INTRODUCTION TO ENGINEERING AND TECHNOLOGY EDUCATION (ETE)

Curriculum Content Frameworks

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Grade Levels: 8 Prerequisite: None

Course Code:

Course Description: This 18 week course is designed to provide 8th and 9th grade students with an introduction and comprehensive overview of the fields of information and communication, construction, manufacturing, energy, power, and transportation technologies. Students will also develop an understanding of the history of technology and how the design loop is used to solve technological problems. Emphasis will be placed on the exploration of principles and concepts as well as the application of technological concepts and practices through the completion of experiments, learning exercises, field trips, writing activities, and design projects.

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Unit 1: History of Technology
Hours: 5

Terminology: Technology, technological literacy, technologically literate people, invention, innovation, consequences, portfolio

CAREER and TECHNICAL SKILLS What the Student Should be Able to Do		ACADEMIC and WORKPLACE SKILLS What the Instruction Should Reinforce		
Knowledge	**Application**	**Skill Group**	**Skill**	**Description**
1.1 Describe technology and the role that technology plays in society, culture, and history	1.1.1 View a video and participate in discussions to describe technology and how it effects daily life. 1.1.2 Develop an historical timeline illustrating the major milestones and development of famous inventions and innovations	Foundation Thinking Skills	Listening Writing Reasoning	Comprehends ideas and concepts related to technology [1.2.1] Communicates thoughts, ideas, or facts in written form in a clear, concise manner [1.6.6] Comprehends ideas and concepts related to technology [4.5.2]
1.2 Define technology and technological literacy and describe how a society can become more technologically proficient	1.2.1 Participate in discussions concerning technology and technological literacy 1.2.2 Develop a Technology Portfolio that demonstrates technological literacy	Foundation Thinking Skils	Listening Writing Reasoning	Comprehends ideas and concepts related to technology and technological literacy [1.2.1] Organizes information into an appropriate format [1.6.10] Comprehends ideas and concepts related to technology [4.5.2]
1.3 Identify and describe the unintended consequences of technology	1.3.1 View a video and participate in discussions concerning unintended consequences of technology 1.3.2 Participate in readings concerning unintended consequences of technology	Foundation Thinking Skills	Reading Reasoning	Analyzes and applies what has been read to specific task [1.3.2] Comprehends ideas and concepts related to the unintended consequences of technology [4.5.2]
1.4 Describe the core concepts and essential characteristics of technology	1.4.1 Participate in discussions concerning the core concepts and essential characteristics of technology 1.4.2 Participate in readings concerning the core concepts and essential characteristics of technology	Foundation Thinking Skills	Reading Reasoning	Analyzes and applies what has been read to specific task [1.3.2] Comprehends ideas and concepts related to the core concepts and characteristics of technology
1.5 Describe the innovations and contributions of significant inventors and innovators	1.5.1 Develop a presentation on a famous inventor 1.5.2 Continue developing a Technology Portfolio	Foundation Thinking Skills	Writing Creative Thinking	Communicates thoughts, ideas, or facts in written form in a clear, concise manner [1.6.6] Prepares presentation based on subject research [4.1.10]

Unit 2: The Engineering Design Process
Hours: 10

Terminology: Design, the design loop, orientation, orthographic projection, pictorial drawing, perspective, visualization

