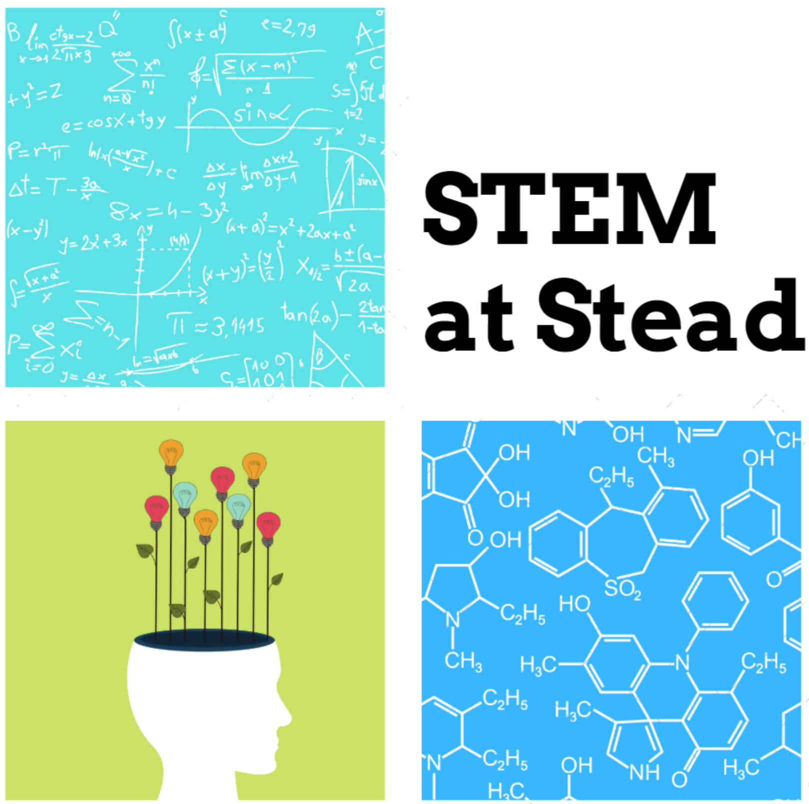
Catapult: Beginner Scientist



SCIENCE WORTH EXPLORING

Written by Aubree Larson

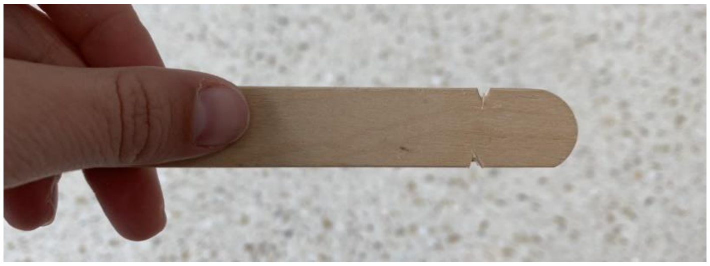
Catapult Teacher Information: Beginner Scientist

How do I prepare?

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

   - Measuring tape | -10 Rubber Bands
   -10 Jumbo Popsicle Sticks → 8 regular, 2 notched
   - 1 Bottle Cap | -1 Sticky Dot
   - 10 pom poms | -10 pencil erasers

2. Refer to the picture below to see where the notches should be cut.



What will they learn?

1. The discussion materials for this experiment will be based off the Iowa Core Standards for third graders. The student does not have to be a third grader to complete this activity, they just need to be able to understand at a third-grade level. The standards covered by this experiment are:
   a. Physical Science → Motion and Stability: Forces and Interactions
      3-PS2-2: Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
      *Observations will be made in part E and predictions will be made in part D
   b. Engineering, Technology, and Applications of Science → Engineering Design
      3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
      *Fair tests will be carried out in part C and failure points/ improvements will be identified in part G

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/energy

www.billnye.com/the-science-guy/gravity

www.billnye.com/the-science-guy/simple-machines

www.billnye.com/the-science-guy/motion

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

Catapult Instructions: Beginner Scientist

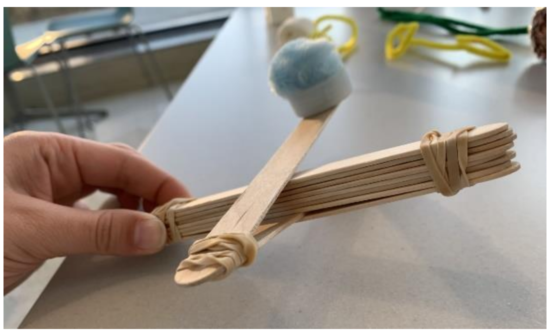
What is the experiment?

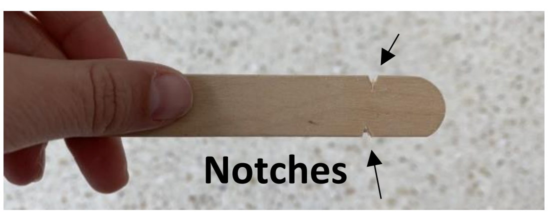
In this experiment you will be building and testing a catapult. The catapult will be made out of popsicle sticks and rubber bands. You will use a soda pop bottle cap as a bucket and place your projectile in there. Your projectile is what you will be testing! You want to use the right projectile so that 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.

