EA jnr club

Lower Primary

TEACHER RESOURCE KIT

Construct a catapult

This guide includes:

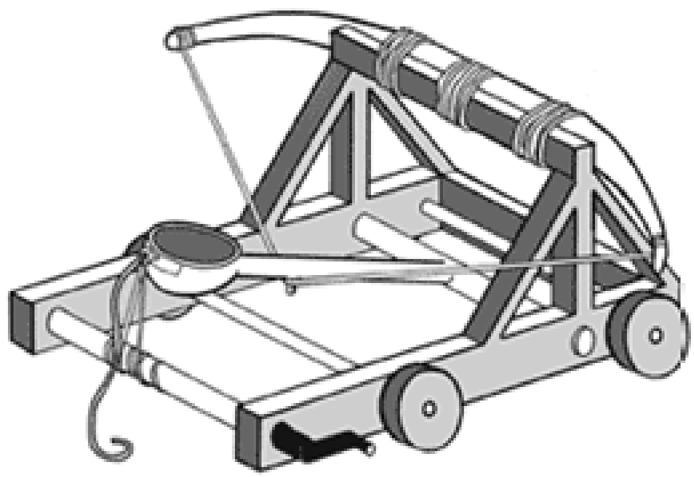
- Background information
- Lesson ideas
- Project instructions
- ‘Experimenting with levers’ activity sheet
- ‘Simple machines every day’ activity sheet
- ‘Tools and machines’ activity sheet
- Know Want Learnt (KWL) Chart
- Think Want Learnt How (TWLH) Chart

ENGINEERS AUSTRALIA

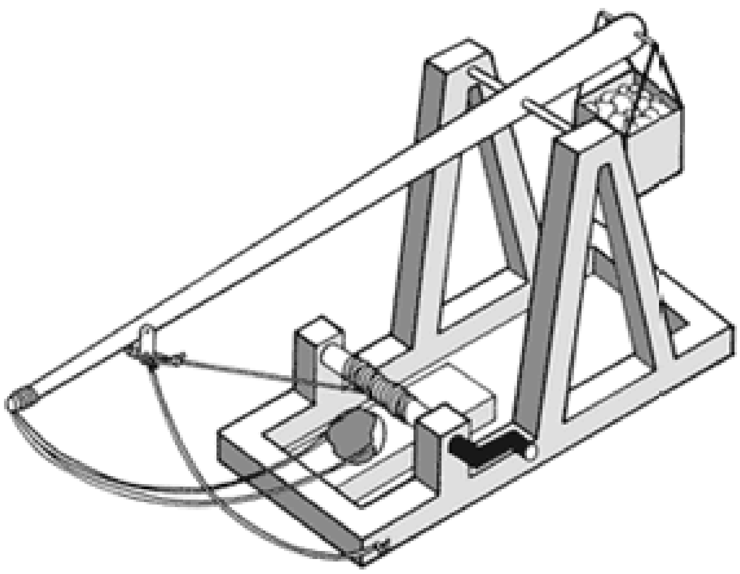
Construct a catapult: *background information*

Way back in Mediaeval times, guns didn't exist! Instead, huge catapults were used as weapons to throw heavy objects *(such as rocks)* at enemies. There were many types of catapults and they all had simple machines in them to make them work.

Simple machines *(such as ropes and pulleys)* would be used to drop weights onto the catapults to propel the missiles. Other simple machines such as levers would be used to project missiles even further.



Ballista catapult



Trebuchet catapult

Construct a catapult: *lesson ideas*

Science

- Students to conduct 'fair testing' on their catapults. Aspects to investigate could include what happens to the distance 'thrown' when variables such as the weight of the object or angle of the launch are changed.
- Students to conduct an investigation exploring what causes the 'turning effect' on a simple lever. Each group will need a simple lever such as a wooden ruler, and a number of objects that all weigh the same *(you could use 20-cent pieces)*. Students to:
    - Place the lever on the table, and balance it in the middle *(for example, by resting it on an eraser)*.
    - Investigate how the effects of the forces *(the weights)* and the distances from the fulcrum *(centre)* affect the 'turning effect', and establish where the weights need to be placed in order to balance the lever.

Technologies

- Students to complete the **'Experimenting with Levers!'** activity sheet.
- Students to brainstorm as many tools and machines as possible *(e.g. hammer, can opener, screwdriver)*, then complete the **'Tools and Machines - Where Do They Belong?'** activity sheet.
- Students to go for a walk around the school looking for different types of simple machines. Where can they see a lever? Students to complete the **'Simple Machines Every Day'** activity sheet.
- Set up a display table of simple machines *(e.g. egg-beater, screw, hammer, pulley, gear etc.)* in the classroom so students can become familiar with them. Encourage students to bring other simple machines in from home.

Mathematics

- Students to measure the distance of an object from their catapult launch site to the landing spot. Students could also time the flight of their object.