CAREER and TECHNICAL SKILLS What the Student Should be Able to Do		**ACADEMIC and WORKPLACE SKILLS** What the Instruction Should Reinforce		
Knowledge	**Application**	**Skill Group**	**Skill**	**Description**
2.1 Understand the importance of the design process	2.1.1 View a video and participate in discussions concerning the design process 2.1.2 Students will compare and contrast trial and error and the concept of using a systematic process in problem solving	Foundation Thinking Skills	Listening Knowing how to learn	Comprehends ideas and concepts related to the design process [1.2.1] Uses available resources to acquire new skills or improve skills [4.3.4]
2.2 Identify the steps in the design process	2.2.1 Students will list and describe the ten steps in the design process 2.2.2 Students will correctly order the steps in the design process and understand the importance of sequential steps	Foundation Thinking Skills	Writing Reasoning	Applies/Uses technical words and concepts [1.6.4] Applies rules and principles to a new situation [4.5.1]
2.3 Recognize the importance of sketching in the design process	2.3.1 Students will identify the correct orientation and relationship between the views of an object 2.3.2 Students will develop orthographic projections and pictorial sketches.	Foundation Thinking Skills	Math Seeing Things in the Mind's Eye	Uses basic geometric symbols, terms, principles, and formulas [1.1.34] Organizes and processes images – symbols, pictures, graphs, objects, etc. [4.6.2]
2.4 Understand the importance of measuring accurately	2.4.1 Students will accurately measure in both imperial and metric units	Foundation Thinking Skills	Math Science Knowing How to Learn	Calculates different units of measurement [1.1.6] Reads measurements from common measuring devices [1.4.20] Applies new knowledge and skills to the design process[4.3.1]
2.5 Demonstrate the ability to apply the steps of the design process to an invention, innovation, or design problem	2.5.1 Students will create and invention or innovation using the steps of the design process and specific criteria 2.5.2 Students will complete a design log for an invention or innovation	Foundation Thinking Skills	Science Problem Solving Creative Thinking	Applies knowledge to complete a practical task [1.4.3] Comprehends ideas and concepts related to the design process [4.4.1] Creates new design by applying specified criteria [4.1.3]

Unit 3: Introduction to Information and Communication Technologies
Hours: 15

Terminology: Communication, communication system, input device, output device, decode, encode, graphic communication, information, message, receiver, transmit

CAREER and TECHNICAL SKILLS What the Student Should be Able to Do		**ACADEMIC and WORKPLACE SKILLS** What the Instruction Should Reinforce		
Knowledge	**Application**	**Skill Group**	**Skill**	**Description**
3.1 Understand information and communication technologies using a systems model that includes inputs, processes, and outputs	3.1.1 Participate in discussions and readings concerning information and communication systems	Foundation	Listening	Comprehends ideas and concepts related to technology [1.2.1]
			Writing	Communicates thoughts, ideas, or facts in written form in a clear, concise manner [1.6.6]
	3.1.2 Students will complete a systems model outline for a given communication scenario	Thinking Skills	Reasoning	Comprehends ideas and concepts related to technology [4.5.2]
3.2 Explain that technological knowledge and processes are communicated using symbols, measurements, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli	3.2.1 Participate in discussions and readings concerning information and communication systems	Foundation	Listening	Comprehends ideas and concepts related to technology [1.2.1]
			Writing	Communicates thoughts, ideas, or facts in written form in a clear, concise manner [1.6.6]
	3.2.2 Students will create a chart that outlines and categorizes the four distinct types of communication		Math	Interprets charts, tables, graphs, and working drawings [1.1.25]
		Thinking Skills	Reasoning	Comprehends ideas and concepts related to technology [4.5.2]
3.3 Demonstrate the ability to communicate effectively using multiple types of media	3.3.1 Students will create and present a multi-media presentation on a form of communication technology	Foundation	Writing	Organizes information into an appropriate format [1.6.10]
			Speaking	Communicates a thought, idea, or fact in spoken form [1.5.5]
	3.3.2 Students will evaluate their peers on the use of effective communication	Thinking Skills	Creative Thinking	Prepares presentation based on subject research [4.1.10]
3.4 Utilize a Technology Portfolio to record ideas, projects, presentations, and other written work	3.4.1 Students will develop a Technology Portfolio that demonstrates their understanding of information and communication systems and their importance in career choices	Foundation	Writing	Communicates thoughts, ideas, or facts in written form in a clear, concise manner [1.6.6]
		Thinking Skills	Reasoning	Uses logic to draw conclusions from available information [4.5.6]

Unit 4: Introduction to Construction Technologies
Hours: 15

Terminology: Construction, building material, section-view, civil structural system, bridge, truss, constraint