Predict what you think will happen in this experiment. For example, which of the projectile (pom poms or pencil erasers) will travel farther? How far do you think they will go?

Draw a picture of what you think will happen when you launch your catapult!

Catapult Instructions: Beginner Scientist





Materials Needed:
10 Jumbo Popsicle Sticks → 2 regular & 2 with notches in the side
Bottle Cap | Sticky Dots
Projectiles | Rubber Bands

Instructions:

1. If all 10 popsicle sticks are regular, you need to cut notches in two of them. They should look like the third picture from the top.
2. Take 8 of the regular popsicle sticks and stack them on top of one another. Secure the stack together with two rubber bands. Look at the second picture form the top to see what your stack should look like.
3. Slide one of the jumbo sticks with notches through the stack between the bottom two sticks. You should be able to see this in the second picture from the top.
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. Look over to the left at the bottom picture for some help! (the sticks held together with the red rubber band) The rubber band holding these two sticks together should rest within the hole from the missing pieces in the two sticks.
5. Place a sticky dot on the angled stick outside of the stack. Put the sticky dot on the opposite end from the rubber band about 0.5 inches from the end of the stick.
6. Place the bottle cap on the sticky dot to create a small bucket. Make sure to take the ring off the open part of the bottle cap. This is where your projectiles will be placed!
7. Use different combinations of projectile and test the distance each combination travels for five trials. Record the results in part A on the next page. Make sure you measure from the same starting spot for each trial. Also make sure to push the catapult arm down with the same force each trial.
8. Now that your trials are complete, fill out part B and C on the next page.
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.
11. Finally, turn in your finished discussion materials to your teacher and clean up your experiment area.

Catapult Discussion Materials: Beginner Scientist

A. Document the results of your trials below:

Where there are blanks, fill in the number of each pom pom and pencil eraser you used for that specific trial. For the blank after the distance traveled, record how far your farthest piece of projectile (if you have multiple objects in your bucket) traveled in inches.

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. Predict the distance of the following example trial:

Projectile: Pom Poms __2__ Pencil Erasers __2__ Distance Traveled_________

How did you make this prediction? Explain why you think it is true.

C. What observations and conclusions can you make from your five trials?

Catapult Discussion Materials: Beginner 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:

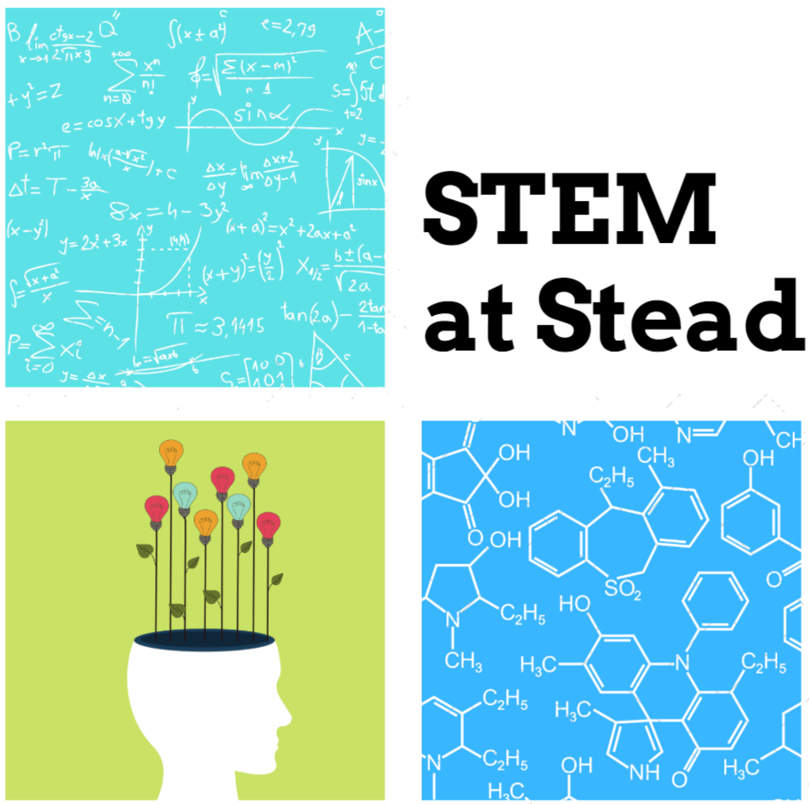
"An object at rest stays at rest, until a force is applied, and an object in motion stays in motion, at the same speed, until a force acts upon it"

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.

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

E. How would you change your catapult, or the projectile, to maximize the distance traveled? How much weight was too much weight for the catapult to handle?

Catapult: Practiced Scientist



SCIENCE WORTH EXPLORING

Written by Aubree Larson

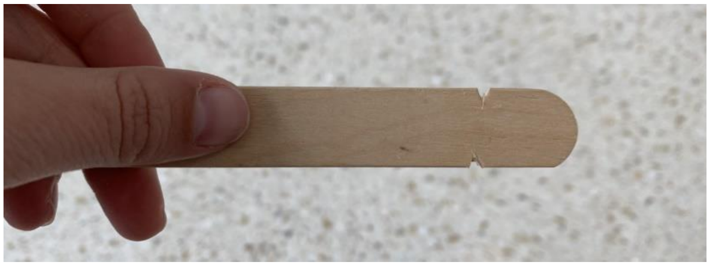
Catapult Teacher Information: Practiced Scientist

How do I prepare?

