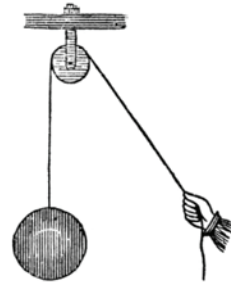




Equipment

Younger Children

1. Rolling pin, string or rope, something to lift up (e.g. a fairly heavy book)



2. Empty thread spool, wooden skewer or round pencil, string, small empty milk carton with handle

3. **FLAG:** Paper, scissors, colouring pencils, sellotape

PULLEY: An empty spool, string, long nail or knitting needle, cereal box or shoe box or equivalent (to act as a 'building'), blutack.



5th - 6th Classes Only

Each group of children: two single pulleys, cord (nylon if possible), force meter (measuring up to approximately 2.5 Newtons or 250g), weight (e.g. a 500 ml plastic bottle with about 200 mls. of water in it to make it heavier), ruler, narrow round stick (e.g. bamboo or dowelling) to attach



Suggested class level

All

Preparation

The younger children could be asked to bring in a rolling pin for their activity.

If possible, the children should be given the opportunity to see and use a pulley.

INVESTIGATING PULLEYS

Background information

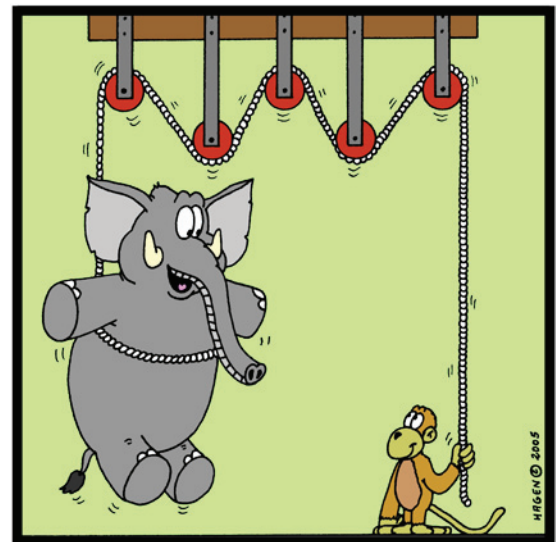
A pulley is a simple machine which is useful for lifting things. It reduces the effort required to raise a load. It consists of a wheel with a groove through which a string or rope runs. The rope has a load on one end and someone or something pulling at the other end.



A simple fixed pulley is one which enables you to pull down while the load goes up (e.g. a pulley on top of a flagpole for hoisting a flag to a height). It requires the same force, but it is easier to pull down (i.e. in the same direction as gravity) than to pull up. (Activity 3b).

A moveable pulley does not change the direction of a force, but it lets you use less force to lift a load. But you must pull the rope a longer distance than the load moves. (Activity 3c).

There are more complicated pulley systems (mixture of fixed and movable pulleys) which enable you to lift quite heavy loads with a small effort. These are used on building sites, in shipyards, on sailing ships to lift heavy sails. The more pulleys you have, the easier it is to move heavy loads.



Alright, alright, you've won your bet:
You can lift me with one hand...

'Alright, alright, you've won your bet:
You can lift me with one hand...'

Trigger Questions

What is a machine?

(A thing that makes a job easier and quicker to do)

Can you name any simple machines?

Scissors, hammer, wheelbarrow, tin opener, hairdryer...

Do you know any more complicated machines?

(Bicycle, lawnmower, car, train, combine harvester...). These have lots of different types of machines all gathered into one, e.g. gears, levers, pulleys, etc.)

INVESTIGATING PULLEYS

Trigger Questions

What is a pulley?

(a wheel with two raised edges so that a string or rope will run around the wheel without falling off.)

Where would you find a pulley?

(Building sites, flagpoles, boats with masts...)

How would you hoist a flag up a very tall flagpole?

How would you get heavy stuff up into a tree-house?



Content

SCIENCE: Forces **MATHS:** Measures – Length, Weight, Ratios

Skills

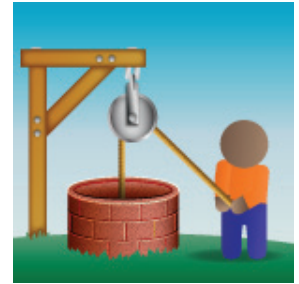
Experimenting, Design and Make

Cross-curricular links

History: In olden times people threw vines over branches of trees to lift up weights. Before people had motorised pumps to pump underground water, they used buckets and pulleys to lift water from wells.

