

What's in STEM Lessons and Challenges

15 Engaging Units

Each grade of *STEM Lessons and Challenges* offers 15 grade-appropriate challenges representing life, earth, and physical science. Each unit is focused on a hands-on activity in which students work together as engineers to design, prototype, test, and refine their creation. Each unit also includes informational text and graphics about the science concepts at the core of the challenge.

Features

Teacher Overview

The unit begins with an overview that explains how to prepare students for the challenge and how students use the design process materials.

STEM Challenge: Helmet

Task: Students will work in small groups to design and create a helmet that will protect a water balloon from breaking upon impact.

Getting Started

Build Content Knowledge
If you wish to provide students with background knowledge about the properties of protective materials, reproduce and distribute pages 82 and 83. Then have students read and discuss the science concept and the visual literacy graphics on those pages.

Introduce the Challenge
Reproduce and distribute the STEM Challenge on page 84. Then have students read the challenge and the testable goal. Discuss the materials with the students and decide on a plan for gathering the materials.

Next, have students research helmets and other protective devices. Ask them to think about how science, technology, engineering, and math are used to create protective devices. Finally, have students independently brainstorm and draw their ideas on page 84.

Completing the Challenge

Assign students to small groups.

Optional: Model the Design Process
You may wish to reproduce and distribute page 86 to students. This resource is intended to help students think about how to approach each step in the design process.

Design Process Worksheets
Reproduce and distribute the STEM design process worksheets to students. Provide support when needed to help students describe and evaluate their plans.

After the Challenge
Have students share their design processes, compare their helmets, and brainstorm ideas for improvements.

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STEM Challenge: Helmet Science Concept

Properties of Protection

Helmets help protect against head injuries. A common type of injury to the brain is called a **concussion**. Concussions are caused by an sudden blow or bump to the head. They can happen when your head hits something hard such as the ground. If you fell, where would you rather hit your head, on a pillow on the grass, on the beach, on a foam mat, on cement, or on bricks? Some of these surfaces are soft and squishy and absorb the force of the hit. The hard surfaces don't.

Your brain is protected by your skull, which is made of bone. Bone is a hard material that grows inside your body. When you are young and healthy, bone does not break easily, but it can break if you have an accident on your bike, skateboard, or skis. That's why you should always wear a helmet when doing these activities or similar ones.

In order to protect something, a helmet has to be harder than the thing being protected. **Hard** materials such as wood or ceramic are often also **brittle** and stiff, however. They will hold their shape unless they encounter a force that is too hard. Then they will crack. A hard material like leather or cardboard that is **flexible**, or can bend, can be useful if it does not bend too much. **Elastic** material, like a rubber ball, can change a greater amount under force and then go back to its original shape.

The inside of a helmet needs to keep the head secure so it doesn't bounce around inside the hard outer layer. It should be lined with softer, absorbent material that can be **compressed**, or squeezed slightly.

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STEM Challenge: Helmet Visual Literacy

hard material

brittle material

absorbent material

flexible material

elastic material

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Science Concept and Visual Literacy
These pages provide students with foundational information about the concepts that are relevant to the challenge they are completing.

STEM Challenge

This page introduces students to the specific task and the goal. It also provides space for students to brainstorm their ideas individually.

STEM Challenge: Helmet Challenge

Helmet

Challenge: Design a helmet that protects a water balloon.

Testable goal: A water balloon inside your helmet does not break when thrown against a wall.

Research: Look at pictures of bike, sport, and safety helmets. Notice how the helmets are constructed. Think about how science, technology, engineering, and math are used to create the helmets.

Brainstorm: Draw one or more design ideas for a helmet. There are many different ways to complete this challenge. Be creative!

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Suggested Materials List

This unit-specific list is divided into two or three sections: items that each group should be given, items that should be available in a central location in the classroom for all groups to use, and items that relate specifically to testing whether each creation meets the goal. You may choose to substitute or add items as needed.

Consider making the testing items available during the creation phase if students need to check their work as they go.

STEM Challenge: Helmet

Suggested Materials List

Items for the whole class

- cardboard
- foam sheets
- floral foam bricks
- air-filled packing pillows
- marshmallows
- plastic wrap
- rubber bands
- packing tape
- string
- cork pieces
- clay
- newspaper

Items for testing

- water balloons

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STEM Challenge: Helmet

Think About the Design Process

- 1 Plan**
Think about the materials available to you. How can you use the materials to create a helmet that will protect a water balloon?
- 2 Create**
Use the materials you have to create a helmet. Follow your design as closely as possible.
- 3 Test**
Place the water balloon securely inside your helmet. Then go outside and throw it against a solid wall.
- 4 Evaluate and Revise**
Evaluate the performance of your helmet. What revisions can you make to improve its performance? Repeat the design process until you are satisfied with your helmet.

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Think About the Design Process Worksheet

This optional page can be used to help students apply the design process to the specific unit.

STEM Challenge: Helmet

Design Process

- 1 Plan:** Describe and draw your design. List your materials.
- 2 Create**
- 3 Test:** Describe and draw your results.
- 4 Evaluate**

STEM Challenge: Helmet

Redesign Process

- 1 Redesign:** Describe what you will change. Draw your new design.
- 2 Revise or re-create**
- 3 Test:** Describe and draw your results.
- 4 Evaluate**

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Design Process and Redesign Process Worksheets

These worksheets guide students through each step of the design process and provide space to document their plan, materials, results, evaluations, and revisions.

