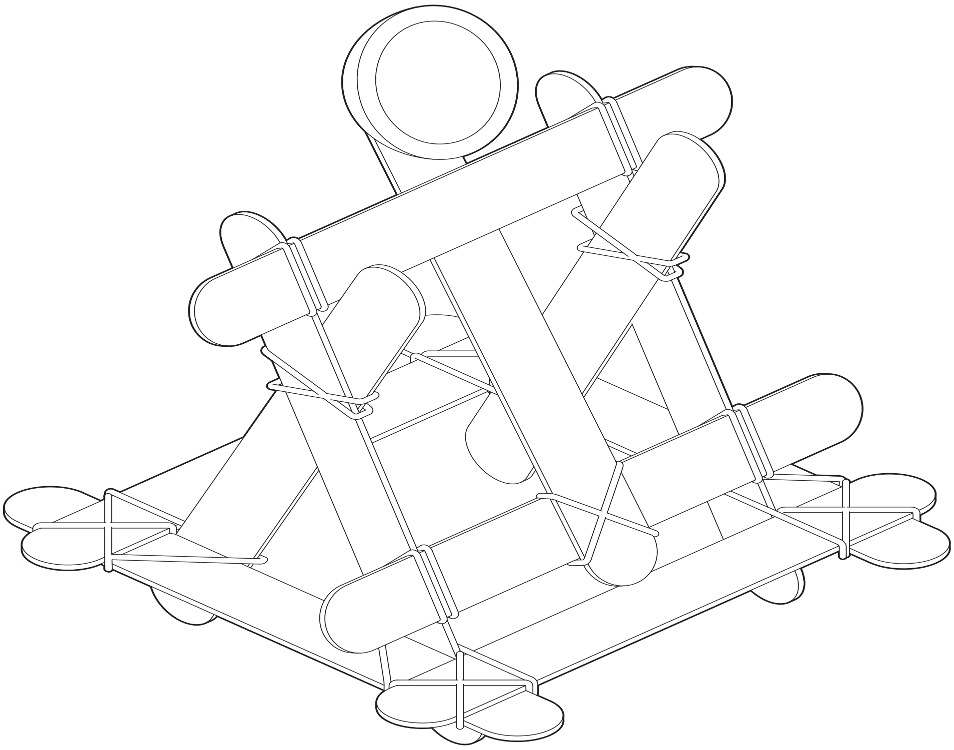


CATAPULT WORKSHEET

GETTING STARTED

5-10m

Have you ever thrown a ball and wondered how to make it go further?

Now it's time to put your skills to the test; with this catapult build you get to design and prototype your very own catapult using your engineering skills.

By the end of this session you will have considered some key principles related to projectiles and built a catapult that puts these concepts into practice.

VOCABULARY

Basket - The part of the catapult where the ball (or load) rests.

Pivot Arm - Part of the catapult that moves the load/ball forward. This is also known as a lever.

Fulcrum - The point about which the pivot arm moves.

Stop Block - The part of the catapult that stops the arm after it launches.

Base - The part of the catapult that supports the catapult.

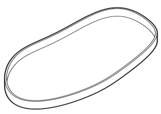
Potential Energy - Energy that is stored in an object either by lifting it up or, if the object is elastic, due to it being stretched or compressed.

Ballista - Missile weapon that launches large projectiles, similar to the crossbow.

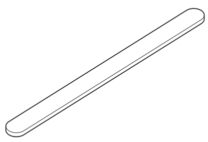
Mangonel/Catapult - This is the most iconic catapult type, with bucket to hold the missile/load.

Trebuchet - Designed for maximum power and distance, and utilises a fulcrum and counterbalance.

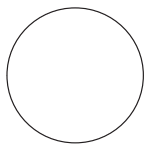
EACH TEAM WILL NEED



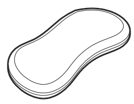
Elastic Band
20



Lollipop Stick
10



Pom-Pom or Ping-Pong Ball
1



White Tac

WARM-UP ACTIVITIES

A

5-10m

Using an elastic band to help you, answer the following questions:

- What happens when you stretch the rubber band? Is this potential or kinetic energy?
- What happens when you release the rubber band? Is this potential or kinetic energy?
- What other objects have potential and kinetic energy?

B

10-15m

Describe the functions of these catapult components, the ambassador will provide answers at the end of the activity.

- Basket
- Pivot arm (lever)
- Fulcrum
- Base
- Potential energy
- Bonus Question: How is potential energy being stored?

MAIN CHALLENGE

30-40m

As a team, you are going to work together to build structurally stable catapults.

Using the materials and instructions provided, you should build a catapult that is stable enough to launch six projectiles. The success of this will be measured in two categories: accuracy and distance.

After completing the instructions, you can try to alter your design to increase accuracy and distance.

Once completed and tested, there will be a class discussion about your findings.

DID YOU KNOW?