Geography: Their chosen country – some facts about it.

Art: Making flags of countries.



Activities

Younger Children

1. Use a rolling pin as a pulley:

The children can be asked to lift up the book in their hands, and feel how heavy it is.

They can then be asked to use the rolling pin and string to find another way of lifting the book.

Which way do they think felt easier to lift the book?

(Using the rolling pin)

Why?

(Because with the rolling pin you are pulling down in the same direction as gravity, whereas by the first method you are pulling up against gravity).



INVESTIGATING PULLEYS

Activities

Younger Children

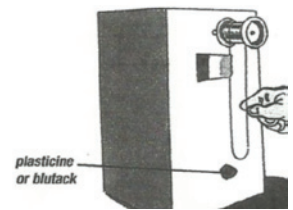
2. Use an empty thread spool as a pulley

Lift a small milk carton with a handle, half-filled with water, using an empty thread spool, pencil or wooden skewer and string.

3. Design and make a pulley to raise a flag up a 'building'

The children can be given the equipment as outlined for Activity 3 and asked to design and make a pulley which will hoist a flag.

- They should first pick their country, find out the flag of that country and then draw, cut out and colour it.
- They can then pick a building from that country and draw or print it out (e.g. GPO and Irish flag, Eiffel Tower and French flag, etc.)
- They then plan how to hoist the flag over the building using a 'pulley'.
- They could keep the flag raised by sticking the string to the box with Bluetack.
- They then make and evaluate their activity.
(How could they do it better next time?)



5th and 6th Classes

4. Using Single Pulleys – Fixed and Moveable

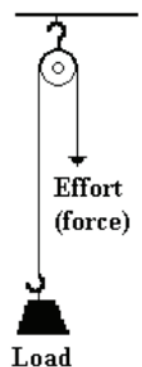
- Weigh the bottle** of water using the Force Meter.
Note the reading (eg. 200g)
- Using one fixed pulley**
Lift the bottle of water and 'feel' its weight.



Put the stick between two desks or chairs which have a gap between them.

Hang a single pulley over the stick, and hang the cord over the pulley wheel. Attach one end of the cord to the bottle, and pull the other end. Was it easier now to lift the bottle?

Attach that end to the Force Meter and pull. Note the reading on the meter. (Approximately the same force is needed, i.e. 200g, but it is easier to pull downwards with gravity than upwards).



INVESTIGATING PULLEYS

Activities

5th and 6th Classes

(c) Using one moveable pulley

(i) Measuring Force:

Attach the bottle of water to the hook on the moveable pulley. Tie one end of the cord to the stick and, putting the other end round the pulley wheel, attach it to the Force Meter. Lift up the bottle with the Force Meter.

Is it easier to lift the bottle this way?

Note the reading on the meter.

Compare the two readings.

Can you explain the difference?

(This reading is approximately half the reading in (a), because the pulley reduces the force needed to lift the bottle. The load is now being shared between two cords).

(ii) Measuring Distances:

Repeat c (i) above, this time raising the Force Meter quite high off the ground.

Measure

(i) the distance the bottle was raised from the ground, and

(ii) the distance the meter (or your hand) moved.

(iii) How far do you need to raise your hand in order to lift the bottle/carton 10 cms?
20 cms?

(The children should plan how they are going to carry out this part of the activity, i.e. where they are going to measure from).

They can compare these two measurements.

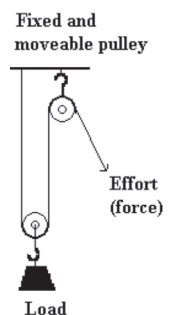
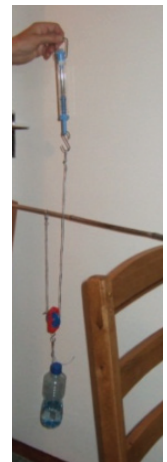
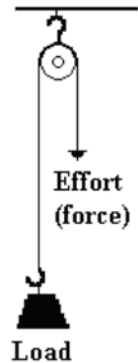
Can they come to any conclusion regarding the connection between the forces measured and the distances travelled? *(The force meter will have moved approximately twice the distance of the bottle).*

(d) Using one fixed and one moveable pulley

Keeping the arrangement in (c) above, take a second pulley and hang it over the stick. Run the cord around it and pull downwards with the Force Meter.

Note the reading on the meter.