CAREER and TECHNICAL SKILLS What the Student Should be Able to Do				ACADEMIC and WORKPLACE SKILLS What the Instruction Should Reinforce		
Knowledge		**Application**		**Skill Group**	**Skill**	**Description**
4.1	Identify and describe the core concepts of human-built structures	4.1.1	View a presentation and participate in discussions about human built structures	Foundation	Listening	Comprehends ideas and concepts related to technology [1.2.1]
					Writing	Communicates thoughts, ideas, or facts in written form in a clear, concise manner [1.6.6]
		4.1.2	Discuss the primary types types of housing in which people live	Thinking Skills	Reasoning	Comprehends ideas and concepts related to technology [4.5.2]
4.2	Identify materials used in construction	4.2.1	Students will sketch and label a standard section-view of a residential structure, identifying the building materials commonly used in construction	Foundation	Listening	Listens to and follow directions [1.2.6]
					Math	Draws to scale [1.1.20]
				Thinking Skills	Seeing Things in the	Visualizes a finished product [4.6.4]
4.3	Identify and describe civil structural systems	4.3.1	Students will participate in discussions about civil structural systems	Foundation	Listening	Comprehends ideas and concepts related to technology [1.2.1]
					Writing	Communicates thoughts, ideas, or facts in written form in a clear, concise manner [1.6.6]
		4.3.2	Students will work in groups to conduct research on important civil structural systems in their community, state, and region and then present their findings to the class	Thinking Skills	Reasoning	Comprehends ideas and concepts related to technology [4.5.2]
4.4	Create a structural model, test a design, and optimize a design	4.3.1	Students will accurately measure in both imperial and metric units	Foundation	Math	Draws to scale [1.1.20]
					Science	Reads measurements from common measuring devices [1.4.20]
		4.3.2	Students will design and test a bridge, truss, or tower with specific constraints			Constructs model to depict basic concept of construction[1.4.11]
				Thinking Skills	Creative Thinking	Creates new design by applying specified criteria [4.1.3]

Unit 5: Introduction to Manufacturing Technologies
Hours: 15

Terminology: Manufacturing, want, need, custom manufacturing, mass production, materials, composite

CAREER and TECHNICAL SKILLS What the Student Should be Able to Do		ACADEMIC and WORKPLACE SKILLS What the Instruction Should Reinforce		
Knowledge	**Application**	**Skill Group**	**Skill**	**Description**
5.1 Understand that modern manufacturing technologies produce quality goods at low prices; therefore, enhancing the quality of life for many people	5.1.1 Participate in discussions and readings concerning manufacturing technologies 5.1.2 Students will create a lifecycle of a manufactured good or product	Foundation Thinking Skills	Listening Writing Reading Reasoning	Comprehends ideas and concepts related to manufacturing [1.2.1] Communicates thoughts, ideas, or facts in written form in a clear, concise manner [1.6.6] Applies information and concepts derived from printed materials [1.3.3] Comprehends ideas and concepts related to manufacturing[4.5.2]
5.2 Classify manufacturing systems as customized production and mass production	5.2.1 Students will compare and contrast different products, classifying them as customized or mass-produced	Foundation Thinking Skills	Listening Reading Decision Making	Comprehends ideas and concepts related to manufacturing [1.2.1] Applies information to new situations [1.3.5] Evaluates information/data to make best decision [4.2.5]
5.3 Describe the core materials used in manufacturing.	5.3.1 Students will participate in discussions and readings that examine specific uses of plastics, woods, metals, and composites in manufacturing 5.3.2 Students will compare and contrast different products, categorizing them in relation to their base materials	Foundation Thinking Skills	Listening Reading Decision Making	Comprehends ideas and concepts related to manufacturing [1.2.1] Applies information to new situations [1.3.5] Comprehends ideas and concepts related to manufacturing [4.2.2]
5.4 Design and construct a class manufacturing project	5.4.1 Students will design and produce a manufacturing project	Foundation Thinking Skills Interpersonal Skills	Science Knowing How to Learn Teamwork	Applies knowledge to complete a practical task [1.4.3] Uses equipment and techniques appropriate in the field of manufacturing [1.4.23] Applies new knowledge and skills to manufacturing [4.3.1] Contributes to group with ideas, suggestions, and effort [2.6.2] Works effectively with others to reach a common goal [2.6.6]

Unit 6: Introduction to Energy, Power, and Transportation Technologies
Hours: 15

Terminology: Energy, power, kinetic energy, potential energy, renewable energy, non-renewable energy, flowchart, transportation, freight, rate, speed, velocity

