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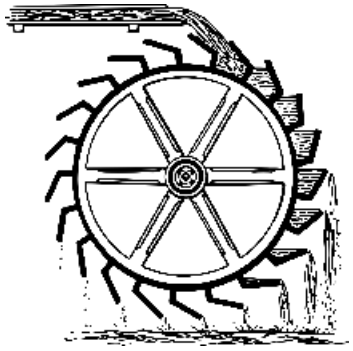
Calderdale Industrial Museum Association

Power: Past to Future

Water wheel

Challenge Pack



This challenge is aimed at upper **KS2** and supports the primary National Curriculum;

KS2 GEOGRAPHY
Human and physical geography

KS2 SCIENCE
Working Scientifically
States of Matter
Forces

KS2 DESIGN AND TECHNOLOGY
Design and Make

…as well as promoting team working, problem solving and creativity!

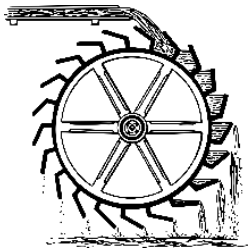
Information for Teachers

The Water Wheel Challenge

Introduction

This activity complements a visit to Calderdale Industrial Museum and the KS2 workshop ***Power From the Past to Future.*** *The challenge can also be used as a post visit activity.*

Included in this pack;



- Useful Websites and Links
- Pupil Challenge introduction
- Object Photo and Fact File
- Background Information Sheet
- Pupil '*Sparking Ideas*' Sheet
- Teacher Notes – Testing and Designs
- Pupil Experiment Sheets
- Pupil Design Sheet

The Challenge

On display in the Museum is a 200-year-old mill water wheel. The challenge is for pupils to help the museum explain why the water wheel is important and it works. The first part of the challenge is to ***research and present information about water power***, this could be however pupils choose – perhaps in the style of a museum panel or a video aimed at museum visitors. The second part of the challenge is to ***design and build a working water wheel model*** which can lift a weight. The finished work would make a wonderful classroom display and could also be emailed to the museum for us to see! schools@calderdaleindustrial.co.uk

Resources Required

You can provide a variety of materials for pupils to choose from as they design their water wheel. Suggested items include;

- Watering can, water supply and 'wet' area for testing
- small weight and string
- wooden dowel or blunt ended skewers
- plastic disposable plates
- small plastic yogurt tubs, disposable cups, plastic spoons
- plastic box or buckets
- large plastic bottles
- corks and foam
- glue, tape and scissors

Related Lesson Ideas

- Geography and Science - The Water Cycle
- Geography and Science - Renewable Energy
- Science - Climate Change
- D& T - Design and Making a Simple Machine
- Literacy – descriptive and factual writing
- History – the industrial revolution
- Local History – textile industry in Yorkshire

Extension Ideas

- Evaluation of design and modifications
- Investigation on the mass which can be lifted by the water wheels
- Design and make other renewable energy models e.g. solar powered car

Useful Websites and links

The following websites and videos have useful information and tips to help pupils research and complete the challenge. Please check they are appropriate and safe for your class before using.

Making wind turbines

https://practicalaction.org/wind-power-challenge-stem

https://www.sustainablelearning.com/resource/build-your-own-wind-turbine

Making water wheels/turbines

http://www.alternative-energy-tutorials.com/hydro-energy/waterwheel-design.html

https://www.youtube.com/watch?v=x8xow_R0YRI

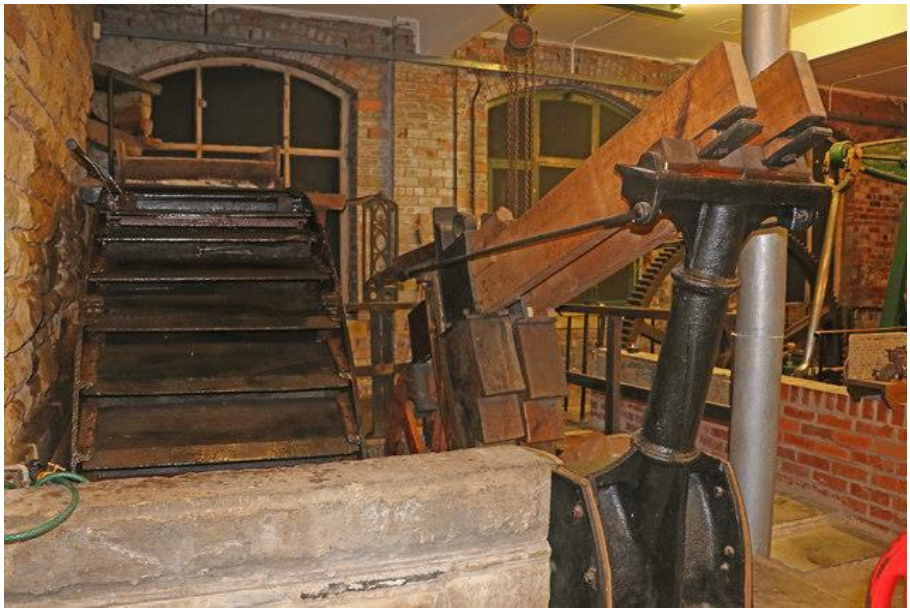
https://www.youtube.com/watch?v=HUaaFE8regs

The Water Cycle

https://www.wateraid.org/uk/publications/the-water-cycle-lesson-plans

Challenge Introduction

This water wheel on display in the museum is over 200 years old.



