STEM Project

Chapter 3: Energy

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Grape catapult

Before humans used gun powder and explosives to fire things through the air, they used catapults. The original concept of a catapult is attributed to the Greeks, who are said to have invented the idea as a modification of the crossbow. Like many technologies, the design and use of catapults flourished during times of war. They were still being used in combat during the First World War, where they were used to fire grenades into enemy trenches.

Catapults are an energy transformation machine. In essence, they transform the elastic potential energy in a springy material into kinetic energy in a flying object.

In this task, you will design a way to harness the elastic potential energy of a rubber band to create a grape catapult that will be as accurate as possible.

The first step will be to create a grape target. On a large piece of butcher's paper, create a target similar to the one shown and stick this up on a wall.

You will also need the following materials to design and make your grape catapult:

- Up to 15 ice-cream sticks
- 1 or 2 rubber bands
- 1 plastic spoon
- Hot-glue gun

To guide you in your design, you will use the steps of the engineering design process. The engineering design process has five major steps:

1 Think Consider the problem or objective from all angles, research it and brainstorm ideas.

2 Design Develop a possible solution and design a prototype.

3 Create Build the prototype.

4 Test Evaluate the prototype to see if it meets the objective.

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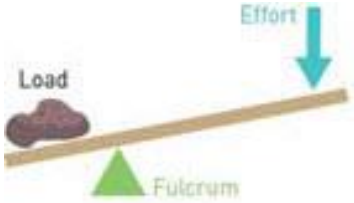
5 Improve From the test results, identify how to make your design better.

1 Think

Your objective is to create a grape catapult, from the materials provided, that is as accurate as possible.

First, think about this objective and how you will tackle it. Follow the questions in the table below to help guide your thinking. Add any additional questions of your own at the end.

Question	Notes
Draw a picture of what you think of when you think of a catapult. What are some of the features that you have drawn?	
Many ice-cream-stick catapult designs already exist. Research some existing designs and note down the features you see. What do they have in common?	
Most catapults include a lever of some type. What types of levers are possible? In particular, think about where the fulcrum (or pivot point) could be located along the lever. 	
Most catapults include a base of some type to support the lever. What designs are possible for the base of a catapult? Explore the options.	
Other questions:	

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Now you have done some thinking, brainstorm ideas for a catapult design using only the materials you have been assigned. Think specifically about the base, the lever and how your catapult will transform the elastic energy into kinetic energy.

2 Design

Choose your best idea and develop it further. Write up a description of your catapult design including a labelled diagram of how it works. Use the following questions to help you.

- What shape will your base be?
- If you are using a lever, how will it be secured and where will the fulcrum be located?
- What will be used to house the projectile grape before take-off?
- How will you be able to vary your catapult launch characteristics (direction and force) to optimise the accuracy of the grape's flight path?
- What safety issues are involved in creating and testing your catapult?

Draw a diagram of your design here.

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3 Create

Build a prototype of your catapult, being especially careful with the hot-glue gun. A prototype is a 'first try' to test if your concept will work. Write down the steps you took to build your prototype below.

4 Test

Once your catapult is created, check to see if it works by placing it 1 metre from your target on the wall. Fire a few grapes at the wall and write down your observations about where they hit the target, if at all. If there are problems, note these down.

5 Improve

Based on your test observations, how could you improve your design? Note down any ideas you have that could make it better.

Repeat steps 4 and 5 to implement as many of your improvement ideas as possible in the time you have.

Data and results

Gather data on the accuracy of your catapult by firing six grapes at the target (from 1 metre in front) and measuring the distance between the centre of the target and the point where each grape hits the target. After each trial, adjust the angle of the catapult and the power of the launch to optimise the results.

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Record your results below.

Catapult trial no.	Distance from centre of target (cm)
Trial 1	
Trial 2	
Trial 3	
Trial 4	
Trial 5	
Trial 6	

Discussion and reflection

Your sixth trial should be the most accurate. Was it? Why?/Why not?

Compare your results with other groups in the class. Whose design was most accurate? What features of the design do you think made it most accurate?

Draw an energy flow diagram to show the path of the energy in your catapult system. Start with the energy that is transferred from your hand when you stretch the rubber band and finish with the energy that is transferred when the grape hits the target.

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