3. 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

4. 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.



5. 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?

2. 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:
   c. 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.
   d. 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

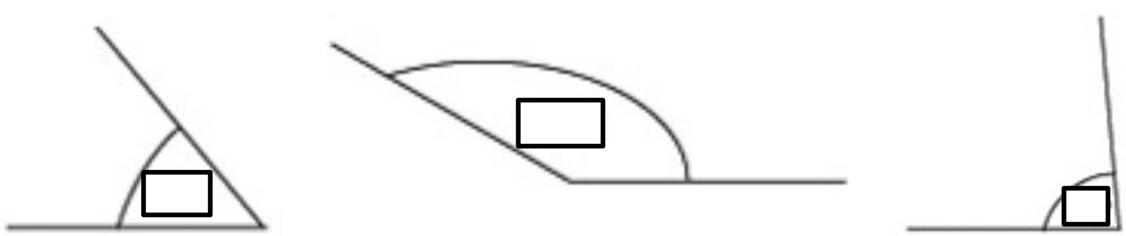
What is the experiment?

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.

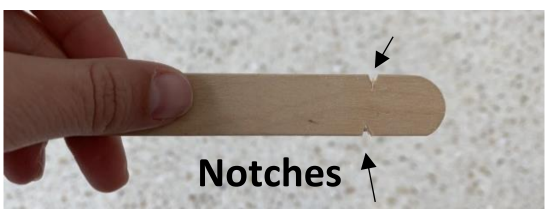
You will also be testing the angle at which the catapult arm launches the projectile. In order to do this, you will be using a protractor. Changing the angle of the arm (by sliding the base back and forth) may have an affect on how far your projectile travels.

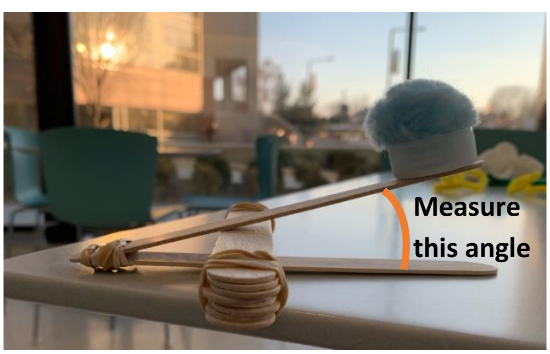
Predict what you think will happen in this experiment. For example, which of the projectile (pom poms or pencil erasers) will travel farther? What will be the best angle to launch the projectile from?

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:

12. 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.
13. 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.
14. 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.
15. 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.
16. 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.
17. 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.
18. 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.
19. Complete parts C on the discussion materials.
20. Read through the information on the second page to learn about the science behind catapults!
21. Answer parts D and E of the discussion materials.

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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"

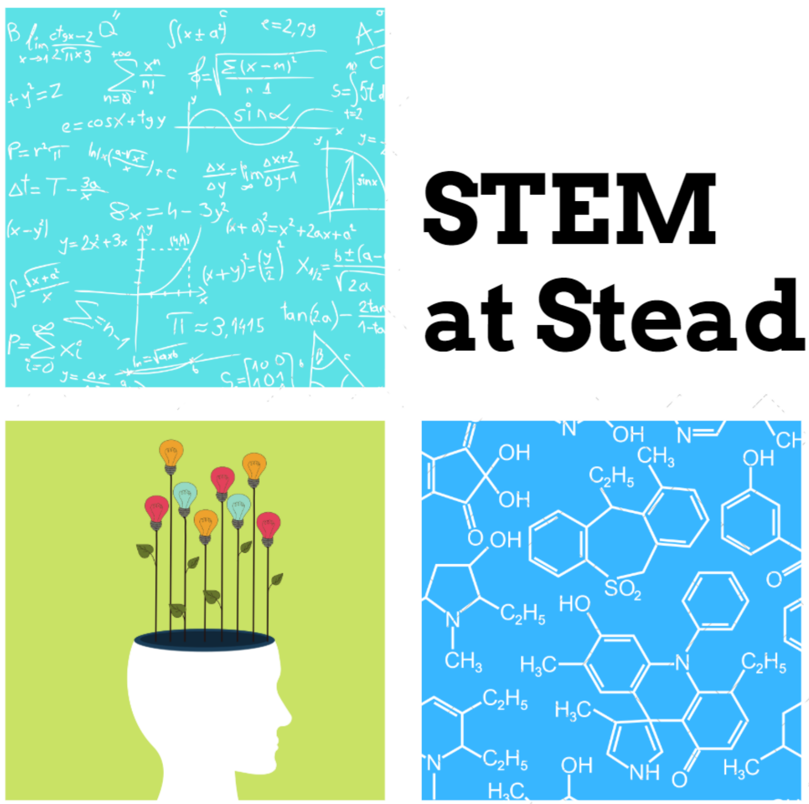
Okay let's break that down. An object at rest stays at rest- this means that the projectile will always sit in the bottle cap if we don't apply a force to it. Until a force is applied- the force we applied was the arm of the catapult. When we pull back the arm it stores up a lot of energy, but when we 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?

