become the axles)



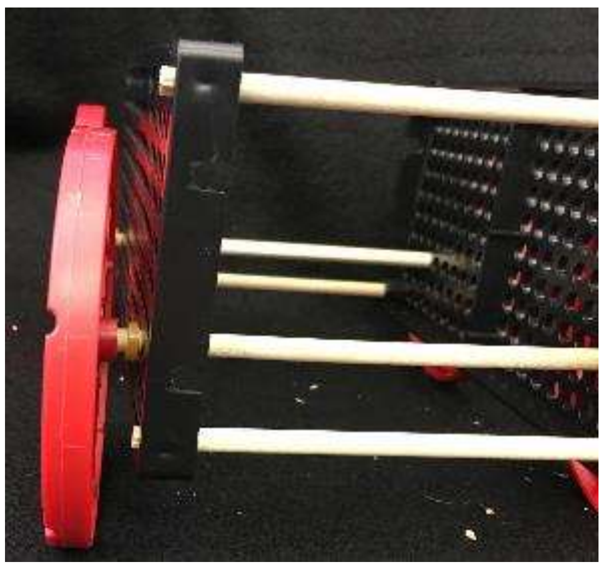
7. Slide the 5 inch dowels into the hole plate(wherever you think best).
8. Put a stop cut on each end of the 5 inch dowel rods. (Two 5 inch dowel rods, 4 stop cuts, 1 stop cut on each end)

9. Put a wheel on each end of the 5 inch dowel rods.



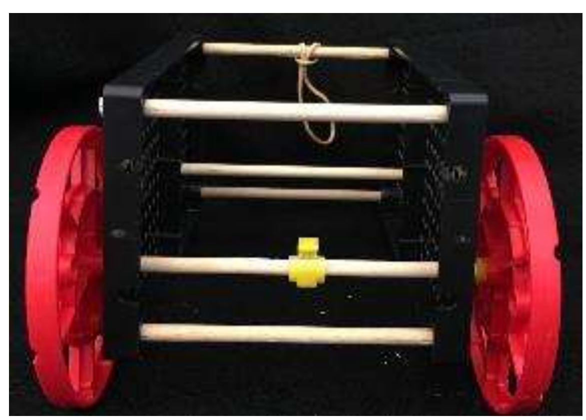


10. The stop cuts should be on the inside of the wheel.

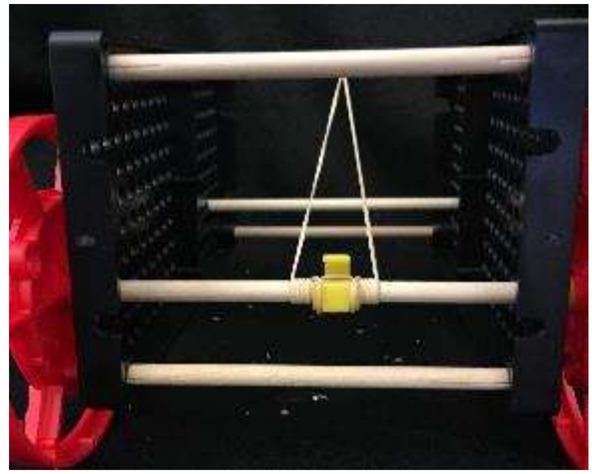


11. Snap on the stop clip on the wheel axle. (Hook facing up and away from the racer)

12. Attach however many rubber bands(1,2, or 3) on the opposite side of the stop clip, on the top dowel rod.



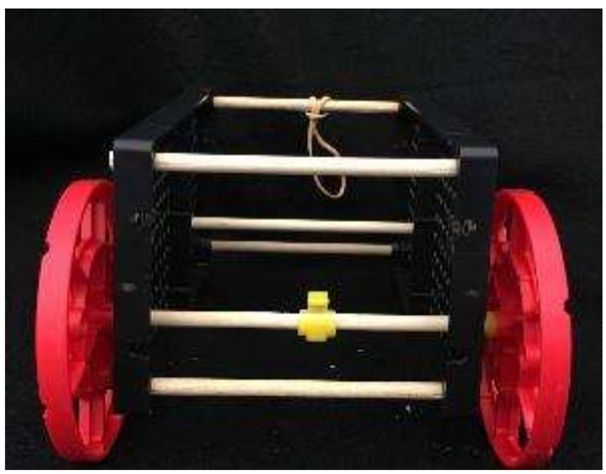
13. Hook the rubber band(s) on the stop clip.



