Professor Brainstorm's
How Strong is a Magnet?

About this Activity
(Information for Parents and Teachers)

This experiment explores Magnetism, compares the relative strengths of different magnets, and 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 9 years (Year 1 to Year 4).

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

What you Need

- One or more magnets. (They don't have to look like the one in this photo. Fridge magnets are fine. Or you may have a spare magnetic door catch. Or perhaps you have a magnetic tool - for picking up nuts and bolts when you drop them in awkward places. A selection of any of these would be ideal.)
- A paperclip
- And some small sheets of paper - about 10cm on each side is fine. (The size doesn't matter too much - as long as all of the sheets are the same size. They should also all be the same thickness. Do not use a mixture of card and paper.)

How Strong is a Magnet? - The Experiment

- Start by placing the paperclip on a table - and covering it with one sheet of paper.
- Press the magnet down gently on top of the paper, and then lift it back up. Hopefully you will be able to lift up the paperclip (and the sheet of paper).
- Put the paperclip back on the table and add another sheet of paper directly on top of the first sheet - so the paperclip is now covered by two sheets of paper.
- Use the magnet to see if you can lift the paperclip again.
- Keep adding more sheets of paper - one at a time - until the magnet does not pick up the paperclip. So now you have found the maximum number of sheets of paper that you can use and still pick up the paperclip. Write down this number. (So for example, if the magnet did pick up the paperclip with 8 sheets of paper, but not with 9 sheets, then the number you should write down is 8.)

Now try the experiment again. (You don't need to start with 1 sheet each time. If it worked last time with 8 sheets, the perhaps start with 7 - and then keep adding one more.) Does the magnet always work with the same maximum number of sheets of paper? (Don't worry if you get different answers each time - this is part of the experiment.)

Once you have tried it a few times with the same magnet, try it next with some different magnets. Find the maximum number of sheets of paper that you can use with each of your magnets.

How Strong is a Magnet? - The Game

- To make the experiment in to a game, again start with the paperclip covered by one sheet of paper. The first person uses the magnet to try to lift the paperclip (and the sheet of paper).
- Now a second sheet of paper is added. And the magnet is passed to the next person - who now tries to lift the paperclip (and both sheets of paper).
- Keep adding more sheets of paper - and passing the magnet to the next person - until you can no longer lift the paperclip.
- Whoever loses (i.e. the person who fails to pick up the paperclip) should start the next game - with just a single sheet of paper again.

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

- For example, if the paperclip is lifted for just a fraction of a second - but then falls off - should that count? So as an example, your rule could be that you have to lift up the paperclip and count to 3 before it constitutes a proper lift.
- You might also have a rule which says how many times you are allowed to try to lift the paperclip.

You might also like to record who loses the most times. And also how many sheets of paper you manage to lift in each game.

How does it work? (This is the science bit)

There are two factors at work here:

- Firstly, as you add more sheets of paper, this means that the magnet has to lift more **weight***. So we have an upwards force - which is the magnetic attraction between the magnet and the paperclip. But we also have a downwards force - which is the effect of **gravity** on the combined **mass*** of the paper and paperclip.
- The other factor is that the force of **attraction** between a magnet and a magnetic object decreases dramatically as the distance between the object and the magnet increases. Even the thickness of just one sheet of paper makes a significant difference to the magnetic force on the paperclip. So as we add more sheets of paper, the paperclip is being moved further away from the magnet - which means that the magnetic force on the paperclip decreases.

So when you have the maximum number of sheets of paper, this means that the (upwards) force of the magnet on the paperclip is only slightly larger than the (downwards) force of gravity on the paperclip and paper. Adding another sheet of paper means that the upwards force is now less than the downwards force - so the magnet can no longer pick up the paperclip.

If you have used several magnets your results will show you which magnet is the strongest - because the magnet which exerts the most force is the one which lifts the paperclip with the most sheets of paper. (And obviously the weakest magnet is the one which works with the fewest sheets of paper.)

(*When we are doing science we should really distinguish the **mass** of an object - which is measured in kilograms - from the **weight** of that object - which is the **force** produced when gravity is pulling the mass downwards. You probably won't learn about this until Year 5 or 6, so if you are younger there is no need to worry too much about this at present!)

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. When you were trying to find out how many sheets of paper you could lift with your magnet, you probably got several different answers. Can you think of any reasons why you might, for example, to be able to lift the paperclip with 6 sheets of paper some of the time, but at other times with the same magnet it only works with 5 sheets of paper?

- One reason why you might get different results is because it depends how carefully you lift the magnet. (If you tried to do this experiment as a game, you might have found that some people lost more times than others. Perhaps the people who lost more often were less careful than some of the others.)
- How many sheets of paper you can lift also depends on whether the paperclip is exactly in the centre of the sheets of paper. (It is a bit hard to tell whether you have managed to get the paperclip in the centre - because obviously you cannot see through the sheets of paper! But you will be able to see the difference that this makes if you try the experiment with the paperclip as close to the middle of the paper as you can manage, and then repeat the experiment with the paperclip at one extreme edge of the paper. When it is at the edge, the extra weight of the paper on one side tends to make the paperclip fall more easily.
- For a similar reason it also depends how carefully you stack the sheets of paper on top of one another. If you place the sheets of paper carefully on top of each other, it is more likely to work than if you just put them on all higgledy-piggledy!

If you did this experiment as a game, we have already mentioned the idea of introducing rules.. For example, sometimes you might only lift the paperclip for a fraction of a second before it falls off. I suggested that you could introduce a rule - for example, counting to 3 - as a requirement to say that the magnet had successfully lifted the paperclip. When we are doing a science experiment, sometimes we have to make rules like this. It doesn't matter too much what the exact rule is, the main thing is that we should use the same rule every time that we do the experiment.