Catapult: Advanced Scientist



SCIENCE WORTH EXPLORING

Written by Aubree Larson

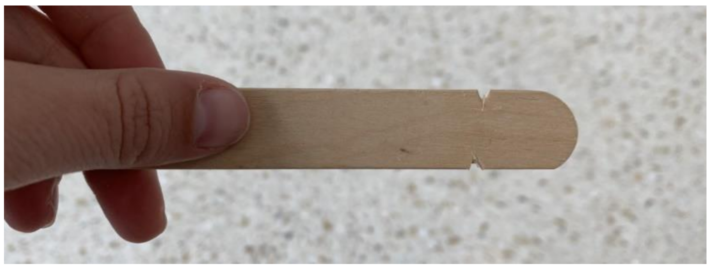
Catapult Teacher Information: Advanced Scientist

How do I prepare?

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

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

7. 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.



What will they learn?

3. The discussion materials for this experiment will be based off the Iowa Core Standards for high schoolers. The student does not have to be a high schooler to complete this activity, they just need to be able to understand content at a high school level. The standards covered by this experiment are:
   e. Physical Science → Motion and Stability: Forces and Interactions
   HS-PS2-1: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
   f. Algebra → Reasoning with Equations and Inequalities: Solve equations and inequalities in one variable
   HAS.REI.B.3: Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters

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 spring scale → https://www.youtube.com/watch?v=SWOmsKkP8ZY&t=33s

Catapult Instructions: Advanced 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 force you pull down the catapult arm with. In order to measure force, you will be using a spring scale. This will let you know how much force you exert when you pull down on the handle of the scale. There is a video of how to use a spring scale listed in your teacher's materials. Ask them to watch this!

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 optimal force?

Research Newton's Second Law of Motion. Define the variables of the equation and write the equation out.

a = F_{net} = m =

You should have found that Newton's Second Law of motion is Force = Mass * Acceleration (F = m*a). Where Force is the force applied to the projectile, mass is the mass of the projectile, and acceleration is the resulting acceleration of the projectile when it is airborne. This can be rewritten three different ways depending on which variable you want to solve for:

$$F = m*a \rightarrow a = F/m \rightarrow m = F/a$$

Specifying F_{net} compared to F means that all forces acting on the object are taken into consideration, not just the force you apply to it to move it forward. Since you cannot calculate F_{net} in this experiment (you would have to be able to measure the force of gravity simultaneously to measuring the force you applied to the projectile), we will just use the force applied by the projectile in order to solve for the other variables.

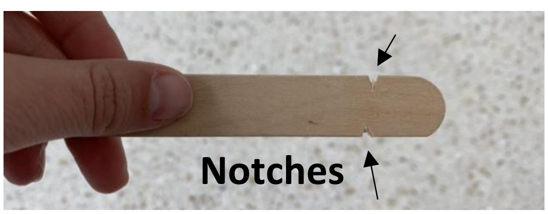
Solve for the missing value below:

#1 a = ________________ F_{net} = ____10 N______ m = _____2 kg______

#2 a = _____5 m/s/s______ F_{net} = ______________ m = _____2 kg______

#3 a = _____10 m/s/s______ F_{net} = ____10 N______ m = ______________

Catapult Instructions: Advanced Scientist



Materials Needed:

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

Instructions:

22. 8 of the jumbo popsicle sticks should be regular. 2 of the jumbo popsicle sticks should have notches cut out on the side. If there aren't 2 with notches cut out on the side, you will need to ask the teacher for scissors, so you can cut them. The sticks should look like the picture second from the bottom.
23. Take 8 of the popsicle sticks and stack them on top of one another. Secure the stack together with two rubber bands. The second picture from the top show what the stack will look like.
24. Slide one of the jumbo sticks with small pieces cut out of the sides (shown in the picture second from the top) through the stack of the eight sticks, between the bottom two sticks.
25. 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 left picture for guidance. The rubber band holding these two sticks together should rest within the notch from the missing pieces in the two sticks.
26. Place a sticky dot on the angled stick outside of the stack. Place the sticky dot on the opposite end from the rubber band about one inch from the end of the stick.
27. Place the bottle cap on the sticky dot to create a small bucket. The bucket should be placed 0.5 inches from the end of the popsicle stick. There is a small ring attached to the opening of the cap, remove that.
28. Your catapult is now ready to launch. Fill out the table in part A on the next page for each of the five trials you complete, as well as an average of all the trials.
29. After your trials are finished, fill out section B.
30. After section B is filled out, graph your results from part A with the graph paper provided in part C.
31. Read through the science behind catapults to learn about what was happening during the experiment.
32. Read the questions for sections D and E and write your answers in the space provided to you.
33. Once you have completed your discussion materials, clean up your experiment area and give your worksheet to the teacher.

Catapult Discussion Materials: Advanced Scientist

F. Calculate the acceleration for each trial:

First… rearrange Newton's Second Law of Motion ($F_{net} = m * a$) to solve for acceleration (a). Write the rearranged equation below:

Now record the mass of the projectile in kilograms and the force you pulled down on the catapult arm with in the middle two columns of the table. Mass should be measured using the electronic scale and the force should be measured using the spring scale provided. Use your rearranged equation to solve for acceleration in the last column. You may need to convert lbs to kg → 1 lb = 0.453592 kg

Trial	Mass (kg)	Force (N)	Acceleration (m/s/s)
1			
2			
3			
4			
5			
Average			

G. **Is there a pattern you can see from your trials? Is there a relationship between the acceleration and how far you think the projectile traveled?**

C. Graph the results from your trials below:

Acceleration

Force

Catapult Discussion Materials: Advanced Scientist

The science behind catapults

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. 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"

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.