14. Pull the racer backwards, with the wheels on the ground the rubber band will wrap around the axle.

15. Let it go!

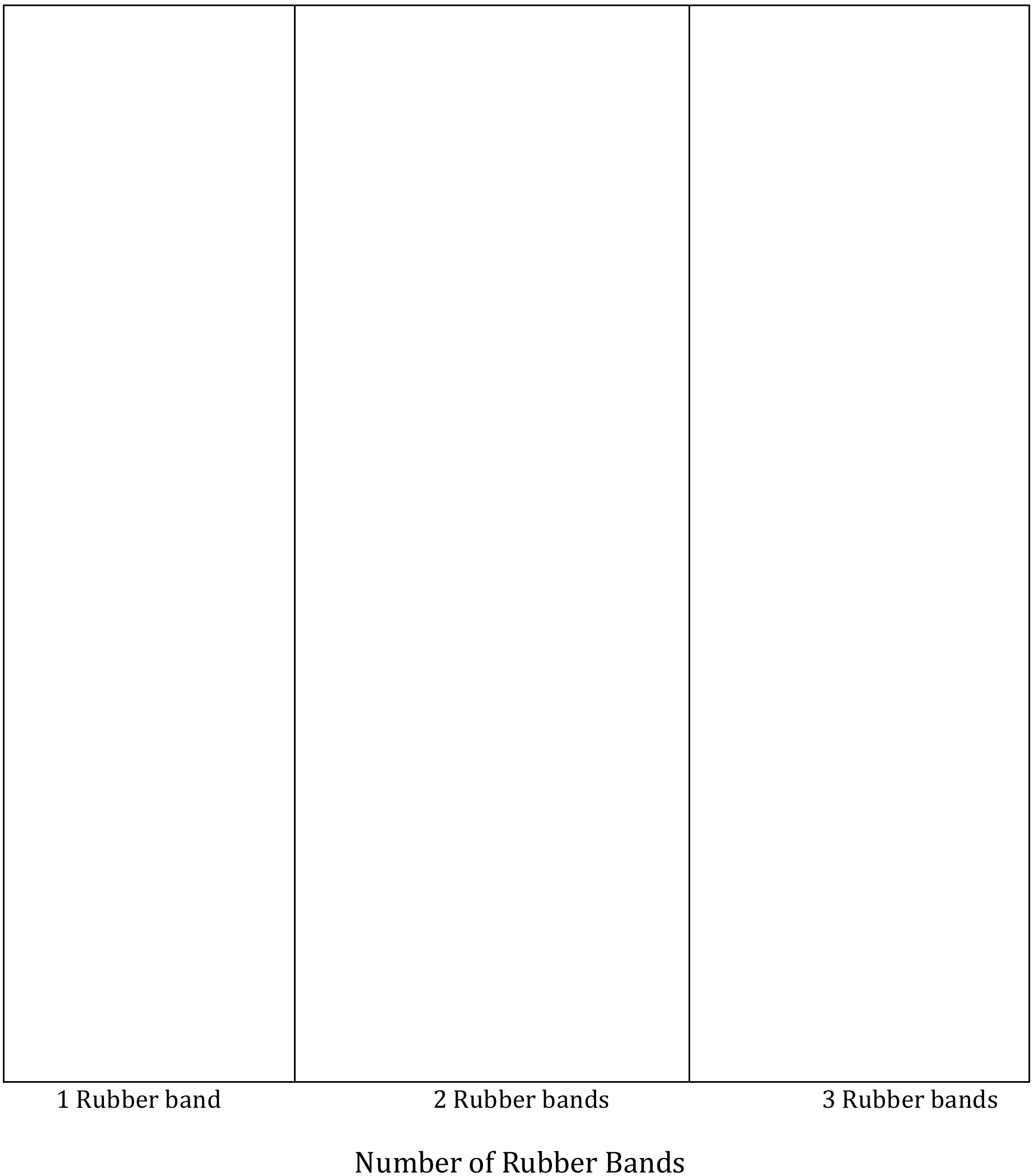
End Result:



Rubber Band Racer: Part 1

Number of rubber bands	**Trial 1 distance**	**Trial 2 distance**	**Trial 3 distance**	**Average distance**

*** Fill in the rest of the Bar Graph by labeling. Include the units of measure! Graph the average distance traveled when using 1, 2, and 3 rubber bands.**



1) What did you notice about the distance the racer traveled with the different number of rubber bands?

2) Look back to question 1. Why do you think that is?

3) What did you notice about the wheels with the different number of rubber bands?

Rubber Band Racer: Part 2

1) After what we learned in class, what are some factors you could add to your racer to travel the farthest distance? (Weight, friction, etc.)

2) Test out different factors your group thinks will make a difference and record them in the table below.

Factor tested	Trial 1 distance	Trial 2 distance	Trial 3 distance	Average distance

3) After testing different factors, what have you discovered during this experiment? Which factors made the rubber band racer go far, and which did not?

Student Assessment:

Worksheet 1 accuracy (1-5 points)

Graph accuracy (1-5 points)

Worksheet 2 accuracy (1-5 points)

Good participation (1-5 points)

Performed well (1-5 points)

Working rubber band racer (1-5 points)

Total Score: /30

Title: Mario Kart Test Track

Grade Level: 4th Grade

Unit: Energy and Acceleration

STEM Content Standards:

- 4th Grade Science:
    - Next Generation Science Standards
        - 4-PS3-1 Use evidence to construct an explanation relating the speed of an object to the energy of that object.
        - 4-PS3-4 Apply science ideas to design, test, and refine a device that converts energy from one form to another.

- Technological Literacy:
    - Standard 1: 3-5
        - Benchmark D: Tools, materials, and skills are used to make things and carry out tasks.
    - Standard 2:
        - Benchmark G: When parts of a system are missing, it may not work as planned.
        - Benchmark J: Materials have many different properties.
    - Standard 12:
        - Benchmark D: Follow step by step directions to assemble a product.

- Math Measurement & Data:
    - AR Math Content. 4. MD.A.1:
        - Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb., oz.; l, ml; hr., min, sec; yd., ft., in; gal, qt., pt, c.
        - Within a single system of measurement, express measurements in the form of a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table.

- Computer Science:
    - D.4.4.1 Compare the representation of existing data in multiple formats

Big Ideas:
- Potential Energy versus Kinetic Energy
- Conversion of potential energy to kinetic energy and vice versa
- Acceleration
- Building rubber band motorized kart
- Represent data using a table
- Represent data using a graph
- Teamwork

- How to follow step-by-step directions

Scenario:
Mario and his friends are getting ready to race in the Rubber Band Regional Cup. The karts in this race must be motorized only by rubber bands. To win the race, Mario needs your help building the fastest rubber band kart he can. Using your knowledge of elastic potential energy, kinetic energy, and acceleration, test the speed of different kart designs to find Mario's winning kart.

Essential Question:
How can you utilize elastic potential energy to create a rubber band motorized kart that will have the greatest acceleration?

Parameters or Constraints:
- Students will work in teams of two
- Students will be given 1 hour to complete karts
- Students will be given 1 hour to test karts
- Students must wear safety glasses when cutting dowel rods
- Students will follow given directions to assemble and test rubber band motorized kart
- Karts must be made of only the given materials
- Karts must be powered by rubber bands
- Students will not push the cart
- No additional weight will be added to the kart during general testing

Tools, Materials, and Resources:

Tools:
- Hammer
- Ruler
- Dowel rod cutter **or** Saw, table guard, and clamps
- Safety Glasses
- Pencil
- Computer with basic graphing capabilities
- Screwdriver (optional)
- Tape Measure
- Masking tape

Materials (per team)

Wheel Hub	4
Hole Plate	2
100mm Dowel Rod (4in)	4

100mm Dowel Rod (5in)	2
Rubber Band (thin)	3
Rubber Band (thick)	5
Slide Stop (½ cm)	4
Stop Clip	3

Content Information:

1. Introduce potential energy and kinetic energy to the students.
   Explain these points:
   - Potential energy is the stored energy of position possessed by an object.
   - Elastic potential energy is a type of potential energy stored in elastic materials as the result of their stretching or compressing.
   - The amount of elastic potential energy stored in an elastic material is related to the amount of stretch of the device.
   - Kinetic energy is the energy of motion.
   - An object that has motion (vertical or horizontal) has kinetic energy.
   - Acceleration is an increase in the rate or speed of something.