English

- Students to brainstorm as many engineering words as possible and then create a page in their science books on which to record these words. Students will add to this as they learn new words. These words could be used to create a class word wall.
- Students to use pictures and key words to create a display in the classroom based on engineering, building and construction.
- Students to complete the **'KWL Chart'** or **'TWLH Chart'** activity sheet.
- Students to brainstorm different ways that a catapult may be used in everyday life. They choose one idea and create a story about it.
- Students to create a simple procedure explaining how to build a catapult.

Humanities and Social Sciences

History

- The invention of tools and simple machines has had an enormous impact on the way humans lived, survived and developed. As a class, discuss why we need machines and tools and how we use them in everyday life.
- Students to brainstorm how catapults were used in the past and are used in modern times (*e.g. launching aircraft from an aircraft carrier's deck*). What would happen if there was no catapult?

Geography

- Engineers make a significant contribution to the community. Organise an excursion to a place where engineering teams are, or have been, at work in the community. On the way there, ask students to look for things that might have been designed by engineering teams.

The Arts

- Students to view pictures of catapults and draw their own 'wacky catapult', labeling its unique features.
- For a drama activity, provide students with a card that has the name of a simple machine on it. In pairs, students to think of a mime which portrays the movement of that simple machine. The class has to guess what simple machine it might be.
- Students to copy a picture of a catapult.
- Students to cut out pictures from magazines of machines and tools. Paste onto a large piece of paper to create a class collage on the topic.

Health and Physical Education

- With a partner, students to brainstorm ideas on how catapults could assist sports people in their chosen field.
- Students to brainstorm ways in which simple machines have helped human beings.

Languages

- Students to investigate the origin of the word 'engineer'.
- Students to learn how to say and write words such as 'launch' and 'catapult', in various languages.

Construct a catapult: *Project instructions*

Important safety information

Allow plenty of time to discuss the safety precautions that are essential when assembling and testing catapults. As a class, discuss how students can keep themselves and others safe. These ideas should be presented on a class poster and displayed in the classroom. All students should agree with these rules before starting and the safety precautions and guidelines should always be observed.

Remind students that their machines may be used only to propel soft, light objects such as marshmallows or table tennis balls. The propulsion of other objects with the potential to cause injury to fellow students, or to other living creatures, is strictly prohibited!

Getting started - research activities

- Students to participate in the 'Construct a catapult' lessons and complete the associated activity sheets.
- Students to investigate various types of Medieval catapults, and describe how they worked. Some examples you might look for include the 'trebuchet', the 'onager', and the 'ballista'.

The design stage

The catapult is to be well designed and constructed, but there are size limits. The base of the model must be no larger than 25cm square, and any levers or arms must be no longer than 50cm.

The machine can be powered by any means of storing up energy *(potential energy)*, such as falling weights, springs or elastic materials such as rubber bands. It must be sitting on the floor *(or table)* at the point of firing. It must not be directly hand powered. In other words, the marshmallow may not be thrown or propelled directly by hand, and the machine may not be moved by hand to bat or hit the marshmallow.

Any simple machines such as levers, wheels and axles, inclined planes, pulleys etc. can be used in the construction.

Teachers to explain that there are several factors that can affect a catapult's accuracy and the distance it can propel an object. Some of these factors include:

- the weight of the object thrown
- the strength and length of the arm
- the flexibility and speed of the arm
- the angle and height of the launch
- the wind and weather conditions at launch *(if outside)*

The construction stage

Having completed the plans, the next stage is for the teams to construct their catapults from the selected materials. Some teams may need assistance with this phase.

Materials

Students are to create their catapults out of recycled and household items. Some examples of materials could include: timber, cardboard, string, cartons, Paddle Pop sticks, plastic spoons, lids, pegs, elastic bands and rulers.

Students will also need objects to launch *(they must be consistent across the class)* e.g. marshmallows, pieces of paper, soft balls.

Testing the catapult

This can be a competition to see:

- which catapult can throw an object the greatest distance *(3 attempts)*.
- which catapult is the most accurate in trying to hit a target *(3 attempts)*.
- which catapult has the most innovative design and construction.

Critiquing the designs

Having attempted a design and construction, and tested it to see whether it works, the student teams should be given opportunities to critique their designs, plan and carry out modifications, and again test their new designs for possible improvements. These observations, planned modifications, and observed results can all be recorded in a journal.

Obviously there is a limit to how many of these critique and modify cycles can be built into a school program, but it does need to be recognised that the capacity to critique a design and its performance, and consequently modify and test it again, is an important basic engineering principle.

Recording the results

Students should be encouraged to record their results in a meaningful way. At the time of recording, this would probably be in the form of a simple table. Students could reflect on their catapult by drawing a picture/taking photographs of it and writing a paragraph about it when completed.

Explaining the catapult

Having constructed a working model of a catapult, the students should then be guided through a process of explaining how their machine works. This explanation should be based on their understanding of the principles of simple machines, energy and forces, mechanical advantage and so on.