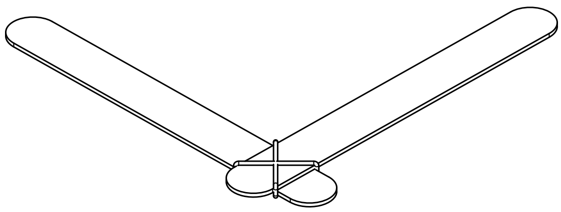
Catapults were originally designed and used as weapons during battles. Today they are used for a variety of different reasons ranging from toys, to launching jets from aircraft carriers that have limited runway space.

BUILDING THE CATAPULT

A

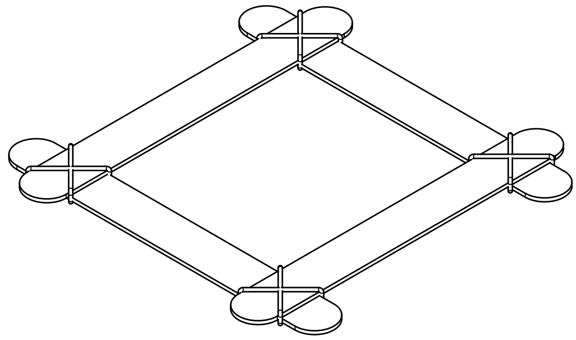
Connect two lollipop sticks to form a right angle. The sticks can be held in place by using an elastic band.

It may be necessary to wrap the band around the joint several times if the joint isn't secure enough. You can also add extra elastic bands if one isn't creating enough stability.



B

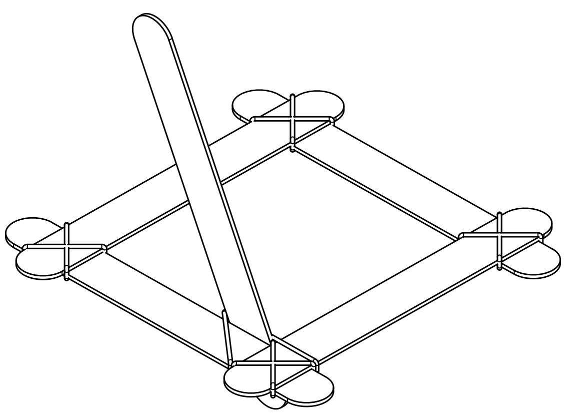
Repeat step **A** until four lollipop sticks have been connected to form a square structure. This will form the base of your catapult.



C

Join a lollipop stick to the inside of your base using an elastic band so that it is vertical, or perpendicular to the base.

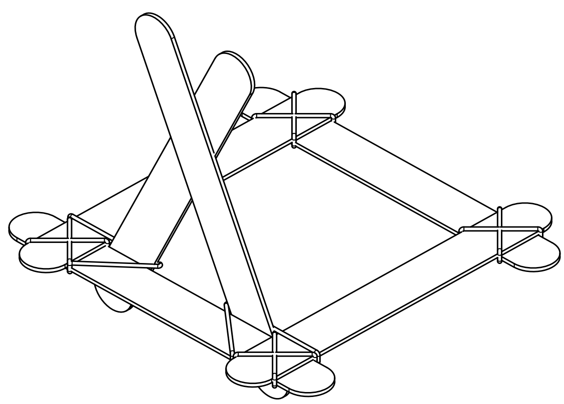
Again, you may need to wrap the band around the joint several times if the joint is not secure enough.



D

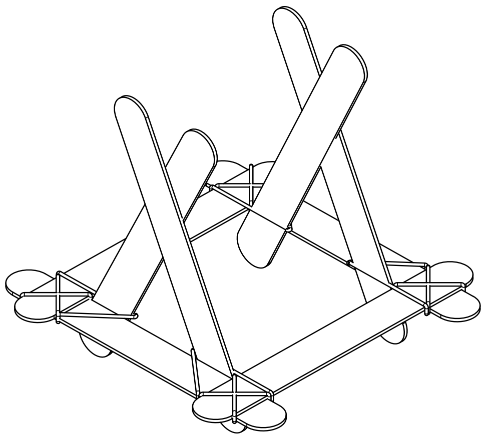
Repeat step **C**, joining another lollipop stick vertically to the base so that it is in line with the one that was fixed in place in step C.

These two uprights should be able to cross over each other to make an A-frame, as shown below.



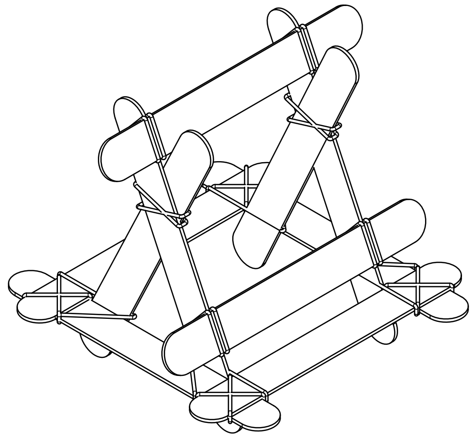
E

Repeat steps **C** and **D** for the other side and fix each side in the A-frame shape using an elastic band as shown below. The location at which you choose to cross the lollipop sticks will dictate the angle the projectile is released from the basket.



