Professor Brainstorm's

Investigating Velcro

About this Activity

(Information for Parents and Teachers)

This experiment explores Forces - and in particular it measures the force needed to pull apart two strips of Velcro. (But don't worry - you won't need a force meter to do this experiment.) It also addresses many other generic practical science issues, such as the importance of working scientifically, repeating measurements, and determining whether it is a 'fair test'.

This experiment is designed for children aged from 5 to 11 years (Year 1 to Year 6).

You can also turn this experiment in to a game. For more information see below.

What you Need

- A plastic container with a screw-top lid - large enough to hold at least 1 litre of water.
- A short strip of Velcro. (This is brand name. It is also sold as 'hook and loop fastener'.)
- Weighing scales. (If you don't have any scales, a measuring jug will do.)

Investigating Velcro - Initial Preparation

Before you do the experiment you first of all need to attach a strip of Velcro to the lid of your container.

- Pull apart the two strips of Velcro. You will notice that one strip feels quite soft and fluffy, whilst the other side is rough and a bit spiky. Cut a length about 6cm long from the soft side, and a shorter length - about 3cm long - from the rough side.
- Stick the short, rough piece of Velcro on to the lid of your container - close to the centre of the lid (as shown in the photo below left). If you are lucky, your Velcro strip will have a self-adhesive layer on the back. If not, you will need to use some strong glue. Leave it for a while until the glue is fully set before you move on to the next step.
- Now press the other strip of Velcro on to the piece which is glued to the lid. Since this piece is longer, part of this strip will be unattached to the strip below. You are going to use this to try to lift the container. (See photo below right.)

Investigating Velcro - The Game

- The first person pours some water in to the container, screws the lid on tightly - and then tries to lift the container using the top strip of Velcro. (See photo on right.)
- The next person adds some more water - and again tries to lift the container.
- When it is your turn, you can add as much or as little water as you like. But of course if you add too much water - so that you can no longer lift the container with the Velcro - you lose the game!

You may have to think about devising some rules for your game:

- For example, the Velcro may lift the container briefly - but then it falls off. Does this count? You could introduce a rule, for example, which says that the Velcro has to be able to hold up the container for a count of 3 before it constitutes a proper lift.

You might also like to record who loses the most times.

Investigating Velcro - The Experiment

This is basically the same as the game - you are trying to find the maximum amount of water that you can lift with the Velcro.

- So keep adding water until you can no longer lift the container with the Velcro. Now pour out a small amount of water - and try again. Once you have poured out enough water so that you can just pick up the container, weigh the container - and write down the amount. (If you don't have any weighing scales, pour the water in to a measuring jug - and write down the quantity of water - measured in millilitres.)
- Repeat the experiment several times - writing down your answer each time. Don't worry if you get several different answers.

Once you have several measurements, the next step is to find the **average** of these results. You can do this in a couple of ways:

- Add up all your measurements, and then divide the total by the number of measurements to find the average. (For example, if you have done the experiment five times, add up all five results and divide the total by 5.)
- Alternatively, rewrite all your measurements down in order, with the smallest number first and the biggest number last. The average measurement is just the middle number in this sequence.

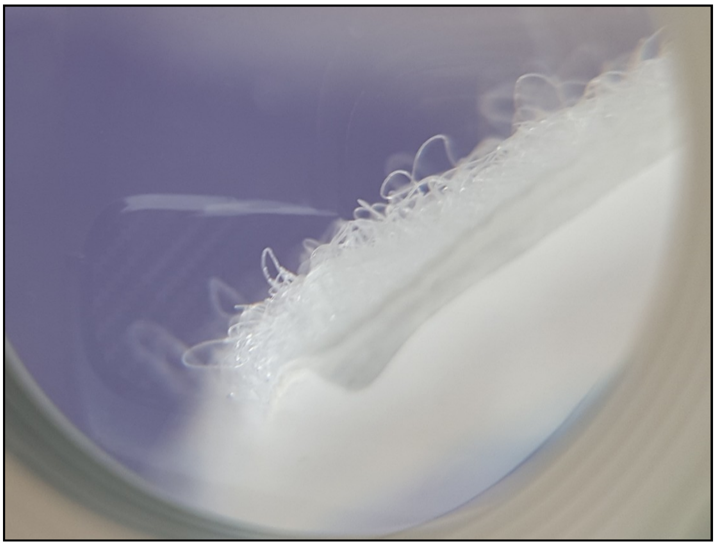
Finally, if we are measuring a **Force**, we want the answer to be in **Newtons**. However, if you have weighed the container on normal weighing scales, then what you have actually measured is the **mass** of the container - and your answer will probably be in **grams**. Fortunately, it is very easy to convert a mass (measured in grams) into a force (measured in Newtons) - you just divide by 100.

