Levers

Student Worksheet

Name:
Class:
Date:

Aim

To build and investigate three different classes of lever.

Background Information

Simple machine: A basic tool that makes a task easier to do.

Lever: A type of simple machine made of a rigid rod that rotates around a fixed pivot point.

Fulcrum: Another name for the pivot point of a lever.

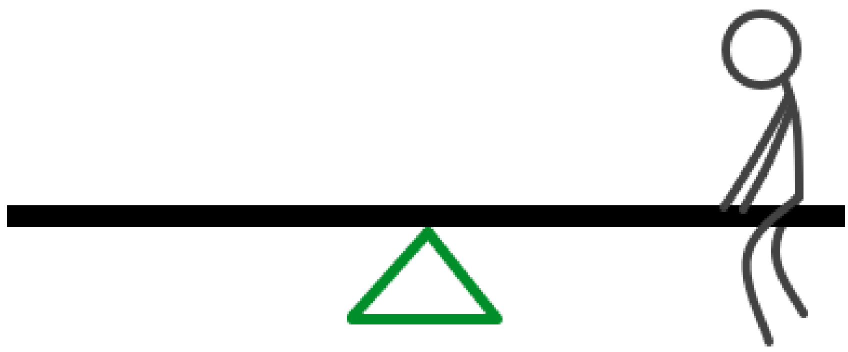
Load: The force on a lever due to an object's weight. This is the force that must be overcome to make the lever rotate.

Effort: The force applied in order to rotate the lever and lift its load.

Pre-Practical Question

The picture below represents a seesaw with a person sitting on one end. In physics, this is called a lever diagram. The triangle shows where the fulcrum of the lever is.

On the diagram, draw an arrow to show the load force due to the person's weight. Draw another arrow to show where you would apply an effort force to lift the person.



Practical

Instructions

Go through the risk management/assessment with your teacher.

Clear the area you will use for your experimental work.

Make sure that all long hair is tied back.

Read through the practical instructions and make sure you understand the requirements.

When you are ready, you can begin.

Materials

- Metre ruler
- 3 x Large butterfly clips
- 1 kg Mass on hook
- Pencil
- Stackable books or blocks

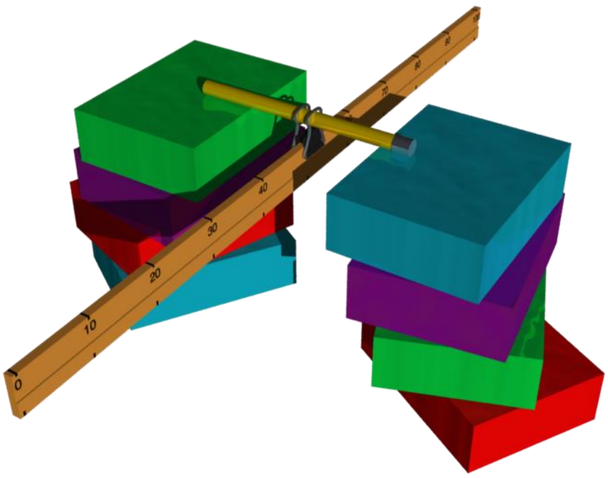
Method

1) Locate the 50 cm mark on the metre ruler. Attach one of the butterfly clips here.

2) Stick the pencil through the metal loops at the top of the butterfly clip. Make sure it can rotate freely.

3) Make two stacks of books on your desk, with a 5 cm gap between them. Each stack should ideally be about 20 cm high.

4) Insert the metre ruler in between your two stacks, so that the pencil balances on the stacks and supports the weight of the ruler.
5) Attach a second butterfly clip to one end of the ruler. Hang the 1 kg mass from this clip and let it sit on the desk.



First Class Lever: Results Questions

1) You have just created a first class lever! For your first test, try pushing down on the metre ruler, on the end opposite to where the 1 kg mass is hanging.