Newton's second law, commonly referred to as the law of acceleration, states:

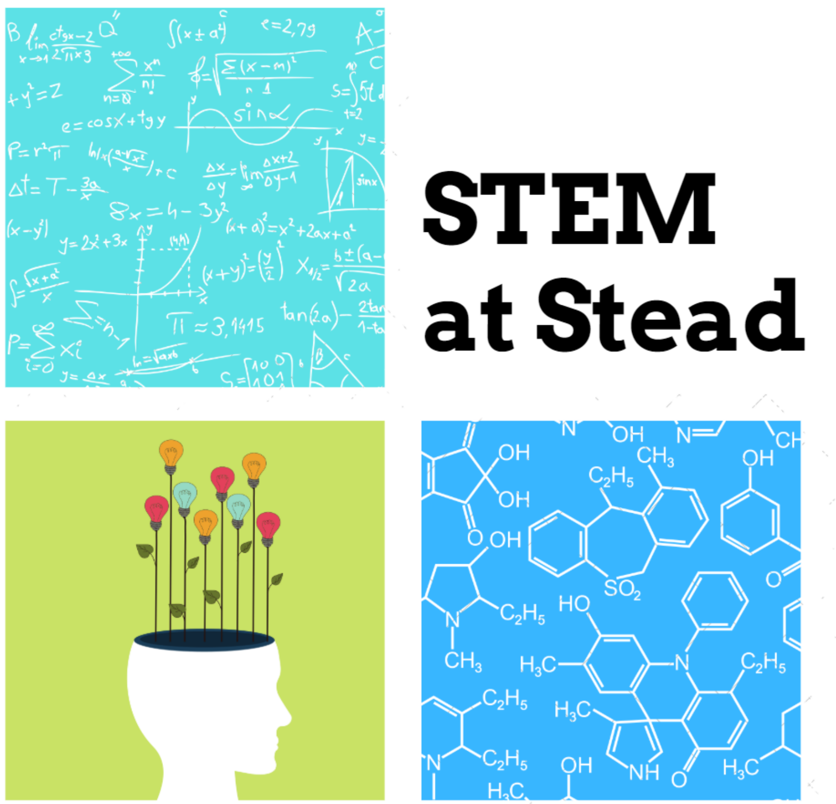
"The acceleration produced by a net force on an object is directly proportional to the net force, is in the same direction as the net force, and is inversely proportional to the mass of the object"

This translates to the equation $F = m * ((V_t – V_0)/ (t_t – t_0))$. Since we know that the change in velocity over a period of time is acceleration, we rewrite the equation as $F = m * a$. An assumption this equation makes is that the mass will remain constant throughout the trajectory. This means that the projectile will not get lighter or heavier after it is launched. Now why do we refer to the force as a net force? Because this is what acceleration is based on. It is not merely the force we applied with the catapult arm, but it is a sum of all forces acting on the projectile. This is why the acceleration we calculated wasn't quite accurate.

D. How do you think adding in the force of gravity to our calculations would affect acceleration?

E. Do the results match your prediction? Why or why not?

Catapult: Personal Power



SCIENCE WORTH EXPLORING

Written by Aubree Larson adapted by A. R. Butz from Promoting Mentee Research Self-Efficacy (Byars-Winston, Leveritt, Branchaw,& Pfund, 2013, 2016). University of Wisconsin-Madison. Supported by NIH grant # R01 GM094573 (ByarsWinston, PI). Branchaw, J. L., Butz, A. R., & Smith A. (2018). Entering Research (2nd ed.). New York: Macmillan.

Catapult Teacher Information: Personal Power

When do I give the student this work sheet?

This work sheet is meant to be completed after the entire experiment has been completed. This worksheet is best if the student performed the experiment without a partner. There is a separate work sheet for scientists who completed this experiment with a partner.

What will they learn?

4. The discussion materials for this experiment will be based off the Iowa Core Standards for Employability Skills. These standards are consistent across all age groups, so this work sheet can be used for any aged scientist. The following standards that will be reflected on through this work sheet are:
   g. 21.9 – 12.ES.2
   Adapt to various roles and responsibilities and work flexibly in climates of ambiguity and changing priorities.
      - Adapt to varied roles, responsibilities, and expectations
      - Work effectively in a climate of ambiguity and changing priorities
      - Demonstrate appropriate risk-taking

   h. 21.9 – 12.ES.4
   Demonstrate initiative and self-direction through high achievement and lifelong learning while exploring the ways individual talents and skills can be used for productive outcomes in personal and professional life.
      - Perform work without oversight
      - Use time efficiently to manage workload
      - Assess one's master of skills
      - Set and achieve high standards and goals
      - Engage in effective problem-solving process