F

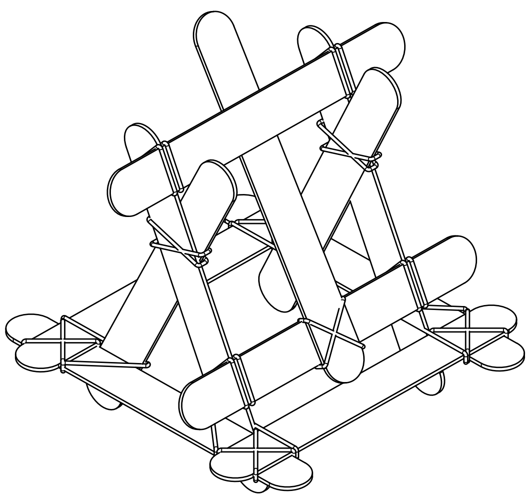
Pick which side will be the front of your catapult and, using elastic bands, fix two lollipop sticks horizontally to the front edges of the two swept back angled lollipop sticks. One lollipop stick should be joined near the bottom, close to the base and one should be added at the top, above the point where the sticks cross.



G

Thread a final lollipop stick vertically between the two sticks added in step **F** as shown below. The bottom should be in front of the lower horizontal lollipop stick and the top should be behind the upper horizontal lollipop stick.

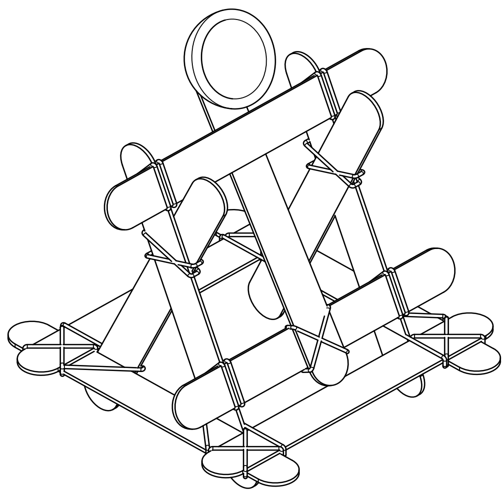
Try to position it centrally and fix the bottom of the stick to the lower horizontal lollipop stick using an elastic band. This will be your catapult's fulcrum.



H

Use your hands to form a basket out of white tac that is large enough to hold the projectile. Stick it to the very top of the vertical lollipop stick added in step **G** to complete your catapult.

When firing your projectile, be sure not to stick it to your basket, but to balance it. This will allow you to launch your projectile successfully.



CATAPULT

10-15m

ELASTIC POTENTIAL ENERGY

KS1/2 PROOF OF CONCEPT

Thinking back to your testing, did you notice any of your bands snapping? If you did, that is because there is a limit to how much you can stretch an elastic band. If you stretch it too far, your band will snap or stretch permanently, leaving you with a catapult that just won't work.

By adding more elastic bands, you can strengthen your catapult's stability and power. The more elastic bands you use, the more elastic potential energy is stored when you pull back the catapult's arm, which results in a higher force pushing your projectile away. Simply put, if you want your catapult to be more powerful - try putting more bands on!

KS3/4 DEEPER LEARNING

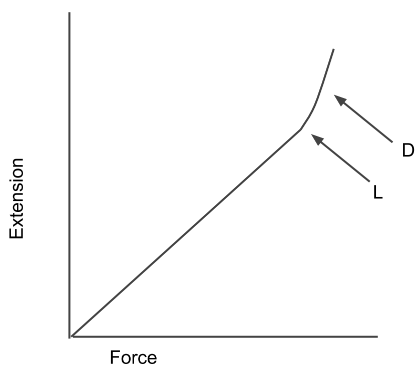
To explain this, we will take a look at an equation commonly referred to as Hooke's Law.

$$F = ke$$

Where F is the force, k is the spring constant and e is the extension.

The spring constant is dependent on the spring/elastic object that you use. The stiffer the spring, the higher the spring constant, so when you add more elastic bands, the spring constant increases. This results in needing a higher force in order to extend it by the same amount.

This equation also tells you that when you extend a spring, or elastic band, the amount of force required is proportional to the distance that you are stretching it, so the further you stretch the band, the more force you need to apply.



Take a look at the graph above, which illustrates Hooke's Law. If you stretch an elastic band beyond a certain point, the relationship in Hooke's Law is no longer observed. This point is labelled L on the graph, and is called the Limit of Proportionality.

Past this point, there is a sharp increase in extension compared to the force applied. When the band then reaches point 'D' - the elastic limit - the band will no longer return to its original length and will be permanently deformed. (You may see this happen where white patches occur on the band).

How could this help develop your Catapult designs?

QUIZ

10-15m

What function does the pivot arm have?

....

....

What happens when you add more elastic bands to the catapult?

....

....

What was the catapult's original purpose?

....

....

What is a projectile?

....

....

What is potential energy?

....

....

QUIZ

10-15m

At what point is the potential energy transformed into kinetic energy?

....

....

What two things dictate how much force is exerted by the bands?

....

....

What does it mean when white patches appear on your elastic band?

....

....

What is a fulcrum?

....

....

What were catapults originally designed for?

....

....