The video at https://www.youtube.com/watch?v=0BObd3DsNFM explains elastic potential energy through visuals and shows how rubber bands gain this type of energy.

   - Make sure to explain that the rubber band on two of the wheels allows the wheels to move on different surfaces and that friction between the surfaces and the wheels allows the wheels to move.

2. Introduce the scenario to the students and place them in pairs.
3. Explain the correct use of tools and proper safety procedures to the students.
4. Provide each student with table print-outs for logging speed results.
5. Discuss proper use of table for logging speed results.
6. Discuss how to average speed results.
7. Demonstrate how students will input recorded data into Word to create a graph, visually representing their results.
8. Provide student team with a copy of Step-by-Step construction sheet.
9. Provide student team with a copy of student handout.

Deliverables:

- Completed kart
- Table with speed results
- Graph with speed results

Evaluation:

- Teacher Rubric
- Presentation of kart design selection
  Presentations will answer these questions:
    - Which kart design had the fastest speed?

- Which kart design had the lowest speed?
- How does your kart design demonstrate potential energy?
- How does your kart design demonstrate kinetic energy?
- What did you learn? What was your favorite part of this activity?

Student Handout

Scenario:
Mario and his friends are getting ready to race in the Rubber Band Regional Cup. The karts in this race must be motorized only by rubber bands. To win the race, Mario needs your help building the fastest rubber band kart he can. Using your knowledge of elastic potential energy, kinetic energy, and acceleration, test the speed of different kart designs to find Mario's winning kart.

Essential Question:
How can you utilize elastic potential energy to create a rubber band motorized kart that will have the greatest acceleration?

Tools:
- Hammer
- Ruler
- Dowel rod cutter **or** Saw, table guard, and clamps
- Safety Glasses
- Pencil
- Computer with basic graphing capabilities
- Screwdriver (optional)
- Tape Measure
- Masking tape
- Stopwatch

Materials (per team):

Wheel Hub	4
Hole Plate	2
100mm Dowel Rod (4in)	4
100mm Dowel Rod (5in)	2
Rubber Band (thin)	3
Rubber Band (thick)	5
Slide Stop (½ cm)	4
Stop Clip	3

Instructions:

1. Gather tools and materials needed to build your kart. NOTE: you will be building only one kart per team.

2. Work with your team member to follow the step-by-step instructions and build your kart.

3. Measure out a straight line of three yards on the floor, using the masking tape to mark the start and finish line. This will be your testing distance. REMEMBER: three feet is equal to one yard.

4. Placing your kart at the starting line, rotate the axle with the yellow stop clip two whole turns.

5. Release your kart in the direction of the finish line. Begin timing your kart when it is released and stop timing once the kart reaches the finish line.

6. Log your time in the table provided. NOTE: each team member will fill out his or her own table.

7. Repeat steps 4-6 two more times.

8. For the remaining tests: make adjustments to your kart design based on the table (adding rubber bands/switching rubber band types)

9. Average your speed results for each design.

10. Use Word to create a graph to visually represent your test results. NOTE: your team will create only one graph.

11. Print out your graph.

Speed Results:

Design	**Trial 1** (sec.)	**Trial 2** (sec.)	**Trial 3** (sec.)	**Average Speed** (sec.)
1 thin rubber band				
2 thin rubber bands				
3 thin rubber bands				
1 thick rubber band				
2 thick rubber bands				
3 thick rubber bands				

What was your fastest design?

What was your slowest design?

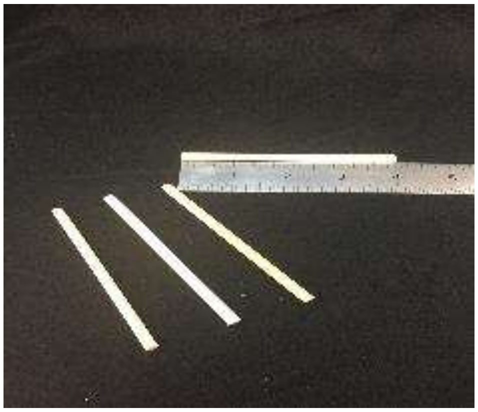
Explain your results.

Category	Excellent 10 pts.	Good 5 pts.	Poor 1 pt.	Score
Followed Steps Accurately	Project is completed using the steps provided.	Varied from steps slightly when creating project.	Did not follow steps given to create project	
Understanding of Different Forms of Energy	Demonstrates understanding of potential energy, kinetic energy, and acceleration.	Demonstrates some understanding of potential energy, kinetic energy, and acceleration	Demonstrates little to no understanding of potential energy, kinetic energy, and acceleration.	
Proper Use of Tools and Materials	Used only tools and materials provided in correct manner.	Used tools and materials provided and some additional materials.	Used a wide array of tools and materials.	
Correct Measurements Used	Materials are cut to the right size as stated in steps and speeds are measured in correct units.	Some materials are cut to the right size and speeds are measured in correct units.	Did not use measurements or units given to create project.	
Completed Table and Graph	Table and graph demonstrate understanding of results.	Table and graph slightly demonstrate understanding of results.	Table and graph demonstrate little understanding of results.	
Good Collaboration with Team Member	Worked well with team member and allowed their input and contribution.	Worked well with team member, but one contributed more than other.	Did not work well as a team.	
Effective Use of Time	Time is used effectively and project completed on schedule.	Team required slightly more time to complete project.	Time was not used wisely.	

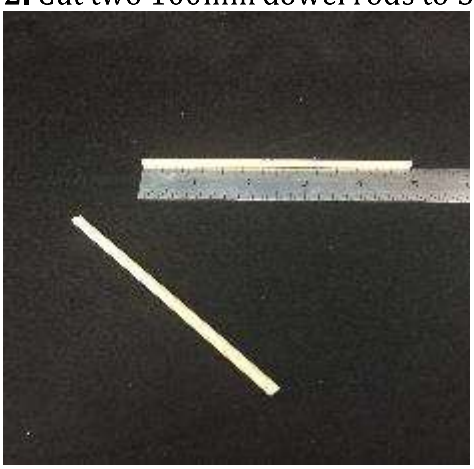
Total Points	
Comments:	

STEP-BY-STEP CONSTRUCTION

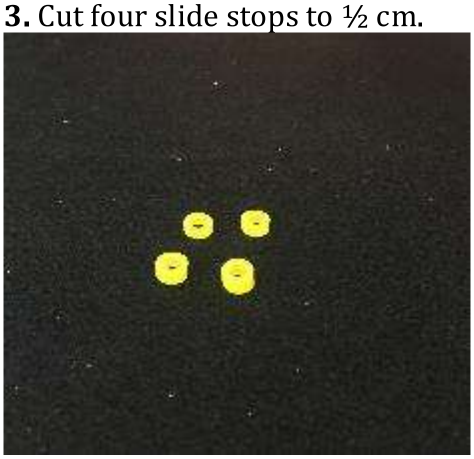
1. Cut four 100mm dowel rods to 4in.



