# Marshmallow Launcher

*Section* ENERGY

**Estimated Time** Setup: 10 minutes; Procedure: 15 minutes

## OVERVIEW

Launch marshmallows from a plastic-spoon catapult to demonstrate the differences between potential and kinetic energy and explore the law of conservation of energy.

This lesson examines properties of matter and introduces kinetic and potential energy and energy transfer. Students create a catapult using a plastic spoon and explore ways to make marshmallows travel the farthest through the air.

## INQUIRY QUESTIONS

**Getting Started:**

- What is energy? Are there different types of energy?

**Learning More:**

- What are differences between kinetic and potential forms of energy?

**Diving Deeper:**

- How is energy transferred between different types? How is kinetic energy converted to potential energy, and what does this energy transfer look like?

## CONTENT TOPICS

**This activity covers the following content topics:** measurement, properties of matter, energy (potential, kinetic)

**This activity can be extended to discuss:** conservation of energy, forces

## NGSS CONNECTIONS

**This activity can be used to achieve the following Performance Expectations of the Next Generation Science Standards:**

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

## MATERIALS

**For one setup:**

- Plastic spoons
- Marshmallows - miniature and regular size
- Permanent marker
- Tape measure or yardstick
- Masking tape

**Optional materials:**

- Protractor

## ACTIVITY NOTES

**This activity is good for:**

- Individuals
- Pairs
- Small groups

**Safety Tips and Reminders:**

- Ensure students have plenty of room for this activity! Pick a place with ample space to launch marshmallows.
- Warn your students not to press the spoon back too far or the spoon may break.
- Be cautious of broken plastic. Protective eyewear can be worn during this experiment.
- Review the Safety First section in the Resource Guide for additional information

# ENGAGE

Use the following ideas to engage your students in learning about energy

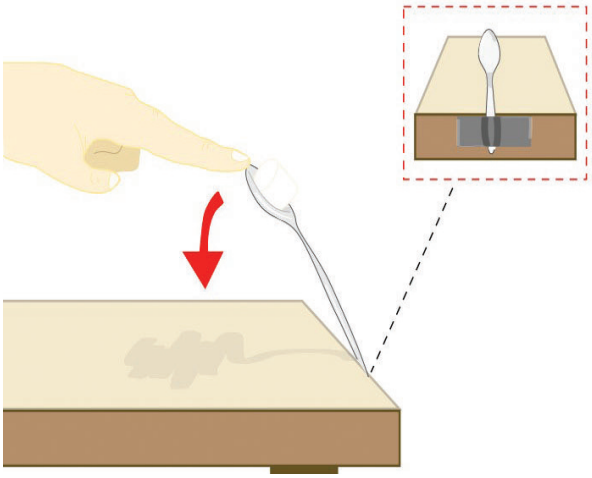
- Present your students with a challenge! Set up a spoon catapult at one end of a room and challenge students to see who can get a marshmallow the farthest. You can measure out the distance by marking the floor with the distance, and allow students to try out different types and size of marshmallows, different sizes of spoons, and other materials they can have access to.
- Let students aim the marshmallow at a target with a white paper as background. Marshmallows may be dipped in a food color to differentiate the different students or groups!
- Connect to history! Have students discuss catapults, how they work, and what materials and features are most important in the creation of catapults.

See more ideas for engagement in the Energy Background section! You can also look at the Elaborate section of this activity for other ideas to engage your students.

# EXPLORE

## Procedure:

1. Set up the room so that you have at least 20 feet (6 meters) of open space from the front of the launching area to the landing area.
2. Construct a catapult by taping a plastic spoon firmly against the edge of a table or desk. The spoon should be perpendicular to the tabletop with the back of the spoon facing toward the table.
3. Use a marker to mark the marshmallows for identification (initials, number, etc.).
4. Test the setup of the catapult and marshmallow. Hold the marshmallow in the bowl of the spoon with their finger, and bend the spoon back carefully. (Use the other hand to help anchor the handle of the spoon against the table where it is taped.)
5. Measure the approximate amount the spoon is bent back from its original position.
6. Release the spoon to launch the marshmallow.
7. Have a partner stand by the landing area to mark the place where the marshmallow originally landed. Then, measure the distance from the edge of the desk (where the spoon is attached) to the place where the marshmallow landed.



# DATA COLLECTION & ANALYSIS

Analyze and discuss the results of this activity using the following questions:

- How can you make the plastic spoon launch the marshmallow?
- What type of energy does the bent plastic spoon have? How does it get that energy?
- What type of energy does the marshmallow have when it is launched? Explain.
- What do you think will happen if you change the angle between the spoon and the tabletop?
- What is the law of conservation of energy, and how does it relate to this experiment?
- Record the distance (in inches) that your marshmallow traveled in a table, noting whether any variables changed for each launch. For example, did you bend the spoon back more? Did you use a bigger marshmallow? Did it roll farther after the original landing?

# EXPLAIN

## What's happening in this Activity?

First review the Energy Background section to gain a deeper understanding of the scientific principles behind this activity.