CAREER and TECHNICAL SKILLS What the Student Should be Able to Do		**ACADEMIC and WORKPLACE SKILLS** What the Instruction Should Reinforce		
Knowledge	**Application**	**Skill Group**	**Skill**	**Description**
6.1 Define energy and power	6.1.1 Students will participate in discussions and readings concerning energy and power	Foundation	Listening	Comprehends ideas and concepts related to energy and power [1.2.1]
			Writing	Communicates thoughts, ideas, or facts in written form in a clear, concise manner [1.6.6]
	6.1.2 Students will create a table that categorizes types of energy and power		Reading	Applies information and concepts derived from printed materials [1.3.3]
		Thinking Skills	Reasoning	Comprehends ideas and concepts related to energy and power[4.5.2]
6.2 Differentiate between kinetic and potential energy	6.2.1 Students will conduct expirements using both kinetic and potential energy	Foundation	Listening	Comprehends ideas and concepts related to energy and power [1.2.1]
			Science	Performs experiment as specified [1.4.19]
		Thinking Skills	Problem Solving	Tracks and evaluates results [4.4.10]
6.3 Identify and describe common sources of renewable and non-renewable energy	6.3.1 Students will participate in discussions concerning renewable and non-renewableenergy and where the energy in their home is produced	Foundation	Writing	Composes and creates documents – letters, manuals, reports, proposals, graphs, flow charts, etc. [1.6.8]
			Listening	Comprehends ideas and concepts related to energy and power [1.2.1]
	6.3.2 Students will design a flowchart that identifies their personal use of energy	Thinking Skills	Problem	See relationship between two or more ideas, objects, or situations [4.5.5]
6.4 Understand the role that transportation plays in the operation of other technologies	6.4.1 Students will participate in discussions and readings concerning transportation and its relationship to other technologies	Foundation	Listening	Comprehends ideas and concepts related to energy and power [1.2.1]
			Writing	Communicates thoughts, ideas, or facts in written form in a clear, concise manner [1.6.6]
			Reading	Applies information and concepts derived from printed materials [1.3.3]
6.5 Identify and describe different modes of transportation	6.5.1 Students will work in groups to create an advertisement for a freight company that provides all modes of transportation	Foundation	Writing	Composes and creates documents – letters, manuals, reports, proposals, graphs, flow
		Interpersonal Skills	Teamwork	Contributes to group with ideas, suggestions, and effort [2.6.2]
		Thinking Skills	Creative Thinking	Combines ideas or information in a new way [4.1.2]

CAREER and TECHNICAL SKILLS What the Student Should be Able to Do				ACADEMIC and WORKPLACE SKILLS What the Instruction Should Reinforce		
Knowledge		**Application**		**Skill Group**	**Skill**	**Description**
6.6	Design and construct an air-powered vehicle	6.6.1	Students will design an air-powered vehicular system with specific constraints	Foundation	Science	Applies scientific principles related to transportation [1.4.5]
					Math	Calculates different units of measurement [1.1.6]
		6.6.2	Students will calculate and evaluate their designs' rate, speed, and velocity	Thinking Skills	Creative Thinking	Creates new design by applying specified criteria [4.1.3]
					Problem Solving	Demonstrates logical reasoning in reaching a conclusion [4.4.2]
						Draws conclusions from observations, evaluates conditions, and gives possible solutions [4.4.5]

Unit 7: Safety
Hours: As needed

Terminology: Safety procedure, OSHA, ergonomics, first aid, hazard avoidance, protective clothing, personal protection equipment, accident prevention, safety tests, materials safety

CAREER and TECHNICAL SKILLS What the Student Should be Able to Do				**ACADEMIC and WORKPLACE SKILLS** What the Instruction Should Reinforce		
Knowledge		**Application**		**Skill Group**	**Skill**	**Description**
7.1	Describe the need for safe work environments in the Engineering and Technology Educational classroom and laboratory	7.1.1	Maintain personal safety, workplace safety, hazard avoidance, safety information systems, protective clothing, fall protection, first aid, ergonomics, and environmental safety	Thinking	Seeing Things in the Mind's Eye	Imagines the flow of work activities from narrative descriptions [4.6.1]
		7.1.2	Explore implemented safety procedures and discuss classroom and laboratory safety		Knowing how to Learn	Applies new knowledge and skills to industrial safety [4.3.1]
					Creative Thinking	Makes connections between seemingly unrelated ideas [4.1.6]
				Personal Management	Responsibility	Pays close attention to details [3.4.8]
7.2	Describe specific procedures such as reporting illness, injuries, safety violations, etc.	7.2.1	Demonstrate understanding of specific work procedures such as reporting illness, injuries, safety violations, etc.	Foundation	Listening	Listens and follows directions [1.2.6]
7.3	Use appropriate and required personal protection equipment	7.3.1	Practice using appropriate and required personal protection equipment (eye protection, ear protection, etc.)	Thinking	Problem Solving	Devises and implements a plan of action to resolve a problem [4.4.3]