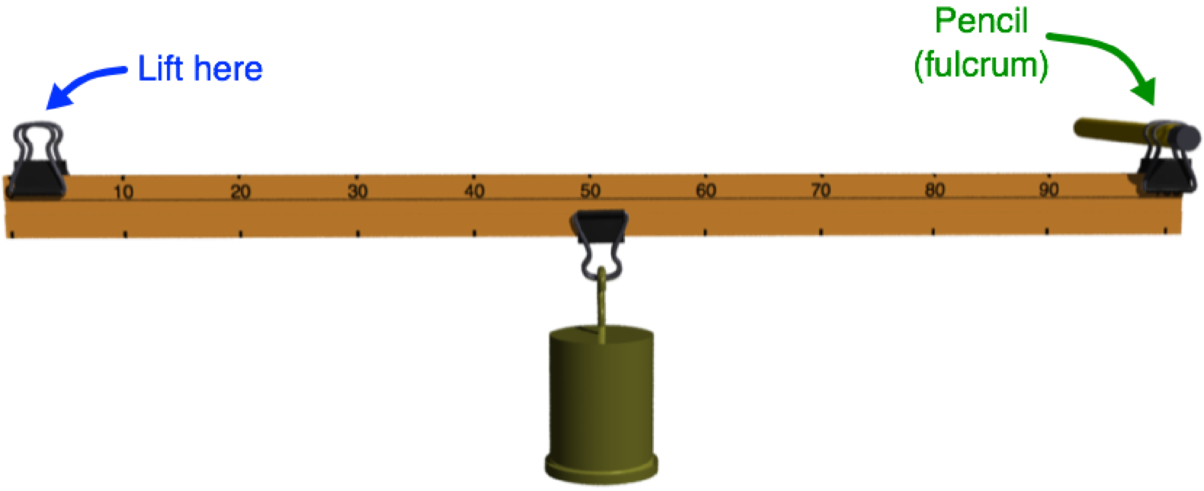
   What happens? Record your observations in the space below:

2) All levers have a pivot point, which scientists call a fulcrum. Where is the fulcrum for your lever?

3) In the space below, draw a diagram to represent your lever. Use a straight line to show the metre ruler and a triangle to show its fulcrum. Also label where the load (weight) and effort forces are applied when you lift the 1 kg mass up.

Second Class Lever: Results Questions

Next, build a second class lever. To do this, adjust your setup so that the fulcrum (pencil) is at one end of the metre ruler. Attach the butterfly clip holding to the 1 kg mass to the middle of the ruler. Take your last butterfly clip and put it on the other end of the ruler, opposite the fulcrum.



1) Try lifting the mass by pulling up on the third butterfly clip. Answer these questions based on what you observe:

   i. How far does your hand move compared to how far the mass moves?

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   ____
   ____
   ____
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   ____

   ii. Does it feel easier or harder to lift the mass than in your first test?

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2) Now move the butterfly clip you pulled on closer to the mass, but not past it. Try pulling on this clip again to lift the mass.

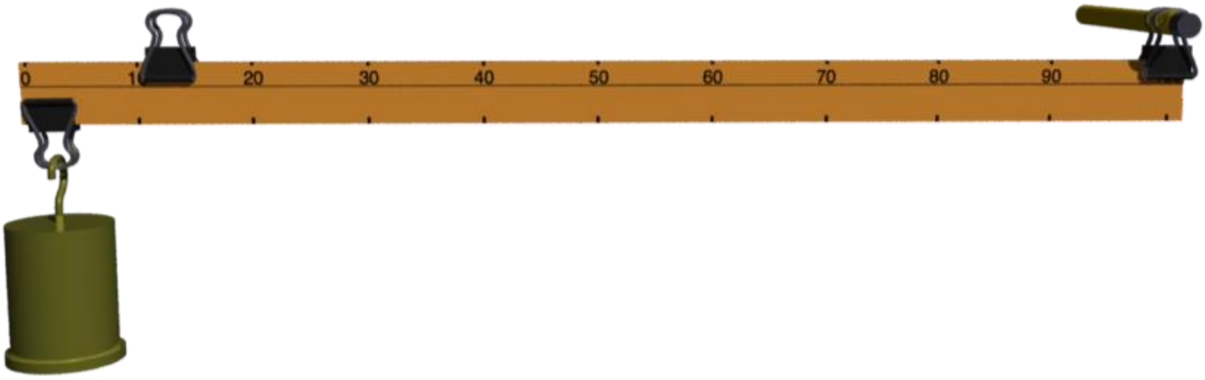
i. Does your hand move a greater or smaller distance than before?

ii. Does it feel like you have to pull harder to lift the mass?

3) Draw a diagram to represent your second class lever. Use a straight line to show the metre ruler and a triangle to show its fulcrum. Also label where the load and effort forces are applied.

Third Class Lever: Results Questions

To make a third class lever, move the 1 kg mass and its butterfly clip so that it hangs from the end of the metre ruler. Move the third butterfly clip so that it is closer to the mass than to the fulcrum.



