Action Contraption

Leader Notes

Design a Rube Goldberg–type machine, using everyday materials, that successfully performs a simple task.

Time
1 to 2 Hours

Careers
Materials Science
Mechanical

Topic
Art & Science
Forces, Motion & Energy

Grades
3–5, 6–8

How to Use This Activity

1. Review the Leader Notes, Student Instructions, and Challenge Video. Then decide how to group students to complete the activity. This challenge is great fun for students working in pairs, if possible. They can collaborate, discuss their design, and enjoy testing together.
2. Make copies of the Student Instructions so that each student has their own copy to reference during the whole-group activity.
3. Find a few videos of simple Rube Goldberg–inspired machines to share with students. In addition to simple examples built by kids, consider showing *This Too Shall Pass* by OK Go for fun and inspiration.
4. Find an indoor space for students to build, such as a gymnasium, cafeteria, or multipurpose room. Each pair will need about 10 feet of space. If space is limited, consider requiring them to build a vertical contraption.

Success Criteria

- The machine must successfully transfer energy to accomplish a simple task, such as ringing a bell.

Engineering Constraints

- The machine must produce a chain reaction consisting of at least four actions, each one leading to the next.
- The chain reaction must span a total distance of at least six feet.

Materials

Per pair:
- Bell, small
- Paper
- Pencils

In addition, provide a variety of building materials for students to explore. You can also introduce the challenge ahead of time and encourage them to bring materials from home. Some possibilities include:
- Action figures
- Balloons
- Balls (ping-pong, tennis, rubber, etc.)
- Blocks
- Books
- Cardboard (boxes, sheets, and tubes)
- Coins
- Cups (non-breakable)
- Dominoes
- Fan
- Funnels
- Instruments (xylophone, drum, tambourine, wind chimes, etc.)
- Marbles
- Plastic containers
- Popsicle sticks
- Rubber bands
- String or yarn
- Tape
- Toy cars

Instructions

Introduce the Challenge

1. Tap into students' prior knowledge about Rube Goldberg by asking questions such as:
   - Has anyone ever heard of Rube Goldberg?
   - Who was he? What is he famous for?
   - What is a Rube Goldberg machine?

2. Explain that Rube Goldberg was an engineer, inventor, and cartoonist who lived in the late 1800s through 1970. He was famous for his comic strips that showed overcomplicated ways to perform simple tasks. His "action contraptions" were made up of a chain reaction that transferred energy from one action to the next.

3. Tell students that each part of a Rube Goldberg machine has potential energy, or energy that is stored in an object because of its position. For example, a skateboard at the top of a hill has more potential energy than a skateboard at the bottom of a hill. If pushed, the potential energy of both skateboards is converted into kinetic energy, but the skateboard at the top of the hill will travel farther because it has more potential energy. Kinetic energy is the energy an object has while it's in motion. When the object slows down and stops, the kinetic energy has been converted back into potential energy.

4. Further explain that kinetic energy can be transferred to another object. Think of a golfer swinging their club at a golf ball. The club has kinetic energy that is transferred to the golf ball upon contact. The ball flies through the air until it uses up its kinetic energy, lands, and comes to a stop.

5. Show the Challenge Video and any others that you've collected. First, show a video of a simple Rube Goldberg–inspired machine. Point out parts of the machine that hold potential energy and instances where the potential energy turns into kinetic energy. Then show a more complex example for fun and inspiration. (Be sure to let students know that the expectation is to design a simple Rube Goldberg machine.) Finally, show the Challenge Video to review the parameters of the activity.

6. If the video examples include visual, auditory, and kinetic elements, point them out and encourage students to incorporate these elements into their designs.

Brainstorm Solutions

1. Introduce the materials that students can use to build their Rube Goldberg machines. Highlight materials that will inspire students to create actions that include visual, auditory, or kinetic elements.

2. Have students work in pairs to brainstorm and sketch their action contraptions. Encourage them to consider the initial action and the transitions between each part of their machine. They can also consider actions that utilize vertical space.

3. Remind students of the design constraints and success criteria.

Build, Test, Redesign

1. Distribute a bell to each pair and assign them a space to build their contraptions.

2. As they work, circulate and provide support as needed. To encourage students to think more deeply about the challenge, ask guiding questions such as:
   - Describe each part of your machine. How will the energy transfer from one part to the next?
   - What action is needed to start your machine? Is there any special equipment you need?
   - Which parts of your machine are the most reliable? Which parts are less reliable? Is there anything you can do to ensure that those parts work every time?

3. Give students time to build, test, and redesign.

4. (Optional) If mobile devices are available, students may enjoy creating videos of their contraption in action—the outtakes as well as the successes!

Reflect

1. Bring students together to discuss and share. Ask questions such as:
   - What did you think of the challenge?
   - Which parts of your machine worked well every time? Which parts were less reliable? Why?
   - What changes did you make to ensure that your machine worked as planned?
   - Who would like to demonstrate how their action contraption works? (Encourage students to use scientific concepts in their explanation, such as potential energy and kinetic energy.)

2. Read the success criteria aloud and have students raise their hands if they met it.

Engineering & Science Connections

- Mechanical engineers solve problems that involve energy generation, storage, and transfer. They consider the potential energy of an object and how it can be converted into kinetic energy. Think about a big roller coaster. The car travels up a steep hill, building its potential energy. When it gets to the top, that potential energy is converted to kinetic energy as the car accelerates downward. If the mechanical engineer successfully designed the track, the car has enough kinetic energy to move through a corkscrew or loop, or up another hill, thrilling its passengers with each turn. The mechanical engineer must know how much kinetic energy the car has at any given point on the track to make sure it has enough to propel it through its next obstacle.

Credit: Photo by Mylo Kaye on Pexels.

Extensions

- Combine pairs into groups of four and have them merge their machines. Challenge them to make the larger contraption work reliably every time to complete a single task at the end.
- Change the task. Let students choose their own end goal for their machine. You may need to set some parameters that are achievable and workable within your space.
- Read the book *Just Like Rube Goldberg: The Incredible True Story of the Man Behind the Machines* by Sarah Aronson.

NGSS Standards

Grades 3–5

4-PS3-1 Use evidence to construct an explanation relating the speed of an object to the energy of that object.

4-PS3-3 Ask questions and predict outcomes about the changes in energy that occur when objects collide.

4-PS3-4 Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Grades 6–8

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.

MS-PS3-5 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.