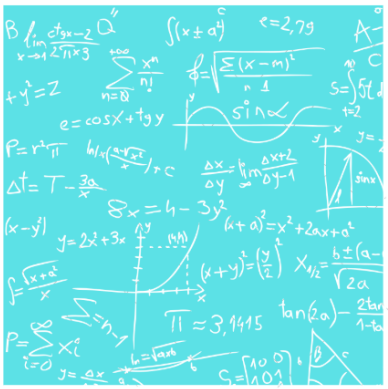
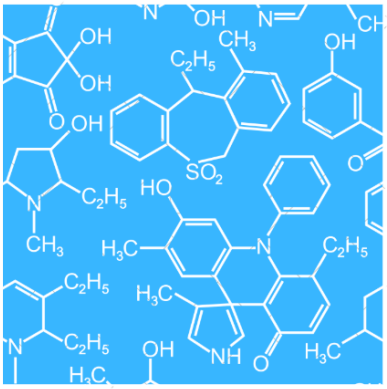


STEM at Stead



SCIENCE WORTH EXPLORING

Written by Aubree Larson

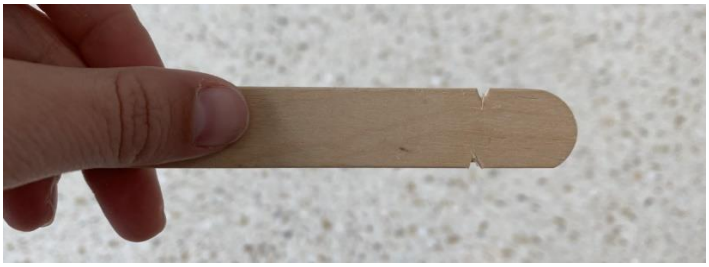
Catapult Teacher Information: Practiced Scientist

How do I prepare?

1. Double check that all the necessary supplies are inside of the kit:

   -10 Jumbo Popsicle Sticks
   - 1 Bottle Cap
   - 10 pom poms & 10 pencil erasers
   - Measuring tape
   -10 Rubber Bands
   -1 Sticky Dot
   -1 protractor

2. You need to cut notches in two of the jumbo popsicle sticks. Refer to the picture below to see where the notches should be cut.



3. The student will need you to check three answers on their work sheet before they start the experiment. They will be using a protractor to measure angles. The angles, from left to right, should be: 50, 150, and 85

What will they learn?

1. The discussion materials for this experiment will be based off the Iowa Core Standards for seventh graders. The student does not have to be a seventh grader to complete this activity, they just need to be able to understand content at a seventh-grade level. The standards covered by this experiment are:
   a. Physical Science → Motion and Stability: Forces and Interactions
      MS-PS2-4: Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
   b. Engineering, Technology, and Applications of Science → Engineering Design
      MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Need extra help?

If you aren't familiar with topics covered or if the student needs extra help, consider these resources:
www.billnye.com/the-science-guy/gravity www.billnye.com/the-science-guy/simple-machines

Setting up the catapult → https://littlebinsforlittlehands.com/popsicle-stick-catapult-kids-stem-activity/

Using a protractor → https://www.youtube.com/watch?v=R4giTrUEF2k

Catapult Instructions: Practiced Scientist

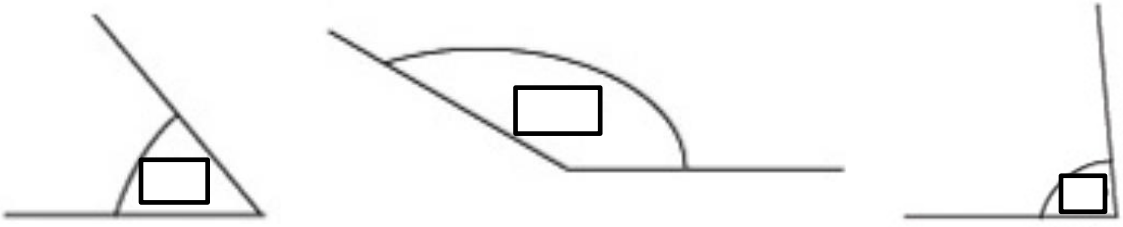
What is the experiment?

In this experiment you will be building and testing a catapult. The catapult will be made out of popsicle sticks and rubber bands. You will use a soda pop bottle cap as a bucket and place your projectile in there. Your projectile is what you will be testing! You want to use the right projectile so that your catapult launches it the farthest distance. You will be using small pom poms and pencil erasers as projectile. When you get to your trials, you can use any number of combinations of these materials.

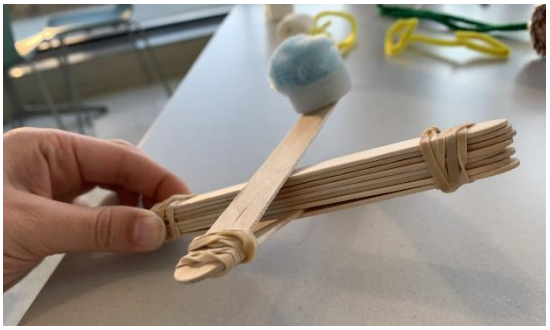
You will also be testing the angle at which the catapult arm launches the projectile. In order to do this, you will be using a protractor. Changing the angle of the arm (by sliding the base back and forth) may have an affect on how far your projectile travels.

