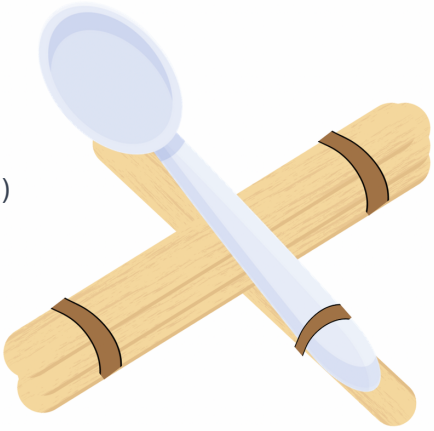
Hands On!

Catapult Challenge

NGSS Standards	MS-PS3-1, MS-PS3-2, MS-PS3-3, MS-ETS1-1, MS-ETS1-2
Cross Cutting Concepts	• Energy and Matter • Cause and Effect • Systems and System Models • Engineering Design
Science & Engineering Practices	• Asking Questions & Defining Problems • Using Models • Planning & Carrying Out Investigations • Obtaining, Evaluating and Communicating Information
Objective	Students will work in groups to design and build simple catapults. By incorporating the concept of **elastic potential energy**, students will deepen their understanding of **energy types and transformations**. This hands-on activity enables middle school students to grasp physics concepts while fostering creativity and collaboration.

Materials

- Craft sticks
- Rubber bands
- Plastic spoons
- Small projectiles (e.g., pom-poms, pencil toppers, crumpled foil etc.)
- Rulers (yard sticks or measuring tape)
- Safety goggles



Lesson Overview

1. Introduction (10 minutes):

- Discuss the concept of energy and how it's involved when things move or change.
- Explain how potential energy is stored when the rubber bands are stretched and how it's released as kinetic energy when the catapult launches.

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2. Building Catapults (15 minutes):

- Divide students into small groups.
- Ask them to design and build a catapult using the materials.
- Encourage them to think about how their design involves potential and kinetic energies.

Suggested Criteria:

- **Students cannot hold the catapult (must stand independently on a surface)**
- **5-10 popsicle sticks may be used**
- **3-5 rubber bands may be used**
- **1-2 spoons may be used**

3. Do the Students Need Help? Try Basic Starter Design –

- Have students take 5 sticks and stack them, securing one end with a rubber band. They will need to wrap the rubber band around several times to make it nice and secure.
- Then they should slide one more stick between the bottom stick and the rest of the stack
- The other end will then get secured with a rubber band.
- Students should place the spoon on top, and attach the end of the spoon to the end of the single stick with the last rubber band.

4. Testing Catapults (15 minutes):

- Each group tests their catapults by launching small projectiles.
- Groups should keep track of their trials by measuring and recording distance traveled.

5. Redesign & Retest (15 minutes)

- Groups should think of ways to improve their catapult, redesign and retest.
- Things to try: vary amount and placement of craft sticks, vary placement of spoon, be creative!

Assessment

- Assess students based on their teamwork, participation in discussions, comprehension of elastic potential energy, and their ability to apply this knowledge to their catapult projects.
- Add a competitive aspect! Who's catapult launches a projectile the furthest?

Take It Further

Real-life Examples:

- Have each group research and share real world applications of catapults.
- Discuss practical applications of elastic potential energy in everyday objects and how potential energy is converted to kinetic energy.

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Student Worksheet

Your Mission:

Utilizing your knowledge of elastic potential and kinetic energies, you will work in groups to design and build simple catapults that can send a projectile as far as possible.

Method

1. Building Catapults:

- In small groups you will design and build a catapult to launch a projectile, using the materials provided.
- Think about how your design involves potential and kinetic energies.

2. Sketch & Label your designs on the worksheet provided.

3. Testing Catapults

- Test your catapults by launching a small projectile.
- Measure and record the distance traveled in cm.
- Re-launch 5 times.
- After 5 launches, calculate the average distance that the projectile traveled for that design.

4. Redesign & Retest

- Think of ways to improve your catapult, redesign and retest.
- Repeat steps 1-3 above.
- (Hints: vary amount and placement of craft sticks, vary placement of spoon, be creative!)

5. Assessment

- You will be assessed based on teamwork, participation in discussions, comprehension of elastic potential energy, and the ability to apply this knowledge to their catapult projects.

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Catapult Activity

Data Tables

Design	Sketch & Label Design Changes Made	Distance Projectile Traveled (cm)
Design 1		Trial 1:
		Trial 2:
		Trial 3:
		Trial 4:
		Trial 5:
		Average:
Design 2		Trial 1:
		Trial 2:
		Trial 3:
		Trial 4:
		Trial 5:
		Average:

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Catapult Activity

Data Tables

Design	Sketch & Label Design Changes Made	Distance Projectile Traveled (cm)
Design 3		Trial 1:
		Trial 2:
		Trial 3:
		Trial 4:
		Trial 5:
		Average:
Design 4		Trial 1:
		Trial 2:
		Trial 3:
		Trial 4:
		Trial 5:
		Average:

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Catapult Activity

Follow Up Questions

1. Which design resulted in the longest trial distance for you?

2. What specific factor(s) in this trial caused the projectile to travel the farthest?

3. What changes would you make to enhance its performance in the future?

4. Describe how the transformation between potential and kinetic energy allowed your catapult to function.

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Suggested Grading Rubric

Criteria	4 Points	3 Points	2 Points	1 Point
Design	The catapult design is creative, well thought-out, and effectively utilizes the concept of elastic potential energy.	The catapult design is mostly creative, well thought-out, and utilizes the concept of elastic potential energy.	The catapult design demonstrates some creativity and understanding of elastic potential energy.	The catapult design is lacking creativity and does not effectively utilize the concept of elastic potential energy.
Functionality	The catapult consistently launches projectiles with great accuracy, distance, and height.	The catapult mostly launches projectiles with good accuracy, distance, and height.	The catapult launches projectiles with some accuracy, distance, and height.	The catapult has difficulty launching projectiles with accuracy, distance, and height.
Understanding of Energy	The group demonstrates a deep understanding of energy types and transformations, as evidenced by their explanation and application of concepts.	The group demonstrates a good understanding of energy types and transformations, with some explanation and application of concepts.	The group demonstrates some understanding of energy types and transformations, with limited explanation and application of concepts.	The group has a limited understanding of energy types and transformations, with minimal explanation and application of concepts.
Collaboration	The group members work together effectively, contributing equally to the design, construction, and testing of the catapult.	The group members mostly work together effectively, contributing fairly to the design, construction, and testing of the catapult.	The group members work together to some extent, but with limited contribution to the design, construction, and testing of the catapult.	The group members struggle to work together, resulting in limited contribution to the design, construction, and testing of the catapult.

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