LESSON 1: CATAPULTS

SUPPLIES

MAIN BIN

- Masking Tape (4)
- Plastic Cups (15)
- Cardboard Squares (4)
- Paper Clips (20)
- Rubber bands (20)
- Index Cards (20)

PENCIL BOX

- Ping Pong Balls (7)
- Pencils (20)
- Scissors (15)
- Tape Measure
- Rulers (6)
- Clear Tape

OBJECTIVES

- ☑ Students will learn about levers.
- ☑ Use the engineering process to create a catapult

HOOK

2-3 min

Have a student come to the front. Play a game of catch with them with a ping pong ball. Ask the class: Could we create a machine to help us in this game of catch?

INTRODUCTION

3-5 min

Have you ever heard of a catapult? A catapult is a machine designed and used by engineers in the Middle Ages to throw heavy rocks a very far distance. A catapult can throw a rock much further than a human--in fact, a catapult's load would be way too heavy for a human to lift!

Today, we will be working in groups to create a catapult that can launch a ping pong ball all the way across the room.

But before we do, we're going to talk about some of the physics concepts that allow catapults to work!

CATAPULTS

DISCUSSION

5 min

A catapult is, in the most basic terms, a giant lever. A lever is a simple machine that helps lift or move objects. Can you think of an example of a lever? Examples include a see-saw, hammer, and scissors.

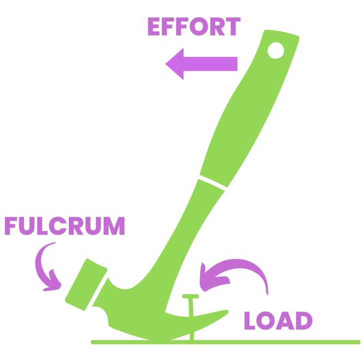
A lever consists of three main components:

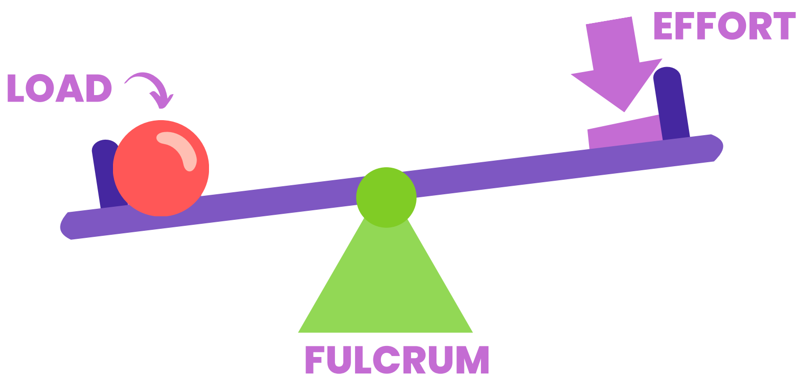
Fulcrum:
- The support point on which the lever pivots.
- Example: In a seesaw, the fulcrum is the point in the middle where it balances.
- Can you think of another example where you might see a fulcrum in action?

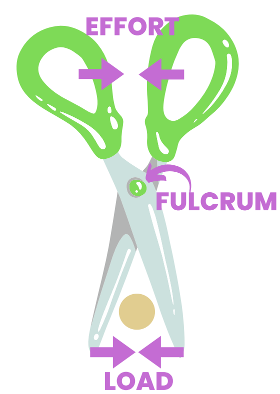
Load:
- The object or weight that needs to be moved or lifted.
- Example: In a seesaw, the load is the person sitting on one end.

Effort:
- The force applied to move the load.
- Example: In a seesaw, the effort is the person pushing down on the opposite end to lift the load.
- Q: Can you think of a time when you applied effort to move something using a lever?

How a Lever Works:
- The effort applied on one end of the lever moves the load on the other end.
- The fulcrum's position affects how much effort is needed to move the load. If the fulcrum is closer to the load, less effort is needed to lift it.







The lever arm of our catapults will have the load (ping pong ball) on one end. The effort will be applied by stretching and releasing a rubber band or using weights. The fulcrum will be the point where the lever pivots.