Compare with the reading in (c). *(the same, but again it is easier to pull down with gravity than pull up).*



INVESTIGATING PULLEYS

More Maths

The more pulleys you have the heavier the weight you can lift; e.g. two pulleys can lift twice the weight of one pulley.

Questions

1. If you can lift 10 kg of potatoes with one pulley, what weight of potatoes could you lift with 2 pulleys? (20 kg).
2. If you can lift 16 kg of bricks with 2 pulleys, what weight could you lift with (a) 3 pulleys (b) 5 pulleys? (24 kg, 40 kg).

Safety

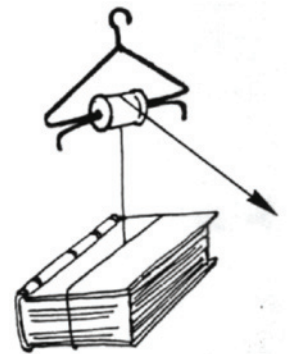
1. Be careful if you are using pulleys at a height, e.g. in a doorway, and using heavy weights on them, in case they fall on someone's head! Don't let children stand under them.
2. Be careful with sharp edges in coat-hanger follow-up activity below.



Follow-up Activity

1. Make a Simple Pulley to Lift a Weight

EQUIPMENT: Wire coat-hanger, wire cutter, empty thread spool, string, cup-hook, board (fixed), weight (e.g. a book)



- Cut the bottom of the coat-hanger in the middle (adult help needed) and insert the spool into the open ends of the wire.
The severed ends of the wire in the coat-hanger activity can be sharp, so be careful when working with them, as well as with the wire cutter. Children should be closely supervised for this activity, and an adult may want to help with this step.
- Adjust the wire so that the spool turns easily, and then bend the ends down to keep the wires from spreading.
- One child holds the coat-hanger by the handle while the other child attaches the weight to the string and loops it over the spool
- Pull the string to lift the weight.

INVESTIGATING PULLEYS

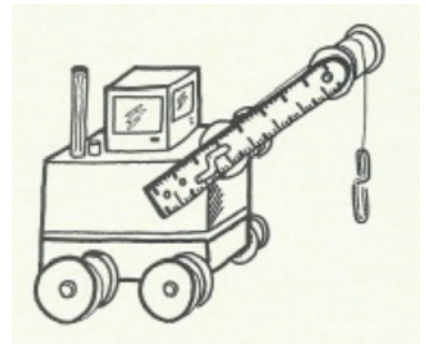
Follow-up Activity

2. Design and Make a Pulley System

The children should be presented with the following problem of making a lifting device that will bring a load up to the roof of a model building. The lifting device should be designed so that loads can be raised and then let down again. The basic materials which the children will use are thread spools and string. The children will need to consider the shape of the lifting device

- how the pulleys will be supported
- the number of pulleys to be used
- the design of a handle

A suggested method is in *SESE: Science, Teacher Guidelines*, Exemplar 46, pp 138-139, with strong encouragement to children to experiment with different pulley systems to discover the best design.

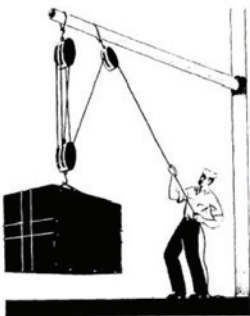


Children Can:

- Think of places around the house where pulleys are used.
- Try to make a simple pulley by gluing the bottoms of two yogurt cartons together.

Did You Know?

Pulleys have been around for a long time. They were probably used for hauling up water in the Middle East around 1500 B.C.



Combinations of fixed and movable pulleys are also known as a block and tackle. Some blocks and tackles have so many pulleys that they allow a single person to lift weights as heavy as that of a car!

The giant telescope (the Leviathan) at Birr Castle is so huge that giant pulleys are used to raise it. (*Birr Castle is a 'Discover Centre' for the Discover Primary Science and Maths programme*).

INVESTIGATING PULLEYS

Useful Websites:

To find out more about pulleys have a look at:

www.dynamicscience.com.au/tester/solutions/hydraulicus/pulleys.html

For other pulley activities, and some 'pulley maths' follow the adventures of Josie True at www.josietrue.com and go to the 'Teachers' Guide' and the 'Ice Block game-pulleys'.

For the coat-hanger activity see the website of the Canada Science and Technology Museum:

http://www.sciencetech.technomuses.ca/english/schoolzone/activities_mach1.cfm