For example:

- A rubber band catapult

  For a catapult that uses elastic or rubber bands to propel the missile by use of a lever, students might explain that the energy is first stored up in the rubber bands through the work done in stretching them *(elastic potential energy)*. The work done in stretching the rubber bands might be made easier by using simple machines such as pulleys. When the catapult is fired, this stored-up energy is changed into the energy of movement *(kinetic energy)*. This moves the load *(the missile)*. The lever multiplies the distance, so that a large force *(from the rubber bands)* makes a smaller load *(the marshmallow)* travel a greater distance.

- Falling weight catapult

  Similarly, for a catapult that uses the energy of a falling weight to propel the missile, students might explain that the energy is first stored up through the work done to lift the weight up to the top of the catapult *(gravitational potential energy)*. Again, in real life, this work was probably made easier by using simple machines such as pulleys or inclined planes.

  When the catapult is fired, the energy of the falling weight is transferred to the energy of movement *(kinetic energy)* of the missile. The use of a lever magnifies the distance, so the missile travels much further than the falling weight.

Building on this understanding

Having accepted this challenge, constructed and tested a working model, critiqued and refined the design, and tested it again, there are further opportunities for student learning.

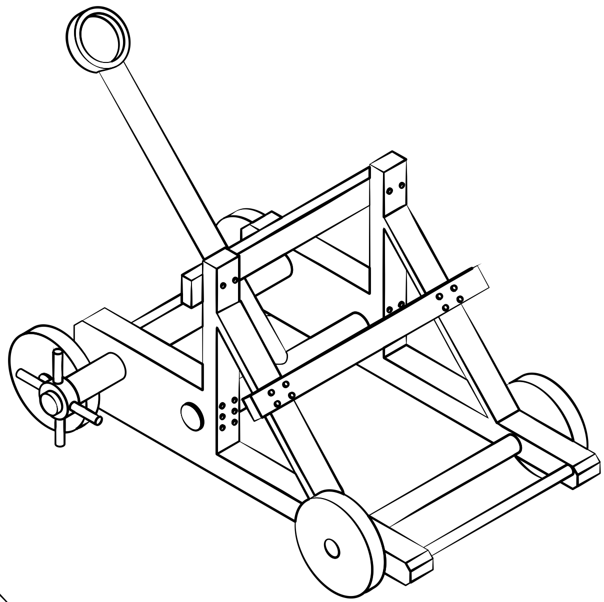
These include:

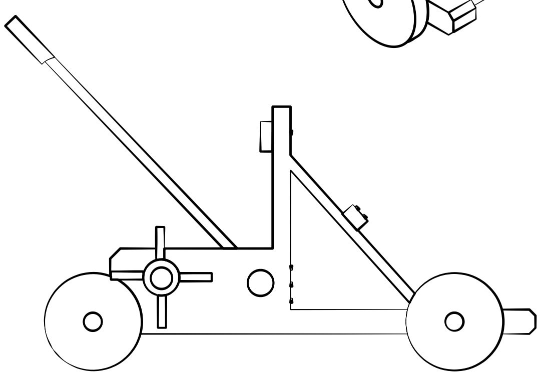
- What other design changes might lead to improved performance of the machine? How could I test these?
- Note: this leads into 'working scientifically', the concept of variables, and the need to vary only one variable at a time whilst keeping everything else the same, in order to conduct a 'fair test'.
- What other machines *(both past and present)* work on similar principles to the catapult?

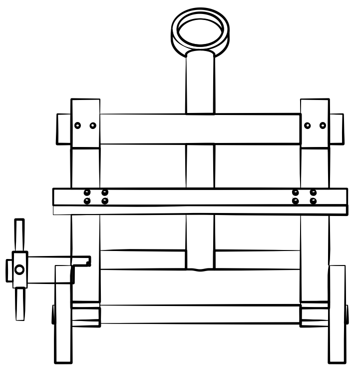
Assessing the projects

Upon completing the construction and the testing of their catapult, students should be engaged in assessing the successes of their projects. They should consider:

- Which particular designs were more successful? Why?
- What have they learned whilst doing the project?
- What else would they like to learn about catapults or energy?
- What would they do differently if they undertook the project again?







Experimenting with levers!

Name: ____________________

A lever is a rigid bar that rotates around a fixed point.

Draw a picture of your lever.

Simple machines every day

Name: ______________________________

You see simple machines every day! But where?

Draw three simple machines you have seen around your school.

Name of machine: ______________________________

Name of machine: ______________________________

Name of machine: ______________________________

Tools and machines - Where do they belong?

Name: ____________________

Simple machine	Put the tools and machines (from your brainstorm) into the correct group
Pulley	
Lever	
Wheel and axle	
Inclined plane	
Wedge	
Gear	
Screw	

Know Want Learnt (KWL) Chart

Name: ______________________________

What I **KNOW** about catapults	What I **WANT** to know about catapults	What I have **LEARNT** about catapults

Think Want Learnt How (TWLH) Chart

Name: ______________________________

What we **THINK** we know about catapults	What we **WANT** to know about catapults	What we have **LEARNT** about catapults	**HOW** we learnt it