Catapult Scientist Information: Personal Power

1. **Read through the following cognitive distortions:**

   Cognitive distortions are irrational thoughts that can influence your emotions. Everyone experiences cognitive distortions to some degree, but in their more extreme forms they can be harmful

   a. Magnification and Minimization: Exaggerating or minimizing the importance of events. One might believe their own achievements are unimportant, or that their mistakes are excessively important
      i. Catastrophizing: Seeking only the worst possible outcomes of a situation.
   b. Overgeneralization: Making broad interpretations from a single or few events. “I felt awkward during my job interview. I am *always* so awkward.”
   c. Magical Thinking: The belief that acts will influence unrelated situations. “I am a good person – bad things shouldn’t happen to me.”
   d. Personalization: The belief that one is responsible for events outside of their own control. “My mom is always upset. She would be fine if I did more to help her.”
   e. Jumping to Conclusions: Interpreting the meaning of a situation with little or no evidence.
      i. Mind Reading: Interpreting the thoughts and beliefs of others without adequate evidence. “She would not go on a date with me. She probably thinks I’m ugly.”
      ii. Fortune Telling: The expectation that a situation will turn out badly without adequate evidence.
   f. Emotional Reasoning: The assumption that emotions reflect the way things really are. “I feel like a bad friend, therefore I must be a bad friend.”
   g. Disqualifying the Positive: Recognizing only the negative aspects of a situation while ignoring the positive. One might receive many compliments on an evaluation, but focus on the single piece of negative feedback.
   h. “Should” Statements: The belief that things should be a certain way. “I should always be friendly.”
   i. All-or-Nothing Thinking: Thinking in absolutes such as “always”, “never”, or “every”. “I never do a good enough job on anything.

Catapult Scientist Information: Personal Power

2. **Identify the cognitive distortion (or multiple distortions) described during these paragraphs:**

   a. *Suzy is completing the catapult experiment. She can't get her bucket to stay glued to her popsicle stick when she launches her firing power. The bucket falls off every time she tries to complete a trial. Suzy feels like she keeps failing at this task. Eventually, Suzy thinks to herself, "I can't get this bucket to stay on and it's making me feel stupid. If I feel stupid during this experiment, then I must be stupid all the time."*

   b. *Bob just finished the catapult experiment. When he hands the materials in to his teacher, the teacher congratulates him. He got 19/20 right on his discussion materials. Bob is mad that he didn't get 20/20. He can't believe he missed a problem. Bob isn't happy with his performance at all, he is mad that he got something wrong.*

   c. *Walter is working through the catapult experiment. He does not quite understand how to put the catapult together. He starts to worry that he won't be able to put any part of the catapult together and he won't finish any of the discussion materials. He imagines this means he is going to fail this experiment.*

d. *Karen handed in her discussion materials to her teacher nearly 5 minutes ago. She can see the teacher writing things on her paper as they go through it. Karen immediately thinks that she did poorly on this experiment. The teacher would not be spending so much time on her paper if she had done well. However, when she gets her paper back she sees she did well. Her teacher wrote things like "good job" and "nice work" throughout her materials.*

3. **Read through these four sources of self-efficacy:**

   Self-efficacy is a belief one has in his/ her ability to successfully complete a given goal or task. In other words, it is a situation-specific self-confidence. It answers the question "can I do this?" Self-efficacy is informed by four sources: mastery experience, vicarious experience, social persuasion, and emotional/ physiological state. Here are some examples:

   1. <u>Mastery experience</u>: a past accomplishment or success: "I've done this before"
   2. <u>Vicarious experience</u>: a model that has successfully completed the task: "I've seen others do this before"
   3. <u>Social persuasion</u>: a social or verbal message reinforcing ability or effort: "Others have told me that I can do this"
   4. <u>Emotional/ physiological state</u>: an emotional, affective, or physiological response: "Doing science in the classroom makes me happy," "I get excited when I am doing a science experiment," or "my heart starts racing when I begin to conduct an experiment."

4. **Identify how Suzy, Bob, Walter, and Karen could use self-efficacy to help deal with their cognitive distortions:**

Suzy:
Bob:
Walter:
Karen:

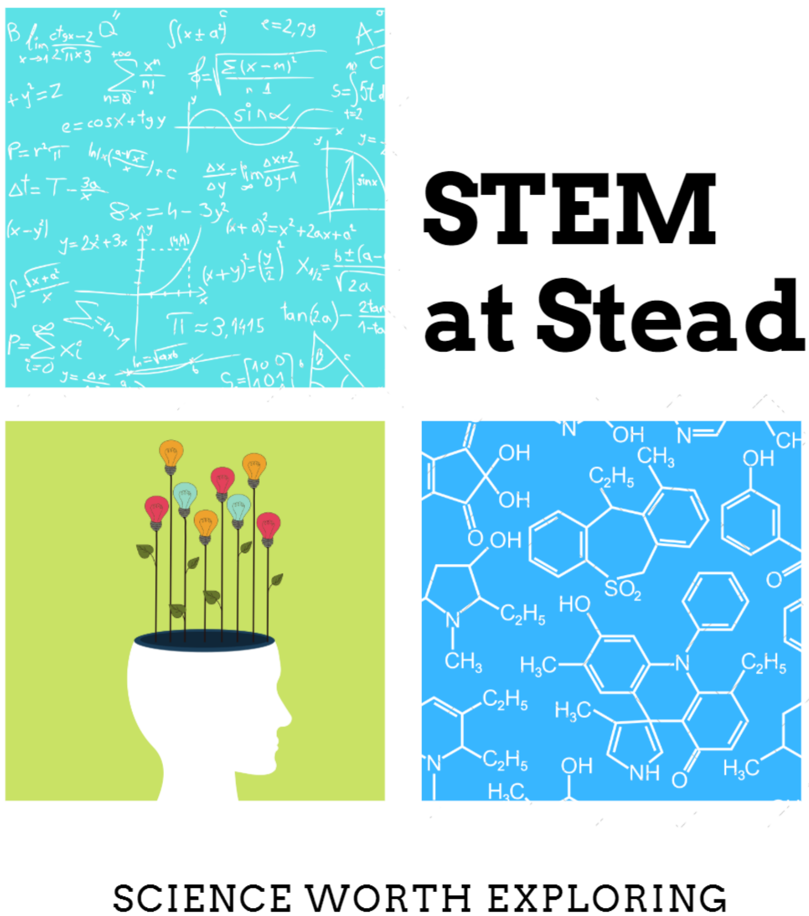
Catapult Scientist Information: Personal Power