2. Cut two 100mm dowel rods to 5in.

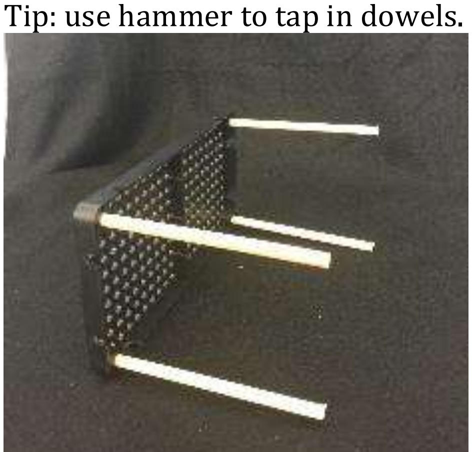


3. Cut four slide stops to ½ cm.

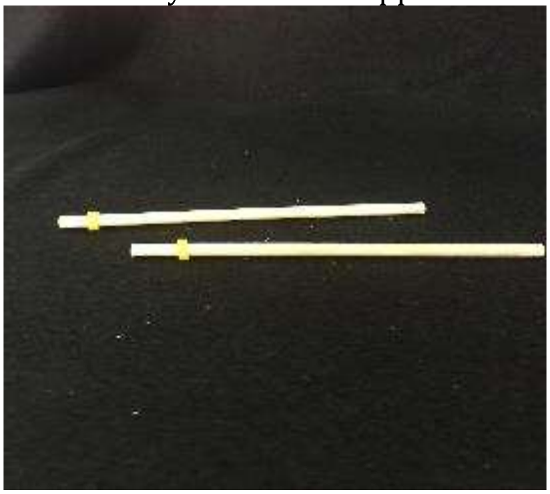


4. Stretch a thick rubber band over two of the four wheel hubs. This detail helps provide traction.

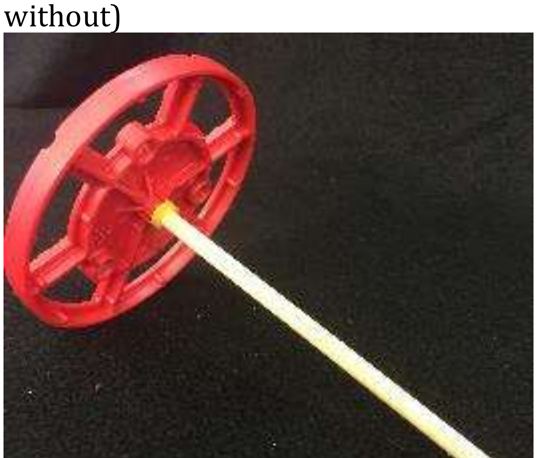
5. Insert the four 4in dowels into two hole plates as shown.
Tip: use hammer to tap in dowels.



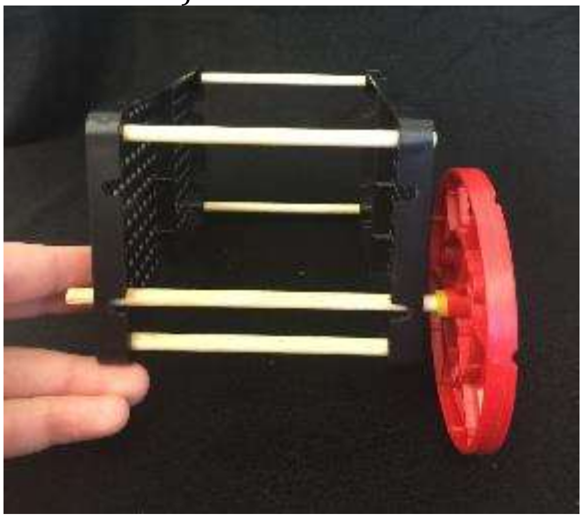
6. Slide one yellow slide stopper onto each of the two 5in dowels.



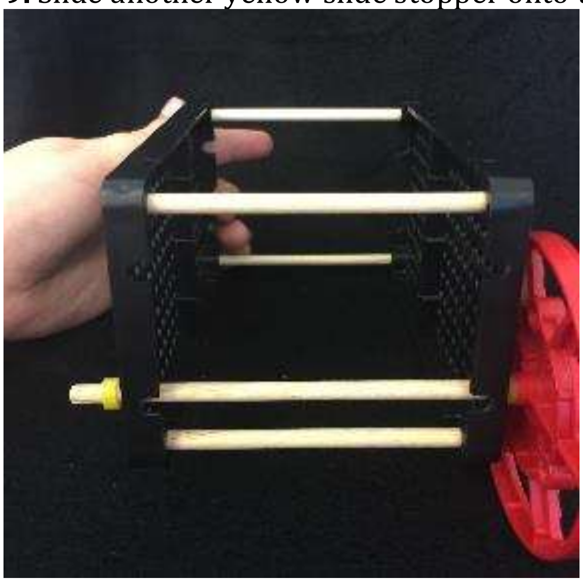
7. Slide a wheel hub onto each of the 5in dowels. (One wheel hub with rubber band and one without)



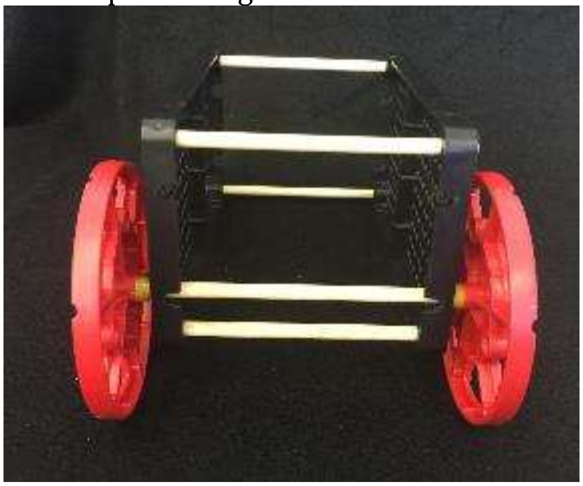
8. Place a wheel hub and axles from step 7 into the plate frame (where you think they will function best)