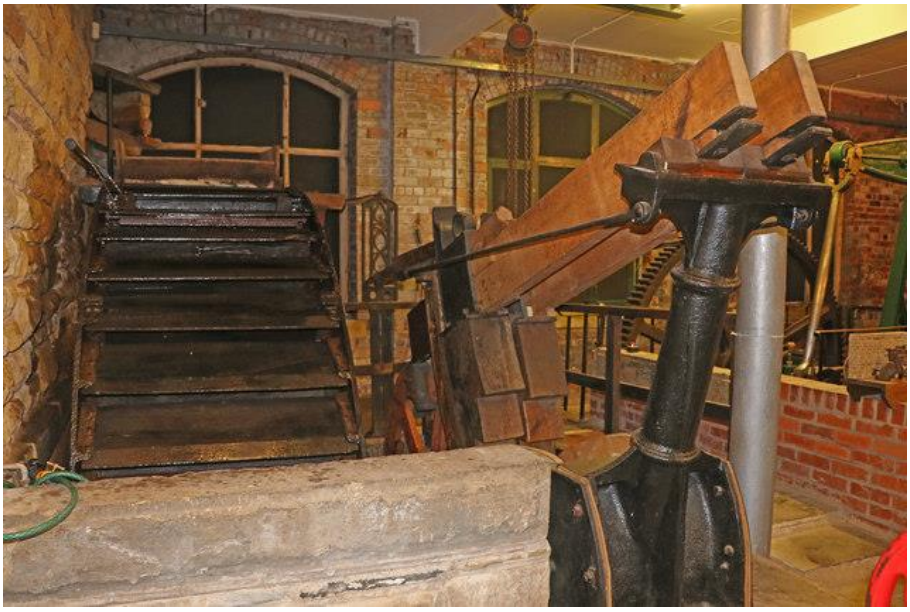
Unfortunately, it doesn't turn anymore, but we would really like to demonstrate and explain to museum visitors how water can be used to generate power. Can you help?

Challenge:

1. Create a presentation to explain how water can generate power
2. Make a model water wheel which can lift weights

Object Fact File

Mill Water Wheel and Fulling Stocks



What is it?

This is a water wheel and fulling stocks from Stone Mill Tannery in Sowerby Bridge.

How old is it?

It is thought to be about 200 years old.

What is it made from?

Oak spokes
Elm buckets
Iron and Steel Wheel

What did it do?

Fulling stocks played an important part of the process of making textiles. New textiles were beaten by heavy wooden hammers, lifted up and down by thick oak cams called 'tappets'. This acted to thicken the textiles as the fibres tightened up. The cloth was then dried and stretched on frames using 'tenter hooks'.

How does it work?

Before the industrial revolution and the widespread use of steam power in mills, water wheels were an important source of energy to power mill machinery. Water falls from above into the buckets of the water wheel causing the axle to turn. The fulling stocks are attached by the axle to a tappet wheel. The larger the diameter of the wheel, the greater 'leverage' and so the greater turning effect on the axle that drives the stocks.

Background Information:

Why is Water an Important Energy Source?

Making Electricity

Electricity can be made from renewable or non-renewable energy sources. Most of our electricity comes from power stations which burn fossil fuels like coal, oil and gas to generate the electricity.

Climate Change

Burning fossil fuels produces 'greenhouse' gases like carbon dioxide which may be causing the Earth's climate to warm up, this is called global warming. The Earth's temperature has risen by 0.5 C over the last 100 years. This doesn't sound much, but it can have a big impact on the environment such as droughts, flooding, rising sea levels and melting ice caps. Fossil fuels are non-renewable energy sources, this means that one day they will run out.

Renewable Energy

Renewable energy sources can be used over and over again – they won't run out. They also don't produce greenhouse gases and so are not are harmful to our environment as burning fossil fuels.

There is a long history of people using the force of water flowing in streams and rivers to produce energy to power machines especially for mills like the Museum's water wheel. Water power is also called Hydropower. Today we can use Hydropower to make electricity.

Hydroelectricity

Falling or flowing water has a lot of energy. We can use the movement of the water to turn the blades of a turbine. The turbine is connected to an electric generator. The generator produces electricity, which is carried in power cable for us to use. We use electricity every day in our homes, schools, street lighting and even cars.

The Water Cycle

Hydropower depends on the water cycle. Energy from the sun heats water like rivers and causes the water to *evaporate*. Then the water vapour *condenses* and falls as *precipitation* (rain or snow). The precipitation collections in rivers and oceans where it evaporates, and the cycle starts again. The amount of precipitation (rain) determines how much water there is for Hydropower.

Sparking Ideas!

Before you start planning and creating, try some ***research*** to help with sparking some great ideas! You could use the internet, books, visit the library or even better visit a museum to find out more! Here are some tips to help.