5. Now practice dealing with your cognitive distortions while you work on through this exercise:

Think about an invention that could help you or society as a whole. The invention needs to use the same scientific principles as the catapult you built earlier. Write down/ draw your ideas:

6. Explain how you improved your behavior this time when you worked towards this invention:

Catapult: Personal Power with Partners



Written by Aubree Larson adapted from Brune (1993). Facilitation Skills for Quality Improvement. Quality Enhancement Strategies. 1008 Fish Hatchery Road. Madison WI 53715. Branchaw, J. L., Butz, A. R., & Smith A. (2018). Entering Research (2nd ed.). New York: Macmillan.

Catapult Teacher Information: Personal Power

When do I give the student this work sheet?

This work sheet is meant to be completed after the entire experiment has been completed. This work sheet is only relevant if the scientist worked with a partner or group to complete this experiment. There is a separate work sheet for scientists who completed this experiment alone.

What will they learn?

5. The discussion materials for this experiment will be based off the Iowa Core Standards for Employability Skills. These standards are consistent across all age groups, so this work sheet can be used for any aged scientist. The following standards that will be reflected on through this work sheet are:
   i. 21.9 – 12.ES.1
      Communicate and work productively with others, incorporation different perspectives and cross-cultural understanding, to increase innovation and the quality of work
      - Work appropriately and productively with others
      - Use different perspectives to increase innovation and the quality of work
      - Use all the appropriate principles of communication effectively
   j. 21.9 – 12.ES.3
      Demonstrate leadership skills, integrity, ethical behavior, and social responsibility while collaborating to achieve common goals
      - Use interpersonal skills to influence and guide others toward a goal
      - Leverage the strengths of others to accomplish a common goal
      - Demonstrate integrity and ethical behavior
      - Demonstrate mental, physical, and emotional preparedness to accomplish the task
   k. 21.9 – 12.ES.5
      Demonstrate productivity and accountability by meeting high expectations
      - Deliver quality job performance on time
      - Demonstrate accountability for individual performance

Catapult Scientist Information: Personal Power

7. Read through the following constructive group behaviors and identify one behavior that you exhibited during the catapult experiment:

Constructive Group Behaviors →

a. Cooperating: Is interested in the views and perspectives of other group members and willing to adapt for the good of the group.
b. Clarifying: Makes issues clear for the group by listening, summarizing, and focusing discussions.
c. Inspiring: Enlivens the group, encourages participation and progress.
d. Harmonizing: Encourages group cohesion and collaboration. For example, uses humor as relief after a particularly difficult discussion.
e. Risk Taking: Is willing to risk possible personal loss or embarrassment for success of the overall group or project.
f. Process Checking: Questions the group on process issues such as agenda, time frames, discussion copies, decision methods, use of information, etc.

One constructive group behavior I showed was…

8. Read through the following constructive group behaviors and identify one behavior that you exhibited during the catapult experiment:

Destructive Group Behaviors →

a. Dominating: Uses most of the meeting time to express personal views and opinions. Tries to take control by use of power, time, etc.
b. Rushing: Encourages the group co move on before task is complete. Gets tired of listening to others and working with the group.
c. Withdrawing: Removes self from discussions or decision making. Refuses to participate.
d. Discounting: Disregards or minimizes group or individual ideas or suggestions. Severe discounting behavior includes insults, which are often in the form of jokes.
e. Digressing: Rambles, tells stories, and cakes group away from primary purpose.
f. Blocking: Impedes group progress by obstructing all ideas and suggestions. "That will never work because ..."