9. Slide another yellow slide stopper onto the axle as shown.

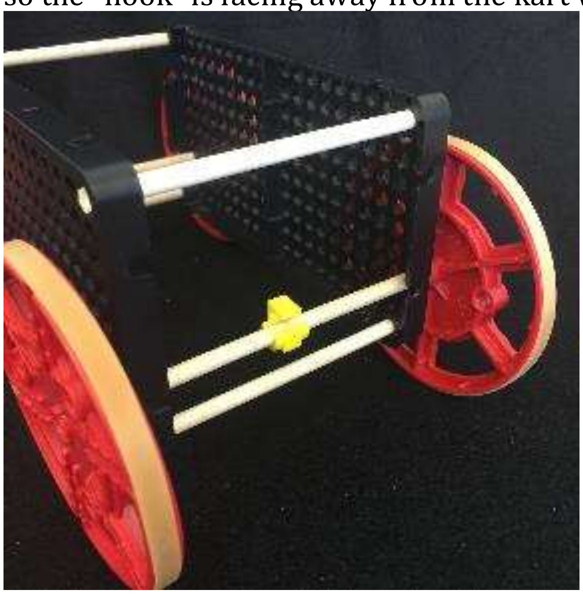


10. Slide the matching wheel hub onto the axle as shown. Tip: make sure the slide stoppers are not pressed against the frame.

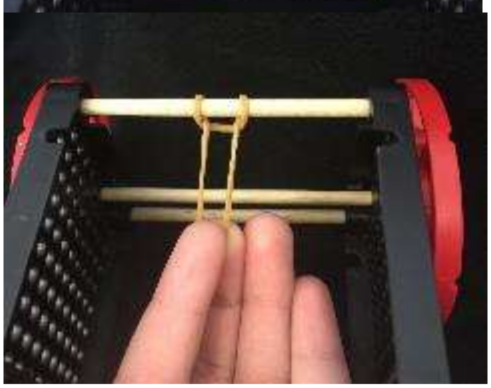


11. Repeat steps 8 and 9 for remaining wheel hubs and axle.

12. Attach one stop clip on the wheel axle with the thick rubber bands. (Attach the stop clip so the “hook” is facing away from the kart when up)



13. Attach one rubber band using the method shown.



Renewable Resource Racers

Disciplinary Area: STEM 4th Grade

Unit: Kinetic and Potential Energy

STEM Content Standards:

Science

Energy 4-PS3-4 Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*

Energy 4-ESS3-1 Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. [Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, or sunlight; non-renewable energy resources are fossil fuels or fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from the burning of fossil fuels.]

Technology and Engineering

Standard 18: Students will develop an understanding of and be able to select and use transportation technologies

- Benchmark E: A transportation system may lose efficiency or fail if one part is missing or malfunctions or if a subsystem is not working.

Math

Measurement and Data: AR.Math.Content.4.MD.B.4

- Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit. Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb., oz.; l, ml; hr., min, sec; yd., ft., in; gal, qt., pt., c

Big Ideas:

- Understanding transfer of energy (potential and kinetic)
- Practicing how to convert units of measurements (inches to feet to miles and seconds to minutes to hours)
- Being able to follow directions
- Being able to expand upon technology and engineering concepts by conducting experiments
- Conservation of fuel (natural resources)
- Solving problems in multiple ways

Essential Questions:
How can your team create a rubber band powered racer that produces the most power, better utilizes friction, or utilizes additional simple machines to propel it the fastest or furthest?

Scenario:
This year, the NHRA (National Hot Rod Association) is offering a grand prize of $500,000 to the team that can create the most effective racer using renewable energy produced by rubber bands. Your team of scientists and engineers has been asked to work on a racer that will provide the most power or travels the fastest. The NHRA has provided your team with the basic instructions to create the racer, but it is your task to modify the racer to create the fastest racer or the racer that provides energy for the longest trip.

Tools, Materials, and Resources:
Teams will need to use at least:
- Four 4 in. dowel rods
- Two 6 in. dowel rods
- Two hole plates
- Four non-reamed wheels
- Four sliders
- One stop clip
- Three rubber bands
- One stopwatch
- Measuring Tape

Teams may also use:
- Extra rubber bands (wide or thin)
- Extra sliders
- Extra stop clips
- Extra wheels (reamed or non-reamed)
- Connector Strips
- Gears (50, 40, or 20)
- Multi-Cutter
- Reamer
- Hammer
- Screwdriver

Content Information:
- Lesson on the effects on the environment caused by using nonrenewable sources of energy
    - Discuss examples of renewable energy sources, such as wind energy or sunlight
- How can energy be transferred from one form to another?
    - Energy: It is neither created nor destroyed, but rather changed from one form of energy to another
    - Potential and Kinetic Energy

- Lesson on Energy: Potential and Kinetic
    - Potential Energy: Energy that is stored within an object (i.e., stretch a rubber band back and hold it)
    - Kinetic Energy: Energy in motion (i.e., release the rubber band and it flies through the air)
- How can you convert inches to feet to miles?
    - 12 in. = 1 ft.
    - 5280 ft. = 1 mile
- Quick discussion on elasticity and items we know to be elastic.
    - Elasticity: *Physics.* The property of a substance that enables it to change its length, volume, or shape in direct response to a force effecting such a change and to recover its original form upon the removal of the force.
    - Possible items to discuss: Spring, bouncing ball, bowstring, bungee cord, trampoline, etc.
- Quick lesson on dragsters (show video of how they work to entertain/ interest students)

Deliverables: Each team must submit the following items at the conclusion of this activity:

- Modified Renewable Energy Racer
- Completed Worksheet

Parameters:

- Groups of 2-3 (to be held accountable with an experiment/modification idea, each student must come up with one)
- Must use rubber bands to transfer energy
- Each student must complete a worksheet with at least three experiments
    - Each experiment must show:
        - One variable that was modified
        - The effects or outcomes of this modification
        - Explanation of why they think this worked/ did not work
- Teams must be able to convert miles to feet to relate our version (measuring tape and the floor of the classroom/hallway) of a raceway to envision the actual distance the dragster could travel
    - Teams will need to time how long their dragster was powered
    - Teams will need to measure how far their dragster sped forward