Presentation

Think about **who** will be reading your information and what would they be interested in finding out?
Have a look at **different styles** of museum panels – which do you like the best and why?

When were water wheels **first** used?

What can you find out about mills or factories and water wheels **in your area**?

What was the water wheel in mills **used** for?

Where were mills using water wheels **located** and why?

Why don't factories use water wheels **today**?

How do we **use** water power today?

Model Design

Have a look at different **types** and designs of water wheels – **undershot** and **overshot**. Which do you think would be best for your model?

What will cause the wheel to **rotate**?

Will **speed** of water flow or **volume** of water be more important?

How can you use **gravity?**

How will you **catch** the water?

Teacher Notes

Experiments

To help pupils think about what the best design for their water wheel, try out some simple tests on key concepts.

Axles

What items can you think of with wheels, which move a 'load'?
Wheelchair, trolley, skateboard, car etc.
Ask pupils what the items have in common – two wheels connected by a bar called an axle.

How do the wheels cause movement of the load?
Wheels help things move by rolling.

Did the ruler make it easier or more difficult?
The ruler acts as a wheel and should make turning the axle and lifting the bucket easier.

The key links to the water wheel design are;

- An axle is a simple machine, which makes a job easier to do.
- The water wheel must have an axle which is able to rotate to generate energy.
- The axle is normally attached to another system which harnesses the energy created.

Turbine Blades

Do you think the size of the sails will have an effect?

Encourage pupils to vary length and width of their sails. Longer turbine blades help the turbine to capture more energy from the wind but will make the windmill rotate more slowly.

Are there any other sail design features which could make it spin faster?

- Number of blades can have an impact – they should be an even number and balanced across the windmill.
- The angle of the blades giving the most surface area facing the direction of the wind flow.

The key links to the water wheel design are;

- The blades or buckets need to designed to capture as much of the water as possible to be efficient.

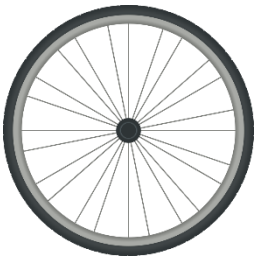
- A constant flow of water is needed so the overshot wheel is the best design. Gravity will have an impact on the efficiency of the wheel and pupils may be able to experiment with the high water is dropped from.

Axles Activity Sheet

When we have to move a heavy load we need to use a force to push it or to lift it, to overcome friction and gravity.

A wheel and axle can work together as a simple machine.

A simple machine is a device which changes the *direction* or *strength* of a force or forces.



1. What items can you think of with wheels, which move a 'load'?

2. How do the wheels cause movement of the load?

Activity

You will need:

2 chairs
broom handle or long cardboard tube
string
bucket with handle
tape
scissors
ruler

Try this:

Place the chairs back to back about a ruler length apart, then rest the broom handle over them.

Tie 60 cm of string to the bucket and tape the other end of the string to the broom handle.

Place a small weight into the bucket.

How can you lift and lower the bucket?

Tape the ruler to the broom handle at one end. Use the ruler to life and lower the bucket.

Did this make it easier or more difficult?

Identify the axle and the wheel in the activity.

Turbine Blades Activity Sheet

A turbine is a machine which is designed to capture energy from a moving source, for example water or air. A windmill is the simplest kind of turbine. As the wind blows past the sales (blades) of the windmill they rotate.

The faster the wind blows, the more energy it contains. The *faster* the sails spin, the *more energy* is supplied to the axle which drives the mill machines or electric generator.

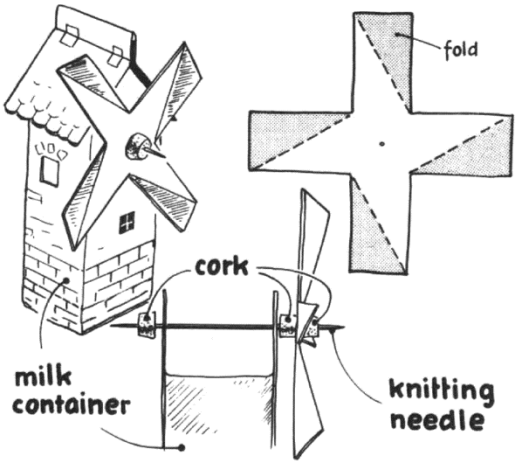
1. Do you think the size of the sails will have an effect?

2. Are there any other sail design features which could make it spin faster?

Activity

You will need:

different sizes and shapes of cardboard windmill sails(blades)
empty and clean 4 pint milk bottle
wooden dowel or skewer
corks (or blue tack lumps)
glue or sellotape
small weight (paperclip) and string



Try this:

Cut out different shaped and sized windmill blades ready to try out

Carefully put holes through the top of the plastic bottle and push the skewer through

Add your cardboard sails onto the skewer and use a cork or small piece of blue tack to hold in place

At the other end of the skewer add a piece of string with a small weight on the end and dangle the weight off the edge of a table

Now experiment blowing onto your sails! Can you exert enough energy to lift the weight?

Try out blowing from different angles and using different sizes of sails. What works best?