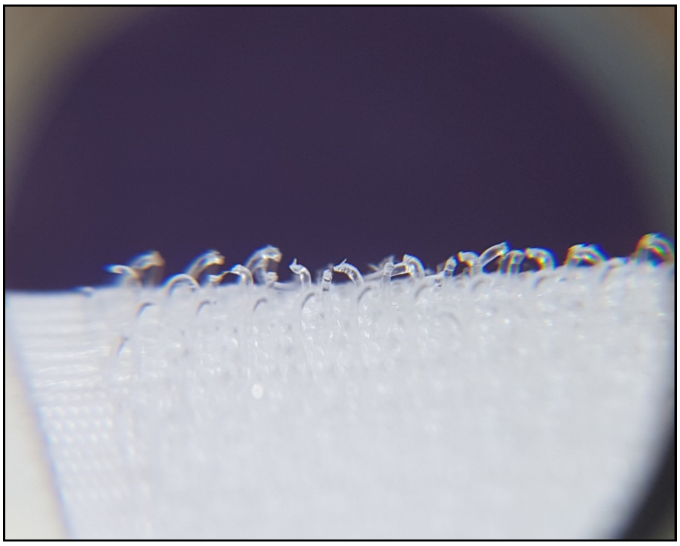
So if your average result was 650 grams, this corresponds to a force of 6.5 Newtons. So from our experiment we have found that we need an average force of 6.5 Newtons to pull apart the two strips of Velcro. (Of course, this is just an example. Your actual answer might be quite different from this!)

(If you used a measuring jug instead of weighing scales, it is also straightforward to work out the force in Newtons - because 1 millilitre of water has a mass of 1 gram. So 650 millilitres also corresponds to a force of 6.5 Newtons.)

How does Velcro work?

We noticed earlier that the two strips of Velcro feel quite different. If you have a good magnifying glass you will be able to see that they look quite different as well. The side which feels soft is made up of a disorganised mess of thousands of very fine fibres which form tiny loops (see photo below left). In comparison, the side which feels rough is made up of thicker fibres in neat rows. Each of these fibres stands more-or-less upright, but is turned over slightly at the top to make a small hook (see photo below right).





When you press two pieces of Velcro together, some of the hooks on the rough piece of Velcro catch in the fine loops of fibre on the soft side, making it difficult to pull the two pieces apart again. However, if you pull hard, the hooks bend enough to release their hold on the loops - and the two pieces of Velcro come apart.

(I should mention that although you may hear a 'ripping' sound when you pull the strips of Velcro apart, the loops and hooks on the Velcro do not actually break. All you are doing is simply disentangling the loops from the hooks. So you can push the Velcro together and pull it apart hundreds of times and it will still continue to work. However, as you may have discovered if you have Velcro shoe fasteners, Velcro does sometimes stop working after a while. Usually this is not because the hooks and loops have broken - it is because the hooks and loops have become clogged up with bits of fluff, dog hairs and other stuff !)

Some types of plants produce seed heads which work in a similar way to Velcro - they are covered in little hooks which make them stick to our clothes. The inventor of Velcro, George de Mestral, came up with the idea after taking his dog for a walk - and finding that his clothes and the dog's coat were covered in these seed heads!

Working Scientifically

When we are doing a science experiment, it is important to repeat the experiment several times - because we may not get the same answer every time. In fact, you may have got some very different answers in this experiment. Can you think of any reasons why your answers might be so different?

One reason is to do with the idea of making sure your experiment is a 'Fair Test'. This means trying to make everything the same each time you do the experiment. For example:

- When you placed the soft strip of Velcro on top of the rough one, did you always make sure that you had completely covered the piece of Velcro underneath? If you were a bit careless and the top strip of Velcro only covered half of the other one, then only half of the hooks on the rough side have a chance of catching on to the loops on the soft side.

- Sometimes when you lifted the container, you may have heard a 'ripping' sound as some of the hooks and loops pulled apart. (But you may have still been able to lift the container if enough of the hooks and loops did not pull apart.) Before you tried to lift the container the next time, did you make sure that you had pressed the strips of Velcro together again. (If not, then fewer of the hooks and loops would be entangled compared to your previous lifts.)

There are also some other factors which affect how much you can lift with the Velcro:

- It depends **how** you try to lift the container. If you try to lift it slowly and carefully you are more likely to be successful than if you try to pick it up with a swift jerk of your hand. This is something that we can control.
- It also depends how many loops and hooks become tangled together. This is something that we can't control, no matter how carefully or how firmly we push the Velcro strips together. However, if we have tried our best to make the experiment a 'Fair Test', and if we try to lift the container as carefully as possible each time, then the range of measurements that we get (i.e. the difference between the smallest force and largest force) tells us how much this last factor affects our results.