CAREER and TECHNICAL SKILLS What the Student Should be Able to Do			ACADEMIC and WORKPLACE SKILLS What the Instruction Should Reinforce		
Knowledge	**Application**		**Skill Group**	**Skill**	**Description**
7.4 Describe machine and tool safety practices and procedures	7.4.1	Demonstrate the ability to safely use common tools and machines found in given industrial settings	Thinking Skills	Decision Making	Demonstrates decision-making skills [4.2.4]
			Foundation Skills	Reading	Comprehends written specifications and applies them to a task [1.3.9]
	7.4.2	Demonstrate the ability to pass given safety tests that show evidence of personal safety competence on given tools and machinery			Reads and follows instructions to operate technical equipment [1.3.19]
	7.4.3	Participate in a discussion concerning securing machinery, securing guards and safety devices, slipping hazards, eye and ear protection, adequate space around machinery, machine vibration, hand feeding and retrieval tools, power transmission parts, blade and cutter safety, worker position safety, safe procedures for adjusting or repairing machinery, shear points, falling objects, flying objects, rotating parts, moving surfaces, etc.			Uses standard occupational resource materials [1.3.22]
				Science	Follows safety guidelines [1.4.15]
				Speaking	Participates in conversation, discussion, and group presentations [1.5.8]
			Thinking Skills	Problem Solving	Comprehends ideas and concepts related to machine and tool safety [4.4.1]
	7.4.4	Design and post a set of rules for machine safety, personal safety, hazard safety issues, rules for horseplay, materials safety, combustible materials, etc			
	7.4.5	Operate tools and equipment in a safe and hazard free manner to the satisfaction of the course instructor			

Glossary
Unit 1: History of Technology

1. Technology: the modification of the natural environment in order to satisfy perceived human needs and wants

2. Technological Literacy: the ability to use, manage, assess, and understand technology

3. Technologically Literate People: evaluate technological information, form opinions about technology, assess technological value, are neither afraid of nor infatuated with technology, understand how technology is created, exhibit a level of comfort with technology, and understand how it shapes and is shaped by technology

4. Invention: a new product, system, or process that has never existed before, created by study and experimentation

5. Innovation: an improvement of an existing technological product, system, or method of doing something

6. Consequence: is that which results from a given action (ie. cause and effect)

7. Portfolio: a graphic record of projects and activities completed by the student over a given period of time that illustrates how well a student has met the performance criteria

Unit 2: The Engineering Design Process

1. Design: an iterative decision-making process that produces plans by which resources are converted into products or systems that meet human needs and wants or solve problems

2. The Design Loop: a systematic problem-solving strategy, with criteria and constraints, used to develop many possible solutions to solve a problem or satisfy human needs and wants and to narrow down the possible solutions to one final choice

3. Visualization: to see in the mind's eye, a mental image that is similar to a visual perception

4. Orientation: the relationship between objects or views of an object

5. Orthographic Projection: the graphic representation of a 3-dimensional object in 2-dimensions, drawn through the use of projecting from one view to another (typically showing front, top, and right-side views)

6. Pictorial Drawing: a drawing that represents an object the way it appears to the human eye (Examples: isometric, perspective, and oblique drawings)

7. Perspective: a 3-dimensional representation of an object as it looks to the eye from a particular point

Unit 3: Introduction to Information and Communication Technologies

1. Communication: the successful transmission of information through a common system of symbols, signs, behavior, speech, writing, or signals
2. Communication System: a system that forms a link between a sender and a receiver, making possible the exchange of information
3. Input: something put into a system, such as resources, in order to achieve a result
4. Output: the results of the operation of any system
5. Decode: to convert a coded message into understandable form using ordinary language
6. Encode: to change a message into symbols or a form that can be transmitted by a communication system
7. Graphic Communication: communication through the use of words and images through the process of design, layout, and typography
8. Information: one of the basic resources used by technological systems. Information is data and facts that have been organized and communicated in a coherent and meaningful manner
9. Message: the information sent by one source to another, usually short and transmitted by words, signals, or other means. An arbitrary amount of information whose beginning and end are defined or implied
10. Receiver: the part of a communication system that picks up or accepts a signal or message from a channel and converts it to perceptible forms
11. Transmit: to send or convey a coded or non-coded message from a source to a destination

