STEM ON A DIME

BASIC CATAPULTS

Activity from South Dakota 4-H

Activity Updated August 2021

SKILL LEVEL

Ages 6-18

KEY TERMS

Catapult, Simple Machines

EDUCATION STANDARDS

South Dakota Science:

- K-PS2-1
- 3-PS2-2
- MS-PS3-1
- MS-PS3-5
- HS-PS2-1

TIME NEEDED

20 minutes

MATERIAL LIST

Materials needed per catapult:

- Eight Large Craft Sticks
- Five Rubber Bands
- One Plastic Spoon
- One to Three Small Marshmallows (see Activity Preparation for alternatives)

Materials to be shared by group:

- Extra Large Craft Sticks
- Tape

EXPECTED LEARNER OUTCOMES

OBJECTIVE 1 – Youth will design and build catapults with simple, everyday materials.

OBJECTIVE 2 – Youth will explore concepts of projectile motion, accuracy and precision.

BACKGROUND

Catapults originated in ancient Greece as a battle tool and continue to be used today for things like launching planes on aircraft carriers where runway space is limited. Catapults are simple machines that can be used to explore forces, energy and motion.

A simple machine is a device that can change the direction or amount of force required to complete some form of work. There are six types of simple machines: the inclined plane, lever, wedge, wheel and axle, pulley and screw. A catapult is an example of a lever.

When someone pushes on the end of the catapult, they apply a force creating potential energy. When the lever is released, the force is multiplied in the opposite direction and the potential energy becomes kinetic energy launching the projectile. Through this process, catapults demonstrate Newton's Three Laws of Motion: 1) an object at rest stays at rest unless acted upon by an outside force; 2) force is equal to the change in momentum per change in time: and 3) for every action, there is an equal and opposite reaction.

VOCABULARY

Catapult - A device that launches a projectile

Projectile - An object that is launched or thrown, usually in the air, by a force

Lever - A simple machine made of a rigid beam and a fulcrum.

Simple Machine – A mechanical device that is used to make work easier.

Fulcrum - The point on which a lever rests or is supported and on which it pivots.

Accuracy - The degree of closeness to a desired location. In this activity, accuracy is the ability to hit the target with the marshmallow.

Precision - The degree to which multiple tests show the same results. In this activity, precision is the ability to hit the same location multiple times with the marshmallow.

ACTIVITY PREPARATION

1. Gather the following materials for each youth or group of youth:
   a. Eight Large Craft Sticks
   b. Five Rubber Bands
   c. Plastic Spoon
   d. Three Small Marshmallows – These will be used as the projectiles for the catapults. You may also choose to use other small round candy like M&Ms, or a non-food item like craft poms. For an added learning aspect, you may choose to use two different projectiles with different masses so that you can compare how they behave when launched.
2. Have extra craft sticks and rubber bands prepared for youth to further explore with after trying out the initial design.
3. Have tape on hand to create 'goals' and to mark where the projectiles land.

ACTIVITY INSTRUCTIONS

1. Building a basic catapult

a. Take eight of the craft sticks and tie a rubber band around each end of the bundle.

b. Wrap a rubber band around the one end of the remaining two craft sticks.

c. Separate the two craft sticks at the unbound end and insert the eight bound craft sticks to create an X.

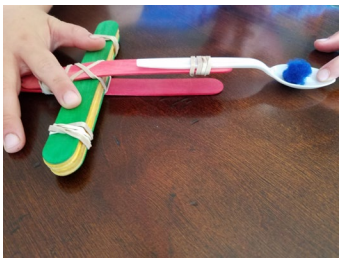
d. Use a rubber band to secure the X formation.

e. Rubber band a plastic spoon, facing upwards, to the end of the top craft stick.

2. Have youth pull back the spoon on their catapult and release it. Ask them, based on the spoon's behavior, what do they predict will happen when they put a projectile into the spoon.

3. Create a target for the marshmallows using tape.

4. Place the projectile in the spoon and allow them to launch it.



5. Record where their projectile lands using small pieces of tape.

6. Discuss what they are noticing about where their projectiles are landing.
   a. Are they hitting the target (accurate)?
   b. Are they landing relatively close together (precise)?
   c. Are they traveling too far, or not far enough?
   d. Do the projectiles fly in the correct direction?
   e. What might they need to change about their design to:
      i. make it more accurate?
      ii. encourage the projectiles to move in the correct direction?

7. Have youth explore altering their design with additional craft sticks and rubber bands. They may want to make longer levers or a larger fulcrum. Continually inquire about what they are observing and if their changes seem to be improving their design.

8. If you have a second type of projectile, allow them to experiment with that.
   a. What do they notice about how different projectiles behave?
   b. Does the size or mass of the projectile impact how it moves?

9. Have the youth share their final designs with one another.
   a. What did they alter about their catapult?
   b. Were the alterations successful in making the catapults more precise or more accurate?
   c. What might they do differently if they had more time or different materials?
   d. Do they notice a pattern in what teams did to alter their catapult?
   e. Did teams experience similar challenges?

EXTENDED LEARNING

The catapult designed in this activity is a very basic catapult. However, as you learn about the functionality of it they can build upon its simplicity and create more advanced catapults with even greater capabilities. Some ideas would be to add a binder clip to the design like that used in the Guinness World Record Marshmallow Catapult (https://www.guinnessworldrecords.com/Images/Marshmallow%20Catapult_tcm25-508181.pdf), or by using the engineering design process to change up the base and fulcrum of the catapult like the Teach Engineering Right on Target (https://www.teachengineering.org/activities/view/cub_catapult_lesson01_activity1).

This activity can also be built upon using the 4-H Junk Drawer Robotics: Parts D and E. Youth can continue exploring this content and learn more about the engineering design process and build a swinging arm trebuchet. The Junk Drawer curriculum can be found at the 4-H mall at https://shop4-h.org/.

These ideas and skills can be further developed through the South Dakota 4-H Engineering and Physics Projects (https://extension.sdstate.edu/4-h-electricity-project).

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