**Energy** is defined as the ability to do work or generate heat. **Work** occurs when a force causes an object to be displaced—to move from its original position. A **force** is a push or pull on an object. Work is a measure of the change in energy. In order for work to be done, some object must supply the force, and it must possess some form of energy to supply that force. If someone picks up a box from the ground and puts it on a table, the person supplies the force that acts on the box. The person has chemical potential energy that is obtained from food, allowing him or her to do the work.

Energy can take many different forms, including mechanical energy, nuclear energy, thermal energy, and light. The **law of conservation of energy** (first law of thermodynamics) states that while energy can change from one form to another, it can neither be created nor destroyed. When matter changes, whether through a physical or chemical change, the amount of energy in the system is the same before and after the change, but the energy may be in a different form or forms.

**Mechanical energy** is a form of energy determined by the motion or position of a substance. The total mechanical energy of a substance is the sum of its kinetic and potential energy. **Kinetic energy** exists when an object is in motion; it is the energy of motion. The faster an object moves, the more kinetic energy it has. **Potential energy** is "stored" energy, typically a result of an object's location. Because of these components, mechanical energy naturally exists in every system in the universe.

When a rollercoaster starts at the top of a hill, it has zero kinetic energy because it is not moving. All of its energy is potential. Once the rollercoaster starts moving down the hill, the potential energy becomes kinetic energy. No energy has been created or destroyed during this process, it has simply changed form.

In this activity, the plastic spoon catapult illustrates the change from potential to kinetic energy. A force (and therefore energy) is needed to bend the spoon backward. As a result, energy becomes "stored" in the spoon as elastic potential energy. The more the spoon is bent (compressed), the more elastic potential energy is stored. When the spoon is released, the potential energy in the spoon becomes kinetic energy, pushing the marshmallow forward. The marshmallow continues to move across the room after the spoon has stopped moving due to its inertia. **Inertia** is the resistance of an object to a change in its state of motion.

When there is more energy, more work can be done. Therefore, the distance the marshmallow travels depends on both force and the amount the spoon is compressed (the energy transferred from the person to the spoon).

## Differentiation for Younger or More Advanced Students

You can differentiate this activity for students of different grade levels by focusing on the concepts outlined below.

| GETTING STARTED | DIVING DEEPER |
|---|---|
| **For younger students, emphasize the following concepts:**<br>• There are different types of energy that exists<br>• Energy is not created or destroyed, just changed from one type to another<br>• Kinetic vs. potential energy | **For more advanced students, emphasize the following concepts:**<br>• Law of conservation of energy<br>• Inertia and work as they relate to energy<br>• There are many other different types of energy: chemical, nuclear, electrical, thermal, radiant, etc. |

## Notes

# ELABORATE

Elaborate on your students' new ideas and encourage them to apply them to different situations. The section below provides some alternative methods, modifications, and extensions for this activity.

- Have a catapult contest. Provide each student with two to three marshmallows. Have them mark each of their marshmallows with their initials, launch them, and record the distance traveled. (If the spoon breaks, the distance will be recorded as zero.) Then, have each student calculate the average distance that his/her marshmallows traveled. Compare the results. The students with the largest average distance recorded wins!
- Ask students how they might change the mass or size of the marshmallow—purchase larger marshmallows to use in the experiment. Ask the class what will happen if they change the mass or size of the marshmallow. Discuss what might make the marshmallow travel farther. Then, test the students' hypotheses. Press a piece of a heavy rubber eraser or a marble deep into the middle of the marshmallow. Have students stand back (far from the landing area) for safety before launching the marshmallow.
- Challenge students to come up with their own catapult design to launch marshmallows. Then allow them to construct, test, and demonstrate their models in class.
- Provide different materials to launch, and targets. Let students experiment with each. Ask them to use varied forces to launch the marshmallows. Make predictions as to what needs to happen to make the marshmallows go farther.
- Try to provide different size spoons/length spoons as well (longer spoons from an ice cream shop or small sample spoons). Try a spork! Maybe even a craft stick or rubber bands.

# EVALUATE

- Students write up an explanation about what made the marshmallows go shorter distances or longer distances. Descript the different techniques used and what the most successful strategy was for getting a marshmallow to move the farthest distance.
- As a challenge, ask students to create their own miniature catapult using spoons, boxes, rubber bands, tape, and any other materials you can find. Have students work to optimize a design that can get a marshmallow to move the farthest distance. is experienced in everyday life.

# CHEMISTRY IN ACTION

Share the following real-world connections with your students to demonstrate how chemistry is all around us.

## Real-World Applications

The catapult is an ancient device used to throw or hurl a large object over a great distance. Catapults were used to attack castles and walled cities. Some catapults could throw stones weighing as much as 350 pounds for distances greater than 300 feet!

Energy transfer occurs all around us. At a bowling alley, people use the chemical energy stored in their bodies to apply a force to the bowling ball, causing it to be displaced (work is done!). As the bowling ball travels down the lane, it has kinetic energy. When it hits the pins, the ball applies a force to the pins, causing them to move and hopefully fall over!

## Careers in Chemistry

- Scientist use their knowledge of energy to improve the world around us! Because energy cannot be created or destroyed, environmental scientists consider the best and most efficient ways to access renewable energy.

# Notes