Assessment Rubric:

5 Points	10 Points	15 Points	20 Points
Made little to no effort to participate in the team.	Made little effort to participate with the team when brainstorming ideas.	Did not fully participate and contribute in all aspects of the team.	Team member appeared to participate by sharing ideas, cooperation was evident, and tasks were completed effectively.
Completed aspects of one experiment.	Completed one experiment with a modification, an effect, and an explanation.	Completed two experiments with a modification, an effect, and an explanation for each.	Completed all three experiments with a modification, an effect, and an explanation for each.
Showed little to no understanding of concepts from lesson and was unable to follow directions.	Showed some understanding of concepts from the lesson and was able to follow some directions.	Applied concepts from the lesson to make modifications and followed most of the step-by-step instructions.	Effectively applied concepts from the lesson to make modifications and followed all of the step-by-step instructions.
Was unable to convert any measurements or show understanding of kinetic/potential energy.	Was able to either convert one of the two measurements on the worksheet. Showed some understanding of kinetic/potential energy.	Was able to complete both questions concerning measurement OR Showed understanding of kinetic/potential energy.	Was able to complete both questions concerning measurement AND showed understanding of kinetic/potential energy on worksheet.
Shows little understanding about nonrenewable and renewable energy sources.	Shows some understanding about nonrenewable and renewable energy sources.	Shows understanding about nonrenewable and renewable energy sources and provides examples of one.	Shows great understanding about nonrenewable and renewable energy sources and provides examples of each.

Renewable Resource Racers

This year, the NHRA (National Hot Rod Association) is offering a grand prize of $500,000 to the team that can create the most effective racer using renewable energy produced by rubber bands! Your team of scientists and engineers has been asked to work on a racer that will provide the most power or travels the fastest. The NHRA has provided your team with the basic instructions to create the racer, but it is your task to modify the racer to create the fastest racer or the racer that provides energy for the longest trip.

How can your team create a rubber band powered racer that produces the most power, better utilizes friction, or utilizes additional simple machines to propel it the fastest or the furthest down the raceway?

The NHRA has provided these materials for your team to build the model of the racer. Once you have shown that you can follow directions, they will provide more materials for your team to choose from.

Tools, Materials, and Resources:

Teams will need to use at least:

- Four 4 in. dowel rods
- Two 6 in. dowel rods
- Two hole plates
- Four non-reamed wheels
- Four sliders
- One stop clip
- Three rubber bands
- One stopwatch
- Measuring Tape

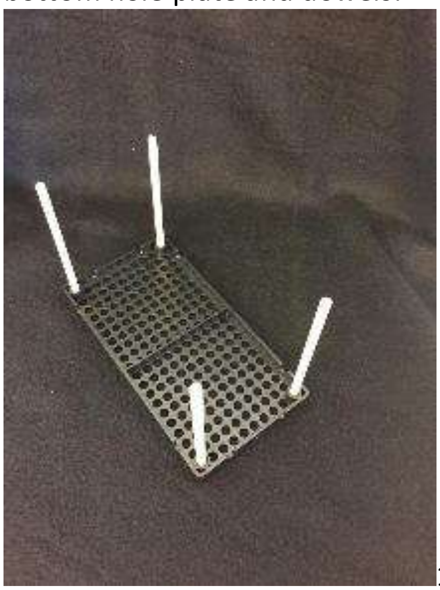
Teams may also use:

- Extra rubber bands (wide or thin)
- Extra sliders
- Extra stop clips
- Extra wheels (reamed or non-reamed)
- Connector Strips
- Gears (50, 40, or 20)
- Multi-Cutter
- Reamer
- Hammer
- Screwdriver

Let's Build!

Phase 1: The frame

1. Cut four 4 in. dowel rods.
2. Place one dowel rod in the hole at one corner of the hole plate. Repeat with each dowel rod.
3. Place the second hole plate on top of this structure so that it matches up with the bottom hole plate and dowels.


1:2

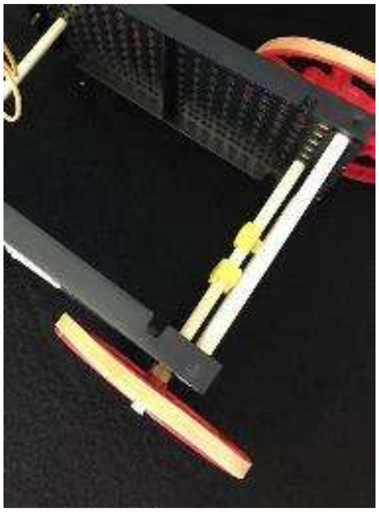

1:3

Phase 2: The Wheels

1. Cut two 6 in. dowel rods. These will be used as axles for the wheels.
2. Measure out about an inch from the end of the dowel rod. Repeat this on each end of each dowel.
3. Place a slider where the inch mark is.
4. Press a wheel onto one end of the 6 in. dowel rods (to the outside of the sliders).
5. Locate the second hole from the side edge of the hole plate and the third hole from the bottom.
6. Place the open-ended dowel rod into that specified hole on the hole plate.
7. Locate the same spot on the second hole plate and place the open-ended dowel rod into that hole.
8. Place a slider on the inch mark of this end.
9. Press the wheel onto this end of the 6 in. dowel rod.
10. Repeat steps 3-9 on the second 6 in. dowel rod.

Phase 3: Traction

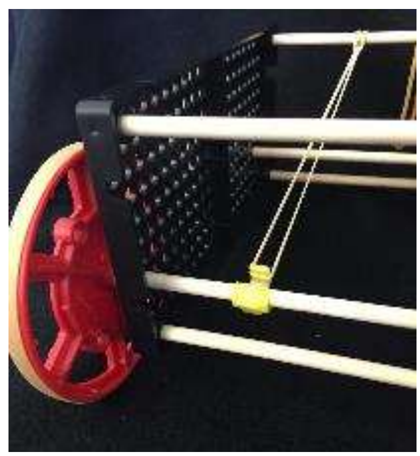
1. Stretch a rubber band around one of the back wheels.
    a. Tip: One student can hold one end of the band down while another stretches the band around the wheel.
2. Repeat step 1 on the other back wheel.


3:1&2

Phase 4: Clip and Band

1. Place the stop clip on the axle (dowel rod) that is attached to the back wheels.
    a. Be aware of which way the "hook" of the clip is facing.
2. Attach a rubber band by either method shown in the pictures captioned 4:2.


