Week 9

Catapult to the Front of the Line

Create a catapult that will hurl a penny through a target from the furthest distance away.

Subjects and Skills

- The effect of changing fulcrum placement
- Effort, resistance, work
- The history of catapults

Materials

- Popsicle sticks
- Clothespins
- Rubber bands
- String or yarn
- One plastic spoon per team
- Pennies (for catapulting)
- A hula hoop (or other target through which pennies can be flung)

Vocabulary

- Mangonel
- Ballista
- Trebuchet
- Torsion
- Lever
- Fulcrum
- Load
- Effort

Purpose

Understanding the principles of levers is important for developing an understanding of Class 2 simple machines. Students will learn how a lever's fulcrum point can impact the effort necessary to lift the load.

Objectives

Students will gain a better understanding of:

- the history of the basic design of the catapult,
- how the lever system can be changed by moving the position of the load and fulcrum,

- how effort is the force needed to move a load or overcome a resistance, and
- how a catapult's design can impact its performance.

Activity Preparation

1. Run off activity sheets.
2. Gather materials and place them in two different areas of the room.
3. Bookmark websites to be used in class.
   a. http://www.catapults.info
   b. http://www.schoolhistory.co.uk/games/fling
   c. http://en.wikibooks.org/wiki/Wikijunior:How_Things_Work/Lever
   d. http://www1.teachertube.com/viewVideo.php?video_id=238758&title=Trebuchets__amp__Catapults
   e. http://www.teachertube.com/viewVideo.php?video_id=238841&title=Roman_Catapult&vpkey=

Activity Procedure

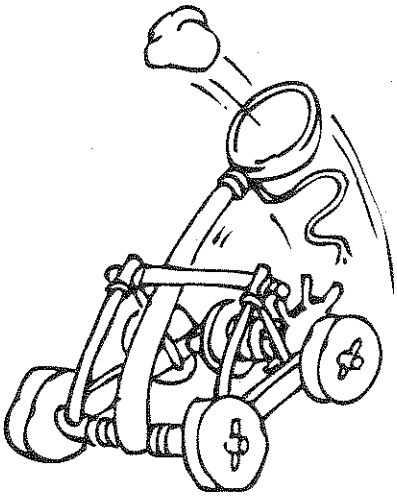
1. Distribute the activity sheets. Read and discuss the information.
2. Go to Link a. for pictures of each type of catapult to layer students' understanding. Continue the discussion.
3. Ask, "What do you think may have been a problem with using the mangonel in a battle?" Guide students to understand that the weight of the mangonel, as well as its slowness to move and its difficulty to load, were problematic.
4. Have students use their own arms to demonstrate the flinging motion. (Students may need to be warned to maintain their personal space.)
5. For active engagement in demonstrating the flinging action, visit Fling the Teacher at Link b. Select a topic, or create your own topic, for your students to play.
6. Teach how levers work using information available at Link c.
7. Show the Trebuchets & Catapults video (04:19) at Link d.
8. Discuss the fulcrum. The fulcrum is the point where a lever is free to rotate. In a seesaw, the fulcrum is the middle support that the lever rests on.
9. Have students draw and label the lever, fulcrum, and load.
10. Before students continue to the team challenge, show the video (02:53) What the Ancients Knew: The Roman Catapult at Link e.
11. Put students in groups of two or three and assign group numbers.
12. Review the team challenge, answering any questions that students may have. Conduct the challenge in whatever manner is most convenient and appropriate for your classroom. If students' catapults are able to hurl the

penny through the target, they can move their catapults further and further away to see what the greatest distances are from which their catapults will be effective. You may, however, want to institute a cap on how many trials each team is allowed.

13. After the challenge has been completed, have students finish their activity sheets.
14. If you wish, assign one of the activities suggested in Extend the Learning With Catapults: Activities.

Name: _____ Date: _____

Catapult to the Front of the Line



GOAL

- Create a catapult that will hurl a penny through a target from the furthest distance away.

MATERIALS

- Popsicle sticks
- Clothespins
- Rubber bands
- String or yarn
- One plastic spoon per team
- Pennies (for catapulting)

TIME TO CREATE

- 25 minutes

INDIVIDUAL ACTIVITY

Read the following, highlighting important information, and answer the questions.

Imagine that you are in the midst of a snowball fight. In addition to preparing for battle, you also need to think about protection. Hiding behind something is helpful, but what if your enemy is able to break down your barrier? Throughout history, finding a way to destroy the enemy's protection while maintaining a safe distance was challenging—until the invention of the catapult, the one-armed throwing machine.