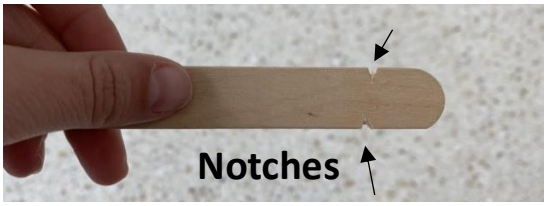
Predict what you think will happen in this experiment. For example, which of the projectile (pom poms or pencil erasers) will travel farther? What will be the best angle to launch the projectile from?

Test your protractor skills! What is the angle shown by these three pictures? Write your answer in the blank and have your teacher check to see if it is right.



Catapult Instructions: Practiced Scientist





Materials Needed:

10 Jumbo Popsicle Sticks	Rubber Bands
Bottle Cap	Sticky Dots
Projectiles (pom poms and pencil erasers)	Protractor

Instructions:

1. 2 of the sticks need notches cut out of the side. If there aren't two in the kit, you need to cut them yourself. Refer to the middle picture to see what they should look like.
2. Take 8 of the popsicle sticks and stack them on top of one another. Secure the stack together with two rubber bands. Refer to the picture second from the top to see what your stack should look like.
3. Slide one of the jumbo sticks with notches (look at the second picture from the top) through the stack of the eight sticks, between the bottom two sticks.
4. Take the remaining jumbo stick with notches and secure it with a rubber band to the other jumbo stick with pieces cut out within the stack. Refer to the bottom right picture for help. The rubber band holding these two sticks together should rest within the notch from the missing pieces in the two sticks.
5. Place a sticky dot on the angled stick outside of the stack. The sticky dot should be on the opposite end from the rubber band about 0.5 inches from the end. Stick the bottle cap onto the sticky dot. Make sure to take the attached ring off the cap.
6. Use different combinations of projectile and test the distance each combination travels. Perform five trials. Make sure you measure from the same starting spot for each trial. Document your results in part A on the next page.
7. Now slide the stack of 8 popsicle sticks around to change the launch angle. Perform five trials. Measure the angle created between the two notched popsicle sticks with the protractor. Refer to the bottom left picture for guidance. Document results in part B.
8. Complete parts C on the discussion materials.
9. Read through the information on the second page to learn about the science behind catapults!
10. Answer parts D and E of the discussion materials.

s

Catapult Discussion Materials: Practiced Scientist

A. Document the results of your trials below:

Example Trial Projectile: Pom Poms __0__ Pencil Erasers __2__ Distance Traveled ___6 in___

Trial 1 Projectile: Pom Poms _____ Pencil Erasers _____ Distance Traveled _____

Trial 2 Projectile: Pom Poms _____ Pencil Erasers _____ Distance Traveled _____

Trial 3 Projectile: Pom Poms _____ Pencil Erasers _____ Distance Traveled _____

Trial 4 Projectile: Pom Poms _____ Pencil Erasers _____ Distance Traveled _____

Trial 5 Projectile: Pom Poms _____ Pencil Erasers _____ Distance Traveled _____

B. Document the results of your trial below: use 1 pencil eraser as the projectile

Example Trial Launch angle _____25°_____ Distance Traveled ___3 in___

Trial 1 Launch angle _____ Distance Traveled _____

Trial 2 Launch angle _____ Distance Traveled _____

Trial 3 Launch angle _____ Distance Traveled _____

Trial 4 Launch angle _____ Distance Traveled _____

Trial 5 Launch angle _____ Distance Traveled _____

C. What combination of design from parts B and C would allow the projectile to travel the farthest?

Launch angle _____ Projectile: Pom Poms _____ Pencil Erasers _____

Why did you make this prediction? Explain your reasoning.

Test this combination for three trials…

Trial 1 Distance Traveled _____

Trial 2 Distance Traveled _____

Trial 3 Distance Traveled _____

Catapult Discussion Materials: Practiced Scientist

The science behind catapults

Physics! The reason the projectile launches through the air and eventually hits the ground can be explained by physics. Sir Isaac Newton discovered the physics behind a catapult back in 1687. That's almost 300 years ago! He describes this in what he called the first law of motion:

"An object at rest stays at rest, until a force is applied, and an object in motion stays in motion, at the same speed, until a force acts upon it"

Okay let's break that down. An object at rest stays at rest- this means that the projectile will always sit in the bottle cap if we don't apply a force to it. Until a force is applied- the force we applied was the arm of the catapult. When we pull back the arm it stores up a lot of energy, but when we let go of the arm it changed the form of energy and applied a force to the projectile. This change in energy created a force that launched the projectile forward! But why did the projectile not stay in the air at the same speed if we didn't apply a force to it? Gravity! It's the force that keeps you and me from floating off into space. Gravity is the downward force acting on the projectile that eventually brought it back down to the ground.

Now let's talk about the angle of the launching arm. Why did that affect the distance? Gravity! The "sweet spot" for a launch angle is known to be 45°. If you had an angle less than 45°, your eraser did not travel as far because it was closer to the ground and therefore pulled faster to the ground by gravitational forces. If you had an angle greater than 45°, most of the force was used to launch the eraser in the vertical direction rather than the horizontal direction. If you launched the eraser right at 45°, it was the perfect combination between height and distance.

D. Do your results align with your prediction? Why do you think this is?

E. Do you think you created the optimal catapult design? Why or why not?