4:2


4:1 & 5:1

Phase 5: Test it out!

1. Hook the rubber band around the clip.
2. Wind the rubber band around by dragging the racer backwards with the wheels on the ground.
3. Let go and watch it propel forward!

Renewable Resource Racers

Team Name: ____
Team Members: _____________________________________
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Experiment 1:

Identify one variable of the model that your team would like to modify.

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What changes, if any, did your team notice after this modification? (Did the racer move faster or slower? Did it move further or the same distance?)

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Was this the outcome that your team expected? Why do you think this modification was successful? OR Why do you think this modification was not successful?

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How many feet did our racer propel forward?	How long did our racer have power (how many seconds or minutes did it go until it stopped)?

Experiment 2:

Identify one variable of the model that your team would like to modify.

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What changes, if any, did your team notice after this modification? (Did the racer move faster or slower? Did it move further or the same distance?)

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Was this the outcome that your team expected? Why do you think this modification was successful? OR Why do you think this modification was not successful?

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How many feet did our racer propel forward?	How long did our racer have power (how many seconds or minutes did it go until it stopped)?

Experiment 3:

Identify one variable of the model that your team would like to modify.

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What changes, if any, did your team notice after this modification? (Did the racer move faster or slower? Did it move further or the same distance?)

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Was this the outcome that your team expected? Why do you think this modification was successful? OR Why do you think this modification was not successful?

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How many feet did our racer propel forward?	How long did our racer have power (how many seconds or minutes did it go until it stopped)?

Which modification either propelled your team's racer the furthest, the fastest, or both?

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Let's apply it!

If one foot on our floor represents a quarter of a mile of the raceway, how many feet would one foot represent on the actual raceway? (Convert a quarter of a mile to feet)

If our team's racer was propelled _____________ft on the classroom floor, then how many feet would it have traveled on the raceway? How many miles is that?

At what point does your racer use potential energy? At what point does your racer use kinetic energy? Be specific.

In your own words, what does it mean if an energy source is non-renewable? What is an example of non-renewable energy source?

In your own words, what does it mean if an energy source is renewable? What is an example of a renewable energy source?

Curriculum Development Teacher Geek (teacher copy)

Title: Rubber Band Racer

Grade Level: 3rd

STEM Content Standards:

Science**:** 3-PS2-2 Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. PS2.A: Forces and Motion - Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) (3-PS2-1)

Math**:** AR.Math.Content.3.MD.B.4 Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch

Technology**:** Standard 12: Students will develop the abilities to use and maintain technological products and systems. Follow step-by-step directions to assemble a product.

Big Idea: Students should be able to follow the assembly directions below, produce a racer with an extension and a weight supporter, and be able to measure lengths using rulers marked with halves and fourths of an inch.

Essential Question: Does the racer travel farther or shorter distance when more weight is having to be carried?

Scenario: The local zoo needs a vehicle that can carry the weight of elephants at a far distance to move them to their new habitat. Assemble the racer as a model for the zoo vehicle, using the golf balls as a model for elephants.

Challenge: Using the materials and tools listed below follow the technical/procedural assembly directions to build a rubber band racer. After the racer is built test the distance the racer travels using halves and fourth inches, with different weight using golf balls. Record your observations in the table provided.

Materials:

- 2 Hole plates
- 4 wheel hubs
- 2 connector strips
- 1 3in slide stop (cut into ¼ in.)
- 4 stretch tire
- 2 rubber bands

- 1 stop clip
- 4 12in dowel (use cutters to create 5 4in. and 4 5in.)
- tape
- cardboard
- 4 golf balls

Tools:

- 1 reamer
- 1 cutter
- Measuring tape

Content: Students will be able to make observations on an objects motion (racer), and be able to predict a future pattern (the distance it travels). They will develop a technology understanding of following directions to assemble a product.

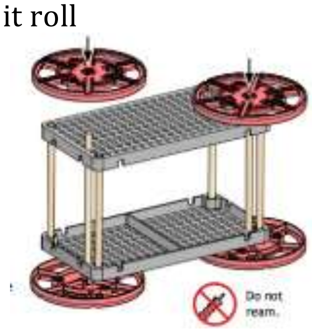
Deliverables: The student's racer, they should have their worksheet chart filled out, and be able to make a prediction in the afterthought question.

Parameters or Constraints: You will only be able to use the materials provided, you will only have 20 minutes to build your racer, and you can only use golf balls as the weight being carried.

Evaluation: We will evaluate if the students created the racer from the instructions provided, their work sheet, and the afterthought answer.

Assembly Directions:

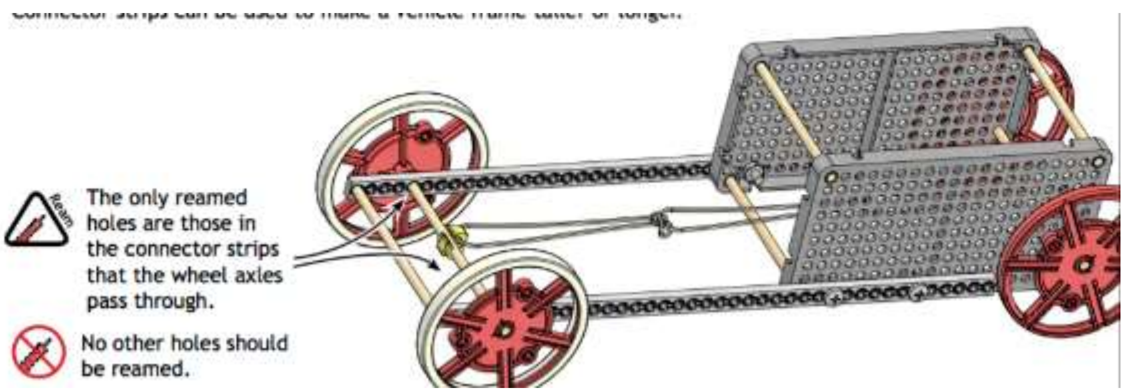
6. Insert the 4 4in dowels into the 4 outside corners of the two hole plates (w/ bottom sides facing)
7. Insert the 2 5in dowels into the wheels. The dowels become axels
8. Place the wheel and axel through the frame
9. Place 1 side stop on the outside of each wheel
10. Let it roll