Ancient Greeks referred to the catapult as a mangonel, meaning "engine of war." The mangonel, weighing approximately 2 tons, functioned by flinging heavy objects over and through walls. Because of its powerful kicking motion, mangonels were also referred to as onagers, a name derived from onagros, meaning "wild donkey."

A ballista was another type of catapult. It was designed similarly to the crossbow. Ballistas relied on the work of torsion to release ammunition that looked like giant arrows.

Over time, gravity catapults, such as the trebuchet, were invented. Trebuchets were designed to hurl a heavy object into a high arc, which was quite useful for breaking down castle walls, especially if the ammunition involved fire. Catapults have been one of the most effective weapons for warfare.

A sling is attached to the end of the catapult's arm. In lowering the arm, the user stores energy in the ropes, and when the arm is released, the arm is flung forward. The force contained in the ropes is at its greatest when the arm first starts to move, and at its least when it hits a padded buffer, which acts as a stopper. This rapid stop allows the object to leave the sling at maximum speed before stopping. Adjusting the length of the ropes allows for the thrown object to aim more accurately at the target.

A lever can help to move or lift objects by applying force to gain a mechanical advantage. The lever has two important parts: a fulcrum, or center of rotation, and a force arm, which is the lever itself. To use the lever, four parts work together: the lever (which is long and rigid),

the fulcrum (the resting point on which the lever turns or pivots), the effort (the force that is applied), and the load (the object that will be moved).

1. What do you think may have been problematic about using the mangonel in a battle?

_____

_____

2. Draw and label the lever, fulcrum, and load.

TEAM CHALLENGE

Participants will work together in teams of two or three for a total of 25 minutes to make a mangonel that can toss a penny through a target. The mangonel must be on the floor and must have a trigger mechanism (it cannot be a person) to launch the penny. A team can win by making a mangonel that is able to hurl the penny through the target from the furthest distance away. Once the teacher starts the time, your team will have 25 minutes to gather your supplies and build your mangonel. After the teacher signals that time is up, you must stop working immediately and take your catapult to the designated challenge site. Any team that continues to work after time has been called may be disqualified.

Start Time _____:_____ + 25 Minutes = _____:_____ End Time

Keep these concepts in mind when making your mangonel:

- the weight of the object thrown,
- the strength and length of the arm,
- the flexibility and speed of the arm, and
- the angle and height of the launch.

During the team challenge, record the results.

CATAPULTS' DISTANCES FROM TARGET

Team 1: _____ft _____in.	Team 2: _____ft _____in.	Team 3: _____ft _____in.
Team 4: _____ft _____in.	Team 5: _____ft _____in.	Team 6: _____ft _____in.
Team 7: _____ft _____in.	Team 8: _____ft _____in.	Team 9: _____ft _____in.
Team 10: _____ft _____in.	Team 11: _____ft _____in.	Team 12: _____ft _____in.
Team 13: _____ft _____in.	Team 14: _____ft _____in.	Team 15: _____ft _____in.

After the team challenge, complete the following questions.

1. What did you use for the lever? _____
2. What did you use to create tension? _____
3. What was the difference between your object's distance from the target and the object closest to the target? _____ft _____in.
4. What contributed to the success of the winning mangonel? _____

   _____

   _____
5. What would you do differently to refine your mangonel? _____

   _____

   _____

EXTEND THE LEARNING WITH CATAPULTS: ACTIVITIES

1. **Velocity ratio and pulleys.** Visit http://www.technologystudent.com/gears1/pulley2.htm to learn and apply different methods of using what we've discussed in class. Print and complete the practice sheet.
2. **Interactive catapult.** Visit http://kids.discovery.com/games/just-for-fun/catapult to see an online replica of an ancient catapult. Discuss how this model is similar to and different from the catapult your team made in a complete paragraph.
3. **Fling the teacher.** Using the template available at http://www.schoolhistory.co.uk/games/fling/, select an academic topic that relates to something you've been studying in another subject. Record the 15 questions and answers that you respond to correctly to fling the teacher.
4. **Simple machines.** Visit http://www.technologystudent.com/forcmom/lever1.htm and http://www.enchantedlearning.com/physics/machines/Levers.shtml. Compare and contrast the different levers: Class 1, Class 2, and Class 3. Create a chart to show the lever, load, fulcrum, mechanical advantages, equal-arm balance, and effort of each type. Include drawings.