1) Try lifting the mass by pulling on the third butterfly clip. How far does your hand move compared to how far the mass moves?

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2) This time, move the butterfly clip that you pull on close to the fulcrum, away from where the 1 kg mass is hanging. Now pull on the clip to try and lift the mass. Answer these questions based on your observations:

i. How far does your hand move compared to how far the mass moves?

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ii. Does it feel easier or harder to lift the mass than in the previous test?

3) Finally, draw a diagram to represent your third class lever. Use a straight line to show the metre ruler and a triangle to show its fulcrum. Also label where the load (weight) and effort forces are applied.

Discussion Questions

1) So far you have built, tested and observed a few different levers.

   For instance, in your second test you used a second class lever, with the load in the middle. You should have found that it was relatively easy to lift the load in this configuration. However, when you applied effort closer to the fulcrum, the task became more difficult.

   Did the same thing happen when you used a third class lever and moved your effort closer to the fulcrum? Do you think this happens for all levers?

2) When you tested the second class lever, your hand had to move further than the load did. However, you didn't need to apply very much force to lift it up.

   Compare this with the third class lever, where your hand didn't move as far as the load did, but you had to apply a greater force. Consider the size of the effort force and the distance between your hand and the fulcrum. In the space below, explain how the force and distance are related.

   (Hint: Does the effort force increase or decrease when the distance increases?)

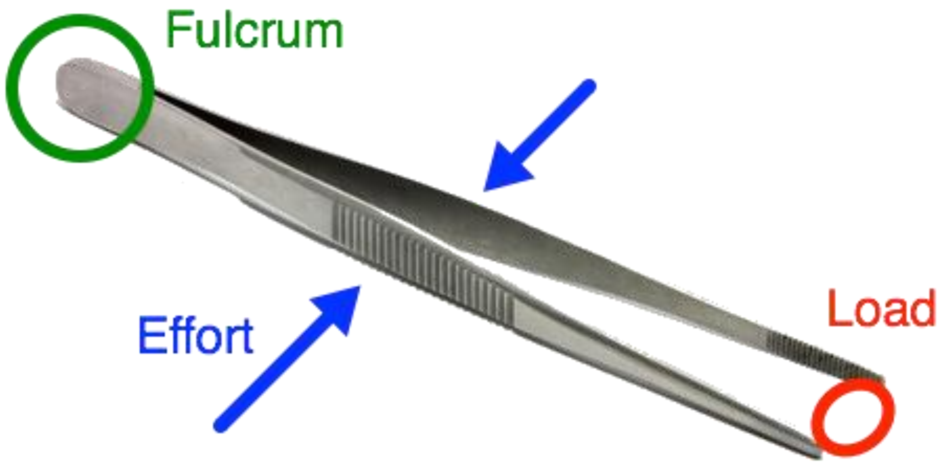
3) Look back on your experiment and record at least two things that worked well.

4) Record at least two things that could be improved if you were to do this experiment again.

5) At the beginning of this experiment, you built and tested a first class lever. First class levers have a fulcrum in the middle, with the load and effort applied on either side. A seesaw is an example of this!

You concluded that it's harder to lift an object with the lever if you apply effort closer to the fulcrum. Using this information, suggest what you should do to more easily lift a heavy person on a seesaw.

6) Tweezers have a fulcrum at one end and hold a load, like a dead insect, in the other end. You operate them by squeezing and applying effort between the fulcrum and the load.



State which class of lever this is an example of. Based on your experimental results, explain whether it's easier to squeeze the tweezers close to or away from their fulcrum.

7) A fishing rod is an example of a third class lever. You have to be quite strong to use a fishing rod, because you apply effort very close to where the fulcrum is. The load is the weight of the fish you've caught, which is applied to the thin end of the rod.

Think back to the third class lever that you built. How far did the load move compared to your hand? Using your findings, consider an advantage of applying effort close to the fishing rod's fulcrum.

Extra for Experts

1) If you aren't touching a lever, it has no effort force applied to it. There is only the fulcrum and the load. As a result, the lever sits still.

   Why do you need to apply an effort force to make the lever rotate? Use Newton's First Law of Motion to explain your answer.

2) Newton's Second Law of Motion is often described using an equation: $F=ma$. It means the net force (F) acting on an object is equal to its mass (m) multiplied by its acceleration (a). Using this formula, explain why you need to apply more effort force to lift a heavier load (mass).

(Hint: Assume you want the acceleration of the load to be the same.)