One destructive group behavior I showed was…

Catapult Scientist Information: Personal Power

9. **What is one constructive behavior that you could work on showing more? How will you work on showing it more?**

10. **How can you help other group members show their constructive behaviors more?**

11. **How can you minimize the amount of time you demonstrate destructive behavior?**

12. **Share your thoughts with your group members. Did they have any ideas for how you could improve your group behaviors? Write some of the things they said below:**

Catapult Scientist Information: Personal Power

13. Now practice the behaviors you can work on through this exercise:

With your group, think about an invention that could help you or society as a whole. The invention needs to use the same scientific principles as the catapult you built earlier. Write down/ draw your group's ideas:

14. Explain how you improved your behavior this time when you worked with your group:

Catapult Supply List

1. One set of popsicle sticks → $1.99
   Craft Sticks 150ct - Hand Made Modern
   https://www.target.com/p/craft-sticks-150ct-natural-wood-hand-made-modern/-/A-53085449?ref=tgt_adv_XS000000&AFID=google_pla_df&fndsrc=tgtao&CPNG=PLA_Seasonal%2BShopping&adgroup=SC_Seasonal&LID=700000001170770pgs&network=g&device=c&location=9018505&ds_rl=1246978&ds_rl=1246978&ds_rl=1246978&gclid=CjwKCAiAqaTjBRAdEiwAOdx9xhz05guPb4m1sOmZJSe78_NN4nLs2akoLEgKeOeje1xCikdEevpHjxoCIRMQAvD_BwE&gclsrc=aw.ds
2. One bag of rubber bands → $12.99
   AmazonBasics Rubber Bands, Size 33 (3-1/2" x 1/8''), 600 Bands/1 lb. Pack, 3-Pack
   https://www.amazon.com/AmazonBasics-Rubber-Bands-Size-3-Pack/dp/B074B1KCWC?ref_=Oct_BSellerC_1069336_2&pf_rd_p=79f25105-5cb9-5c68-92f0-e6ec590925a3&pf_rd_s=merchandised-search-6&pf_rd_t=101&pf_rd_i=1069336&pf_rd_m=ATVPDKIKX0DER&pf_rd_r=BCQDJHMV68400X49150B&th=1
3. One bag of plastic bottle caps → $7.73
   Midwest Homebrewing Supplies Plastic Screw Caps for PET Bottle, 28mm, bag of 24
   https://www.amazon.com/Midwest-Homebrewing-Supplies-Plastic-Bottle/dp/B07G19RMW3
4. One pack of double-sided adhesive dots → $3.99
   Scotch CLEAR SCOTCH DOTS MEDTHIN 200CT
   https://www.target.com/p/scotch-clear-scotch-dots-medthin-200ct/-/A-18776841?ref=tgt_adv_XS000000&AFID=google_pla_df&fndsrc=tgtao&CPNG=PLA_Seasonal%2BShopping_Local&adgroup=SC_Seasonal&LID=700000001170770pgs&network=g&device=c&location=9018505&ds_rl=1246978&ds_rl=1246978&ds_rl=1246978&gclid=CjwKCAiAqaTjBRAdEiwAOdx9xoafpbHt1jXbOPhjSsrmKksRp30c327Hzc-LrGzK0cPfIKTfuoC_vRoCG7MQAvD_BwE&gclsrc=aw.ds
5. One bag of pom poms → $7.99
   Acerich 2000 Pcs 1cm Assorted Pompoms Multicolor Arts and Crafts Fuzzy Pom Poms Balls for DIY Creative Crafts Decorations
   https://www.amazon.com/Acerich-Assorted-Multicolor-Creative-Decorations/dp/B0773MQY4H/ref=sr_1_1_sspa?ie=UTF8&qid=1550463420&sr=8-1-spons&keywords=craft+pom+poms&psc=1
6. One bag of pencil erasers → $5.99
   Mr. Pen - Pencil Erasers, Pencil Top Erasers, 100 Pieces Cap Erasers, Eraser Tops, Pencil Eraser Toppers, School Erasers for Kids, School Supplies for Teachers, Eraser Pencil, Earasers
   https://www.amazon.com/Mr-Pen-Supplies-Teachers-Earasers/dp/B07DPVVMWB?ref_=Oct_BSellerC_705369011_0&pf_rd_p=3e414208-c3d2-5ece-8279-3f363dbdc01d&pf_rd_s=merchandised-search-6&pf_rd_t=101&pf_rd_i=705369011&pf_rd_m=ATVPDKIKX0DER&pf_rd_r=BVNEVHYN0AM30K01QF48&pf_rd_r=BVNEVHYN0AM30K01QF48&pf_rd_p=3e414208-c3d2-5ece-8279-3f363dbdc01d

7. Measuring tape → $9.99
   Komelon SL2825 Self Lock 25-Foot Power Tape
   https://www.amazon.com/Komelon-SL2825-Self-25-Foot-Power/dp/B000BQKXLE/ref=sr_1_5?ie=UTF8&qid=1550464004&sr=8-5&keywords=measuring+tape
8. Scientific scale → $10.99
   AMIR 3000g/0.1g Digital Food Scale for Christmas Gifts, Pocket Kitchen Scale, Electric Pro Mini Scale with Back-Lit LCD Display, Tare, Hold and PCS Features, Stainless Steel
   https://www.amazon.com/dp/B01LYYVJ71/ref=biss_dp_t_asn
9. One protractor → $6.95
   eBoot Plastic Protractor 180 Degree, 4 Inch and 6 Inch, Clear, 2 Pieces
   https://www.amazon.com/eBoot-Plastic-Protractor-Degree-Pieces/dp/B01LS90074/ref=sr_1_1_sspa?s=office-products&ie=UTF8&qid=1551128036&sr=1-1-spons&keywords=protractor&psc=1
10. One spring scale → $16.20
   Weston 20 Pound Spring and Hook Scale (14-0302-W)
   https://www.amazon.com/dp/B001IHF6GC/ref=dp_cerb_2