Additional Feature

STEM Planner

Students can fill out this sheet in conjunction with their individual brainstorming. It guides students to anticipate how each aspect of STEM may contribute to the project.

STEM PLANNER

How to Make STEM Challenges Successful

- **Prepare for the lesson and the challenge.** Review the first page of the unit, which contains details for using each page of the unit. Also review the Suggested Materials List to see which materials you need for the challenge.
- **Determine the size of the groups students will work in.** Think about the materials needed, how long it will take to test their creations, and the optimal group size that encourages every student to be actively involved.
- **Determine the pace for completing the lesson and the challenge.** Plan how much time you will allot for students to read and discuss the Science Concept and Visual Literacy pages and to complete the individual and group brainstorming. The challenges can be created in a single time block. Some may require more than a day to dry, and some may require specific weather conditions in order to test the results.
- **Display the materials.** Allow students to see the available materials before they start to brainstorm. The materials may elicit ideas and also let them know what their constraints are.
- **Foster a creative environment.** Have students begin by brainstorming independently. This will allow students to work through their thought processes at their own pace. Once students are working in groups, let them design and problem-solve however they wish: sketch on paper, see how materials work together, or conceptualize in their head first. Remind students that there is no one correct solution.
- **Consider increasing the difficulty.** You may wish to set constraints, such as time limit, size, or minimum/maximum number of materials used.
- **Facilitate productive struggle.** Productive struggle is often part of the learning process. Guide students with leading questions if needed. Learning that occurs when students find and correct their own mistakes is strongest.
- **Support discussion and discourse.** Allow sufficient time for sharing solutions and results and discussing design strategies. Modeling a variety of approaches offers valuable learning benefits and encourages peer respect and cooperation.
- **Extend the lesson.** You can expand the activity to incorporate other content areas:
 - Have groups give their creation a brand name or design (art and economics).
 - Have groups create an ad for their creation (art and economics).
 - Give each material a dollar value and require groups to stick to a budget (math and economics).
 - Have groups summarize their stumbles and success and details of what they learned along the way (science and language arts).

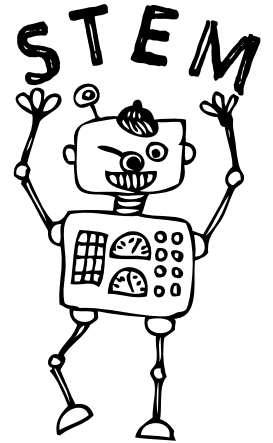
Why STEM Is Important

Including STEM lessons in your curriculum is more important than ever. Economists say that by the middle of the century, there will be 80,000,000 new jobs in automation. Technology is growing at a tremendous rate. The students you are teaching now will be tomorrow's innovators. They will need to reason and be creative to solve problems that don't exist yet!

STEM projects integrate science, technology, engineering, and math skills in a problem-solving challenge. These hands-on challenges invite students to apply critical thinking, innovation, and communication to solve all types of real-world problems, even those in areas other than science or engineering.

The STEM projects in this book foster an innovator's mindset: an innovator is collaborative, observant, persistent, flexible, aware of others' needs, and unafraid to risk failure. There are many routes to solutions. Few are clear; most have dead ends along the way. Students learn much about what not to do from dead ends, which are as valuable as the more obvious successes. Even if students don't meet the original goal, what they have learned along the way makes the trip valuable.

The STEM projects should be attempted in groups. As in real jobs, people work in teams, contributing their unique perspective and ideas and learning from others. This fosters communication, collaboration, and respect for others.



Reproduce and distribute to students.

Tips for STEM Challenges

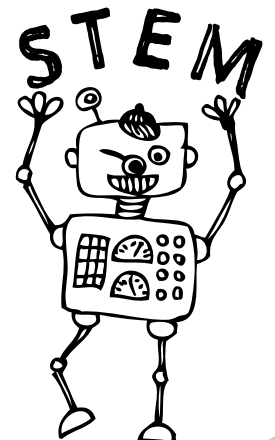
STEM challenges allow you to exercise your brain in new ways. There is no single way to solve any problem. Be creative and innovative! These tips can help.

Think about all the ways to use the materials: For example, you can use a straw in many ways. A straw can be something you use to blow through or something that rolls, holds things up, provides stiffness, insulates, floats, bends, and guides round objects and water.

Think about how the science concept relates to the goal: Use the concept as a clue. Think about how you've seen the concept work before. Compare the examples described or shown with what you are trying to make.

Use trial and error: Start experimenting with the materials. Put things together, see what they do, and add something that gets you closer to what you are trying to accomplish.

Keep trying: Sometimes it takes several tries to make an idea work. Learn from new problems that happen, and don't give up. When you find a solution, you'll feel great!



STEM Materials Needed

Dear Parent/Guardian,

Our class is doing a STEM activity on _____
(date)

Can you please provide the following materials by the date above?

Thank you!

Sincerely,

_____, Room _____

STEM Planner

Name: _____

What are some **S**cience ideas that you might need to use?

How will you use **T**echnology to learn about or complete your challenge?

How will you use **E**ngineering to invent a solution?

What kind of **M**ath measurements, calculations, or data might you make or collect?
