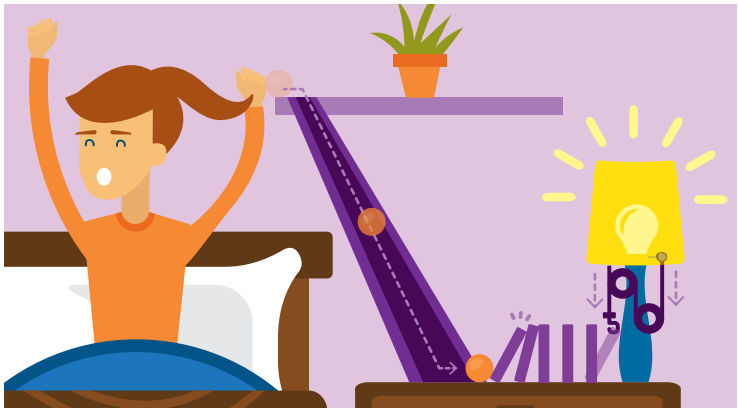
EDUCATOR GUIDE

Exploring Chain Reactions

Grade Levels: 4-8
Duration: 60 min

Students explore concepts around simple machines and energy transfer by building components for chain reactions. With additional time and materials, they refine their designs into a connected chain reaction.



Concepts/Skills

Simple machines, energy transfer, potential and kinetic energy, perseverance, cause and effect

Objectives

Students will:

- Explore simple machines and energy transfer by building several components of a chain reaction.
- Identify the ways in which energy is transferred and stored in their chain reaction.
- Explore the use of triggers (release mechanisms).
- Iterate and improve their designs based on testing and observation of failure points.

The Tech Challenge

This activity can be used to prepare students for the 2022 Tech Challenge: Kinetic Commotion, presented by Amazon.

This resource provides guidance for leading the **Exploring Chain Reactions activity** in an educational setting, virtually or in person.

Materials and Preparation

- Tape off an area for each team to work.
- If working on the activity over several sessions, provide bins or bags for teams to store their materials. Remind teams to measure and keep records about their devices so that they can ease the set-up process.
- For a virtual implementation, have students do a **Materials Treasure Hunt** to gather items for the challenge.

See the **Exploring Chain Reactions Activity Guide** for the full materials list.

thetech.org/bowersinstitute
thetech.org/thetechchallenge
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The Bowers Institute
The Tech Challenge
Presented by Amazon

Sample Outline

Frame the Challenge			**15 min total**
Activate Prior Knowledge	Spark student interest and lead an initial discussion about simple machines and energy transfer.	10 min	
Introduce the Challenge	Introduce the design problem and materials. Set criteria and constraints.	5 min	
Design Challenge Part 1			**45 min total**
Explore	Each team picks a Chain Reaction Challenge Card. Teams explore the materials while they brainstorm what they will build.	7 min	
Create and Test (Prototype)	Students work in teams to build and test their designs, taking notes on their iterations in journals or data collection tools.	20 min	
Share Solutions	Teams briefly share their device and engineering process, including what they would do if they had more time.	13 min	
Debrief	Debrief the experience and concepts with students.	5 min	
With additional time and resources, teams move on to the Chain Reaction part of the activity.			
Design Challenge Part 2			**45 min total**
Introduce New Criteria	Review the design problem and set new criteria and constraints.	5 min	
Create and Test (Prototype)	Students work in teams to build and test their devices, taking notes on their iterations in journals or data collection tools.	20 min	
Share Solutions	Teams briefly share their device and engineering process, including what they would do if they had more time.	15 min	
Debrief	Debrief the experience and concepts with students.	5 min	
Extensions			
Provide additional prototyping sessions or continue to introduce new criteria through the Explore More section of the activity.			

Facilitation Tips

This resource is designed to accompany the **Exploring Chain Reactions Activity Guide**. See the guide for detailed procedures and additional suggestions.

Introduce the Challenge

- Use criteria and constraints to define the problem. (Have middle and high school students work together to identify criteria.) Examples might include:

Criteria	**Part 1** • Include at least one simple machine. • Works consistently three times in a row. **Part 2** • Include at least three different simple machines. • Device has three different places where the energy is transferred from one object to another.
Constraints	• Budget: Only use the materials available. • Schedule: 20 minute time limit

Create and Test (Prototype)

- Ask open-ended questions to support students throughout the process:
  - *How can you use stored **potential energy** or **kinetic energy** to your advantage as you build?*
  - *What **failure point(s)** did you notice during testing? What caused the failure?*
    - *How could you alter that part of the device?*
  - *Where does the energy in your design come from? How is **energy transferred** from the beginning to end?*
  - *How could you use simple machines differently in your device?*
  - *What **trade-offs** might you need to make to **optimize** your design?*

Share Solutions

- Encourage teams to point out where they used key concepts (e.g., identifying the simple machines in their design, or describing how energy is transferred within their machine).
- When demonstrating the machine, it may be useful to limit the number of resets that students can make if their machine does not run as expected. *For example:* Limit teams to three tries with a reset time of 30 seconds.
- Remind students to focus on the process and what they are learning from the experience overall. Encourage them to reflect on key mindsets like perseverance and collaboration throughout the challenge.

Standards Connections

Next Generation Science Standards

Grade	Standard		Description
4	**Performance Expectation**	4-PS3-4	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
6-8	**Performance Expectation**	MS-PS3-2	Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
9-12	**Performance Expectation**	HS-PS3-3	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
Related Standards		3-5-ETS, 4- PS3-3, MS-ETS1-4., MS-PS3-5, HS-ETS1	

Vocabulary

For more tips on vocabulary and common engineering terms see our **Tech Tip: The Language of Engineering**.

- **Energy:** The capacity to do work; appears in many forms, all of which are either kinetic or potential.
- **Energy transfer:** The conversion of one form of energy into another, or the movement of energy from one place to another.
- **Failure point:** A place where the design or system failed.
- **Kinetic energy:** Energy of motion, includes heat, sound, and light (motion of molecules)
- **Optimal design:** The design or device that best meets the criteria and constraints.
- **Optimization:** The process of iterating, refining and making trade-offs until a solution is found that best meets the criteria within given constraints.
- **Potential energy:** Energy that is stored and held in readiness; energy of position (gravitational or elastic potential energy); or chemical potential energy (e.g. fossil fuels, electric batteries, and food consumed).
- **Trade-off:** A situation in which you must choose between or balance two things that are opposite or cannot be had at the same time.
- **Trigger:** A built-in mechanism that releases the stored energy in a device.
- **Motion kinetic energy:** A moving object like throwing a ball.
- **Gravitational potential energy:** Potential energy created by increasing height.
- **Elastic potential energy:** Potential energy created by deforming an elastic object like a rubber band or a bouncy ball.
- **Sound kinetic energy:** Sound waves are made when something vibrates.
- **Stored energy:** Stored energy is captured energy produced at one time for use at a later time.

Tech Tips

See our **educator guides and videos** for more design challenge facilitation techniques.
For this lesson check out:

- Innovator Mindsets
- Materials Strategies for Engineering Design