________________ **(^^This is the basic racer design^^)**______________________

Additional Assembly Directions for Frame Extension

1. Remove the front wheels and axels, and set aside
2. Align the connector strips with the bottom row of holes on the hole plates, go in 10 holes
3. From the wheel go over three holes, ream the connector strip hole and insert a 5in dowel rod, put a yellow stopper on
4. From that dowel rod go over six holes and ream the connector hole and insert a 5in dowel rod, put a yellow stopper on the end
5. From the front of the connector strip count 2 holes back and insert a 4in dowel rod
6. From that dowel rod count 3 holes back and insert the 5in dowel rod with the wheels attached
7. On the back axel place a stop clip
8. Tie 2 rubber bands together and tie on the top 4in dowel on the hole plate structure
9. Place a stretch tire around each wheel
10. Tape a piece of cardboard on top of plates, w/a plastic cup to hold the balls
11. Wind the rubber band and let it roll

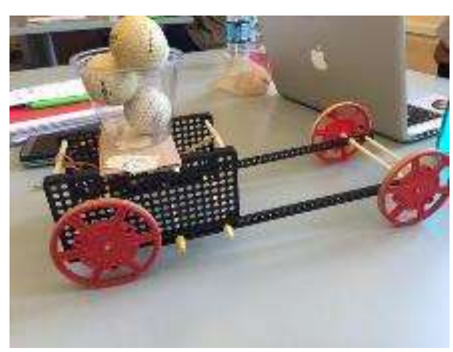


Directions for conducting experiment.

- Using different amounts of golf balls (testing weight), and placing the weight with the racer, determine the distance the racer travels with the different weights.

Check to see if they fill out their weight and distance table on their packet.

- The students need to start from a starting point and start with no golf ball in the cup, wind the rubber band and see how far the car travels. Repeat the same steps with 1, 2, 3, and 4 golf balls. They will be measuring the distance using whole, half and one-quarter measurements



Curriculum Development Rubber Band Racer (student copy)

Name____________________

Scenario: The local zoo needs a vehicle that can carry the weight of elephants at a far distance to move them to their new habitat. Assemble the racer as a model for the zoo vehicle, using the golf balls as a model for elephants.

Essential Question: Does the racer travel farther or shorter distance when more weight is having to be carried?

Challenge: Using the materials and tools listed below follow the technical/procedural assembly directions to build a rubber band racer. After the racer is built test the distance the racer travels using halves and forth inches, with different weight using golf balls. Record your observations in the table provided.

Materials:

- 2 Hole plates
- 4 wheel hubs
- 2 connector strips
- 1 3in slide stop (cut into ¼ in.)
- 4 stretch tire
- 2 rubber bands
- 1 stop clip
- 4 12in dowel (use cutters to create 5 4in. and 4 5in.)
- plastic cup
- tape
- cardboard
- 4 golf balls

Tools:

- 1 reamer
- 1 cutter
- measuring tape

Deliverables: The student's racer, they should have their worksheet chart filled out, and be able to make a prediction in the afterthought question.

Parameters or Constraints: You will only be able to use the materials provided, you will only have 20 minutes to build your racer, and you can only use golf balls as the weight being carried.

Evaluation: We will evaluate if you created the racer from the instructions provided, your work sheet, and the afterthought answer.

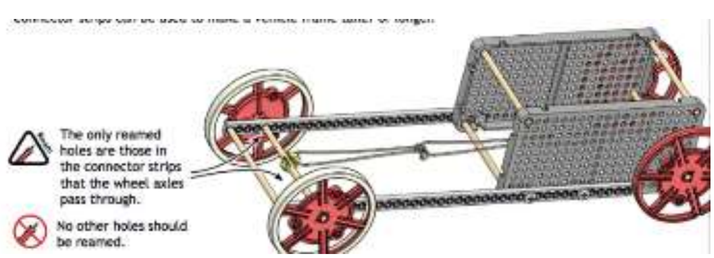
Assembly Directions:

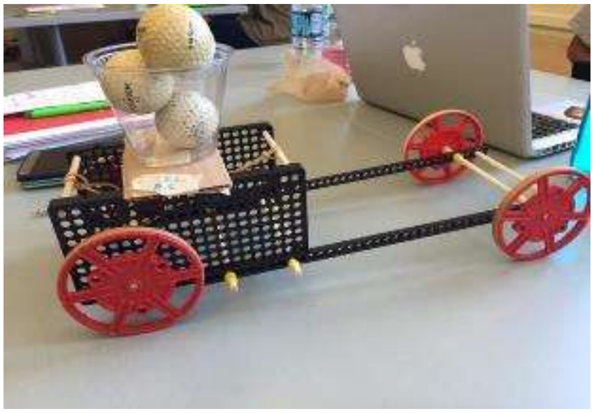
6. Insert the 4 4in dowels into the 4 outside corners of the two hole plates (w/ bottom sides facing)
7. Insert the 2 5in dowels into the wheels. The dowels become axels
8. Place the wheel and axel through the frame
9. Place 1 side stop on the outside of each wheel to help keep them from falling off
10. Let it roll

____________________ **(^^This is the basic racer design^^)**__________________________

Additional Assembly Directions for Frame Extension

1. Remove the front wheels and axels, and set aside
2. Align the connector strips with the bottom row of holes on the hole plates, go in 10 holes
3. From the wheel go over three holes, ream the connector strip hole and insert a 5in dowel rod, put a yellow stopper on
4. From that dowel rod go over six holes and ream the connector hole and insert a 5in dowel rod, put a yellow stopper on the end
5. From the front of the connector strip count 2 holes back and insert a 4in dowel rod
6. From that dowel rod count 3 holes back and insert the 5in dowel rod with the wheels attached
7. On the back axel place a stop clip
8. Tie 2 rubber bands together and tie on the top 4in dowel on the hole plate structure
9. Place a stretch tire around each wheel
10. Tape a piece of cardboard on top of plates, w/a plastic cup to hold the balls
11. Wind the rubber band and let it roll





<u>Directions for conducting experiment.</u>

- Using different amounts of golf balls (testing weight), and placing the weight with the racer, determine the distance the racer travels with the different weights.

Check to see if they fill out their weight and distance table on their packet.

- The students need to start from a starting point and start with no golf ball in the cup, wind the rubber band and see how far the car travels. Repeat the same steps with 1, 2, 3, and 4 golf balls. They will be measuring the distance using whole, half and one-quarter measurements

Number of Golf Balls	**Distance Racer Traveled** *(inches)*
0	
1	
2	
3	
4	

After Thought: *What pattern have you noticed that weight has on your racer?*