Unit 4: Introduction to Construction Technologies

1. Construction: the systematic act or process of building, erecting, or constructing buildings, roads, or other structures
2. Scale: a proportion between two sets of dimensions used in developing accurate, larger or smaller prototypes, models, and drawings of design ideas
3. Building Material: any tangible substance (wood, metal, glass, etc.) used in the construction process
4. Section-View: a view that shows an object as if part of it were cut away to expose the insides
5. Civil Structural System: a system that is designed to support or resist loads Ex. bridges, dams, pipelines, railways, roads, tunnels, waterways, etc.
6. Bridge: a structure spanning and providing passage over a gap or barrier, such as a waterway or roadway
7. Truss: a rigid framework, usually designed in triangles, designed to support or span a structure
8. Constraint: A limit to the design process. Examples of constraints are: appearance, funding, space, materials, human capabilities, etc.

Unit 5: Introduction to Manufacturing Technologies

1. Manufacturing: the process of making a raw material into a finished product; especially in large quantities

2. Want: something that you would like to have (television, cell phone, video games, etc.)

3. Need: something that you need in order to survive (food, water, shelter, etc.)

4. Custom Manufacturing: A type of manufacturing or production in which products are designed and built to meet the specific needs and wants of an individual

5. Mass Production: the manufacture of goods in large quantities by means of machines, standardized design and parts, and, often, assembly lines

6. Materials: the tangible substance (chemical, biological, or mixed) that goes into the makeup of a physical object. One of the basic resources used in a technological system
7. Composite: a type of material that results when two or more different but complimentary substances are physically combined

Unit 6: Introduction to Energy, Power, and Transportation Technologies

1. Energy: the ability to do work. Energy is one of the basic resources used by a technological system
2. Power: force over time (measured in foot-pounds, newton meters, or watts
3. Kinetic Energy: the energy possessed by a body as a result of its motion
4. Potential Energy: the energy of a particle, body, or system that is determined by its position or structure
5. Non-Renewable Energy: Finite energy resources that will eventually dwindle, becoming too expensive or too environmentally damaging to retrieve
6. Renewable Energy: any naturally occurring, theoretically inexhaustible source of energy, as biomass, solar, wind, tidal, wave, and hydroelectric power
7. Flowchart: : a common type of diagram that shows a process, generally showing the steps in a series of boxes and connected by arrows
8. Transportation: The process by which passengers or goods are moved or delivered from one place to another
9. Freight: goods that are transported, generally for commercial gain by ship, aircraft, train, or truck
10. Rate: a quantity measured with respect to another measured quantity (for example: a rate of speed would be 30 miles per hour)
11. Speed: the rate or measurement of motion. Distance traveled divided by time
12. Velocity: a vector measurement of rate and direction of motion of an object, the scalar magnitude of the velocity vector is the speed of motion

Unit 7: Safety

1. Safety procedures: Proper usage techniques for a given piece of equipment or tool
2. OSHA: Occupational Safety and Health Administration. A division of the Department of Labor that sets and enforces occupational health and safety rules
3. Ergonomics: The applied science of equipment design, as for the workplace, intended to maximize productivity by reducing operator fatigue and discomfort
4. First Aid: Emergency aid or treatment given to someone injured, suddenly ill, etc., before regular medical services arrive or can be reached
5. Hazard Avoidance: Systems designed to plan ahead and prevent dangerous workplace situation before they occur
6. Protective Clothing: Clothing aimed at protecting the skin from various health hazards that may be encountered in the workplace
7. Personal Protection Equipment: Includes equipment like safety glasses, gloves, hearing protection, etc. designed to protect the worker in hazardous areas
8. Accident Prevention: The practice of developing practices and habits that prevent accidents before the occur
9. Safety Test: A test designed to prove that a student has the appropriate skills and knowledge to safely operate a given tool or machine
10. Materials Safety: The act of using materials and resources in a safe and environmentally friendly manner