Marvellous magnets

Magnets come in lots of different shapes and sizes (Figure 1) and after some free play, observing and exploring their properties, learners will be ready to undertake more systematic investigations.

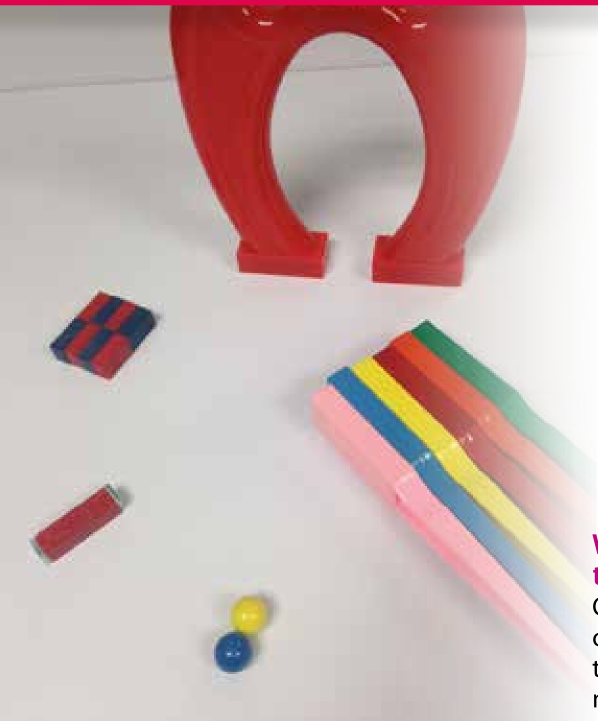

Figure 1 - A variety of magnets.

Experience and Outcome

By exploring the forces exerted by magnets on other magnets and magnetic materials, I can contribute to the design of a game [1] - *SCN 1-08a.*

Key vocabulary: pole, south pole, north pole, attract, repel.

Which materials are attracted to the magnet?

Often learners will discover that only metal objects are attracted to a magnet and so, to avoid misconceptions, it is important to ensure that some metal objects which are not attracted to magnets e.g. gold, copper, aluminium etc. (Figure 2a) are available for testing. Figure 2b shows the objects which "are magnetic".

From this collection only the objects which are made from, or contain, iron are attracted to a magnet. The metals nickel and cobalt are also magnetic.

Magic? No, magnets

For a simple activity to demonstrate magnetic force, you will need the equipment shown in Figure 3.

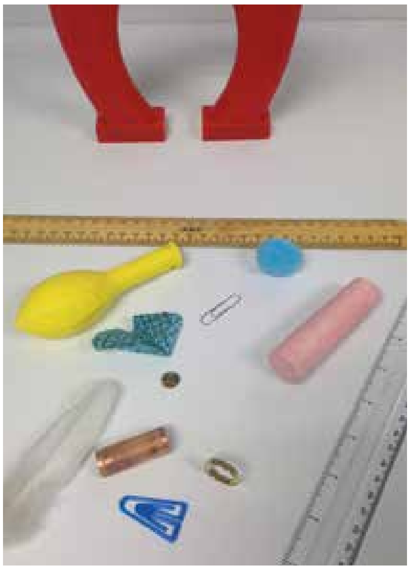

Figure 2a - Objects to test.

Figure 2b - Magnetic objects separated from the collection.

Secure the magnet to the base of one container using tape (Figure 4).

Tie a length of thread to one paperclip so that there is a length of thread on either side of the paperclip then secure the thread to the sides of one container with tape. Repeat this with the other container and then stand the containers side by side so they each clearly show a paperclip hanging in the container (Figure 5).

Predict what will happen if you turn both jars upside down. Gently turn both jars upside down. What did happen? Why did this happen? Our result can be seen in Figure 6.

Even though the magnet is not touching the paperclip, the magnetic field is strong enough to hold the paperclip in place when the container is turned upside down. The result is that the paper clip looks as though it is hanging 'up' in the container. Try placing the containers on their sides and observe the result. If you turn the containers upside down and shake them, what happens and why do you think this happens?

This activity is a great way to explore the topic of magnetism. Prepare the containers in advance and cover the base of both containers so that the magnet is not obviously seen but the hanging paperclips are still clearly visible. Encourage the children to gently turn the containers upside down and to observe and discuss what happens.

Figure 3 - