TURNING IDEAS INTO REALITY:
ENGINEERING A BETTER WORLD
Save Max!

Targeted Grades
6, 7, 8

STEM Career Connections
Mechanical Engineering
Chemical Engineering
Anatomy
Geology

STEM Disciplines
Science
Technology
Engineering

Non-STEM Discipline
English Language Arts

Academic Content Standards

Ohio's New Learning Standards: Science Cognitive Demands
Expectations for Learning Cognitive Demands K-12 **Designing Technological / Engineering Solutions Using Science Concepts:** Requires student to solve science-based engineering or technological problems through application of scientific inquiry. Within given scientific constraints, propose or critique solutions, analyze and interpret technological and engineering problems, use science principles to anticipate effects of technological or engineering design, find solutions using science and engineering or technology, consider consequences and alternatives, and/or integrate and synthesize scientific information. **Demonstrating Science Knowledge:** Requires student to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather and organize data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments. **Interpreting and Communication Science Concepts:** Requires student to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

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Expectations for Technology and Engineering Design: Guiding Principles Grades PreK-8

Technological Design:

Technological design is a problem or project-based way of applying creativity, science, engineering and mathematics to meet a human need or want. Modern science is an integrated endeavor. Technological design integrates learning by using science, technology, engineering and mathematics and fosters 21st Century Skills.

Technology and Engineering:

Technology modifies the natural world through innovative processes, systems, structures and devices to extend human abilities. Engineering is design under constraint that develops and applies technology to satisfy human needs and wants. Technology and engineering, coupled with the knowledge and methods derived from science and mathematics, profoundly influence the quality of life.

Examples of grades 5-8 appropriate skills expected of students:

- Understand and be able to select and use physical and informational technologies
- Understand how all technologies have changed over time
- Recognize role of design and testing in the design process
- Apply research, innovation and invention to problem solving

Ohio's New Learning Standards: Science Guiding Principles Grades 5-8

There is no science without inquiry. Scientific inquiry is a way of knowing and a process of doing science. It is the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Scientific inquiry also refers to the activities through which students develop knowledge and understanding of scientific ideas as well as an understanding of how scientists study the natural world.
Teachers need to model scientific inquiry by teaching with inquiry.

Theme: Order and Organization

This theme focuses on helping students use scientific inquiry to discover patterns, trends, structures and relationships that may be described by simple principles. These principles are related to the properties or interactions within and between systems.

During the years of grades 5-8, all students must use the following scientific processes, with appropriate laboratory safety techniques, to construct their knowledge and understanding in all science content areas:

- Identify questions that can be answered through scientific investigations;
- Design and conduct a scientific investigation;
- Use appropriate mathematics, tools and techniques to gather data and information;
- Analyze and interpret data;
- Develop descriptions, models, explanations and predictions;
- Think critically and logically to connect evidence and explanations;
- Recognize and analyze alternative explanations and predictions; and
- Communicate scientific procedures and explanations.

Ohio's New Learning Standards: Physical Science Grade 6

Matter and Motion

Content Statement: All matter is made up of small particles called atoms.

Each atom takes up space, has mass and is in constant motion. Mass is the amount of matter in an object.

Elements are a class of substances composed of a single kind of atom.

Molecules are the combination of two or more atoms that are joined together chemically.

Compounds are composed of two or more different elements. Each element and compound has properties, which are independent of the amount of the sample.

Content Elaboration:

Matter has properties of mass and volume. Mass measures the amount of matter in an object (e.g., a wood block) or substance (e.g., water), and volume measures the three-dimensional space that matter occupies. Equal volumes of different substances usually have different masses. Some materials, like lead or gold, have a lot of mass in a relatively small space. Other materials, like Styrofoam® and air, have a small mass in a relatively large amount of space. This concept of comparing substances by the amount of mass the substance has in a given volume is known as density.

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Ohio's New Learning Standards: English Language Arts College and Career Readiness Anchor Standards Grades K-12
Speaking and Listening **Comprehension and Collaboration:** ● Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. ● Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. ● Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric. **Presentation of Knowledge and Ideas:** ● Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.
Language **Vocabulary Acquisition and Use:** ● Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Learning Experience Overview

Essential Question

How can my team design a life vest to rescue a drowning dog from the lake? How can we use different types of materials to design a lifesaving flotation vest that can save a dog from drowning in a lake?

Enduring Understandings

- Collaborating and using the engineering design process can result in designing unique solutions to society's challenges.
- The properties of a material (such as its density) determine its ability to float or sink in water.

Design Challenge Problem/Scenario

You are on a vacation at your friend's lake house. You and your friend's family decide take Max, the family dog, and go out on the lake for a boat trip. While out on the boat, the water becomes rough and Max falls overboard into the water. Since Max is still a puppy, he does not know how to swim yet.

Engineering Design Challenge

Your team's challenge is to use supplies that are on the boat to create a life vest that will keep Max afloat. Max has already fallen overboard, so the life vest must be put on quickly to save him.

The goal for the students to design and test a floatation device to keep a soup can above the water. The device must be in one attached piece and able to be affixed to the can within a 20 second period (so students cannot just add attach foam or balloons to the can -- but they could assemble their floatation device and then put their can in it, or wrap it around the can). Some

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portion of the can must touch the water and get wet. The can should not be placed in a boat, for example, where it would remain dry.

***To add more of a challenge and/or extra time, limit the amount of materials they can use for their design (or even eliminate some materials from the design).*

Prerequisite Knowledge & Skill (as connected to academic content standards)

- **Grades PreK-2:** Properties are descriptions that can be observed using the senses. Materials can be sorted according to their properties. Changes in materials are investigated.
- **Grades 3-5:** Objects are composed of matter, which has mass* and takes up space. Matter includes solids, liquids and gases (air). Volume is the amount of space an object takes up. The total amount of matter and mass* remains the same when it undergoes a change.
  **While mass is the scientifically correct term to use in this context, the NAEP 2009 Science Framework (page 27) recommends using the more familiar term "weight" in the elementary grades with the distinction between mass and weight being introduced at the middle school level. In Ohio, students will not be assessed on the differences between mass and weight until Grade 6.*

Activity Timeframe and Overview *(50 minutes)*

Activity	Time	Overview
Introduction	*2 minutes*	Introduce Yourself Provide Brief Activity Overview to Foster Excitement
Pre-Assessment	*3 minutes*	Administer Kit's Pre-Activity Survey
Design Challenge Introduction	*10 minutes*	Begin PowerPoint Presentation: ● Guide Discussion ● Briefly Explain How Life Vests Work ● Present the Engineering Design Challenge ● Explain the Engineering Design Process
Individual Brainstorm	*2 minutes*	Team Members Individually: ● Write Solution Ideas on Post-It Notes
Prototype Design and Construction	*15 minutes*	Teams Collaboratively: ● Discuss Individual Ideas ● Choose and Sketch Final Idea for Approval ● Gather Materials and Construct Team Prototype
Testing	*10 minutes*	Prove Device Can be Put on Can in Less Than 20 Sec. Perform and Observe Prototype Testing
Conclusion	*5 minutes*	Cleanup Relate to Engineering; They Did What Engineers Do Connect to Types of Engineering

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Post-Assessment	*3 minutes*	Administer Kit's Post-Activity Survey

Material List

Material	Quantity per Team	✓	Quantity per Kit	✓
Tomato Soup Cans	~		3 (testing)	
Balloons	1		8	
Foam Pieces	1		8	
Paper Cups	1		8	
Rubber Bands	3		24	
Paper Clips	4		32	
String	1 foot		8 feet	
Elmer's Glue	1 bottle		8 bottles	
Ziploc Snack Bags	2		16	
Bucket *(Filled with water for testing)*	0		1	
Water *(to fill bucket)*			1	
Paper	5 sheets		40 sheets	
Pencils	5		40	
Pre-Activity Survey	~		25 copies	
Post-Activity Survey	~		25 copies	
Cardstock	1 sheet		1 pack	
Paper *(For individual brainstorming)*	1 sheet		25 sheets	
Paper *(For team design sketch)*	1 sheet		15 sheets	

Instruction

Instructional Sequence

Note: The activity's PowerPoint presentation guides instruction and visually presents information to students. Therefore, the instructions include corresponding slide numbers.

1. Slide 1: As the pre-activity survey is distributed to students, introduce yourself and provide enough of an activity overview to gain students excitement.
2. Allow time for students to individually complete their pre-activity survey.
3. Divide group into teams of 2 to 4 students (preferably 3 is possible).

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4. Slides 2 and 3: Discuss engineering and what engineers do.
5. Present the engineering design problem and challenge, following presentation:
   - Slide 4: Explain that students will be taking on the role of mechanical engineers as they complete the engineering design challenge.
   - Slide 5: Present the real-world engineering design problem (scenario).
   - Slide 6: Introduce the Engineering Design Challenge.
   - Slide 7: Share Engineering Design Goals.
   - Slide 8: Introduce resources (materials) available to each team.
   - Slide 9: Explain prototype-testing procedures.
6. Slide 10: Introduce the Engineering Design Process. Explain that engineers use it as a tool to help them more effectively solve problems.
7. Slide 11: Explain how teams will use the engineering design process as they complete the challenge.

   Imagine *(10 min.)*
   - INDIVIDUALLY: observe available materials, and brainstorm and write design ideas *(5 min.)*
   - TEAM: share individual ideas *(5 min.)*

   Plan *(5 min.)*
   - Choose and sketch a team design plan

   Create *(10 min.)*
   - Gather materials
   - Construct your team design plan

   Improve and Test *(10 min.)*
   - Teams decide on and make any last minute improvements before testing
   - Each team tests their prototype while other teams observe.
8. Slide 12: Facilitate a whole group reflection on final prototype design and testing results by asking questions such as the following.
   - What do you like best about your design?
   - What do you like least about your design?
   - What aspects of other team designs stood out to you, and/or gave you ideas for improving your own team's design?
   - What modifications would you make if we had time to complete the design challenge again?
   - What was special properties of the materials you used in your design helped it be able to float?
9. Slide 13: Conclude by cleaning up and discussing the following questions as post-activity surveys are distributed.
   - What ideas do you have for engineering a better world?
   - How can you turn ideas into reality?
10. Allow time for students to complete their post-activity survey.

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STEM Career Connections

STEM Career Connection

- **Mechanical Engineering (MEE):** Mechanical Engineering is an area that can be affected by personal floatation devices because these PFDs need to be carefully designed in order to secure the safety of the individual. If designed incorrectly or with some sort of flaw, this can result in very serious consequences.
- **Chemical Engineering (CME):** Chemical Engineering is an area that can be affected by liquids due to the density of the liquids in comparison to other liquids or solids. The density of an item can affect whether it floats or sinks. This can be seen in food products, where if you don't mix up the item, it may have a layer of oil or water on top since that liquid is less dense than the liquid underneath of it.

Technical Brief:

Very useful resource that provides explanation of the activity:
"Live Vest Challenge" http://www.tryengineering.org/lessons/lifevest.pdf
(Life vest challenge, n.d.)

Assessments

- Pre-Activity Survey
- Post-Activity Survey

References

Life vest challenge. (n.d.). *Tryengineering.com*. Developed by IEEE as part of TryEngineering. Retrieved from: http://www.tryengineering.org/lessons/lifevest.

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