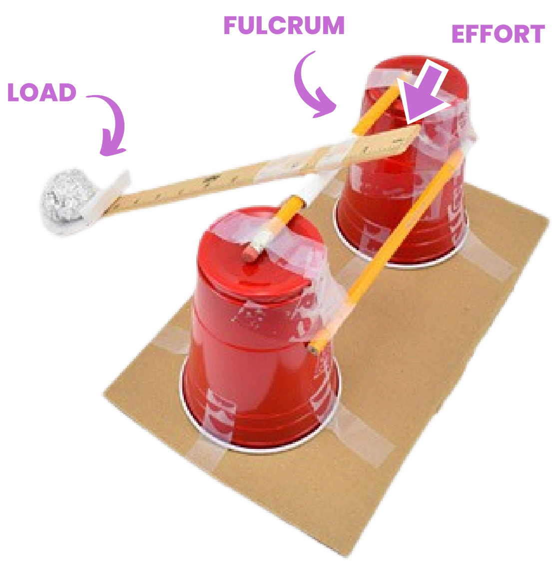
Where do you think we should place the fulcrum to make the ball go the farthest? When building your catapults, experiment with different positions for the fulcrum to see how it affects the amount of effort needed and the distance the ping pong ball travels.

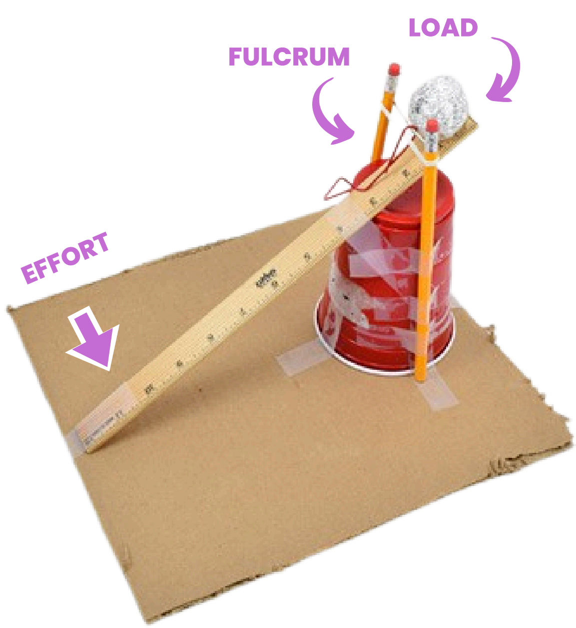
CATAPULTS

DESIGN EXAMPLES

If students need inspiration, show them the two below examples.

Remind them that a catapult needs a flucrum, a place to hold the pin pong ball load, and a place to apply effort to make the ball fly. Encourage students to use a ruler as the beam of the lever!





DESIGN & BUILD

20-25 min

1. Divide the class into four groups of 3-4 students and pass out printer paper/pencils.

2. Explain that the students will have 3-4 minutes to plan and sketch their designs, then 15 minutes to make their ball launcher.

3. As students sketch their designs, pass out these materials to each group:
    - 1 cardboard base
    - 4 plastic cups
    - 1 Ruler
    - 5 rubber bands
    - 5 Paper Clips
    - 5 index cards
    - 1 roll of masking tape

4. Give the students 15 minutes to build, with regular reminders of the time.

5. After time is up, let each group test their machine and measure how far each ball went.

EVALUATE & REDESIGN

10-15 min

1. As a class, discuss the following questions:
    - How does the speed of a ball affect how far it travels?
    - How does the angle the ball is launched affect how far it travels?

2. Have the students brainstorm how to improve each design.

3. Give the students 10 more minutes to improve their designs. Re-test the machines and measure how far each ping pong ball goes.

CATAPULTS

OBSERVE & EXPLAIN

3-5 min

Ask students the following questions. After they've given their answers, follow up with the explanations.

- What were key engineering elements that made your design effective?
- What was the ideal angle for your ball to be launched?
  - The ball would travel the furthest when it was released with a slight upward angle.
  - Explanation: The angle the ball is launched affects the distance travelled. If the release is too vertical, the ball will travel upwards, but gravity will make it fall right back down. If the angle is too horizontal, gravity will make the ball travel towards the ground, rather than gaining distance.

Successful catapults were likely the models that had a strong force applied, a strong frame, and a release that took gravity into account.

Extension

Have the students use the remaining supplies to create an object to catch the ball. If needed, one team member can hold the object, but they can not catch the ball directly with their hands. For an added challenge, the object should be placed directly on the floor, with no team member holding it.

Exit Ticket

Ask each student one of the following questions as they walk out the door.

- Q: What type of machine did you use to build you catapult?
  - A: A lever, which is a a simple machine
- Q: What is one component of a lever?
  - A: Fulcrum, load, effort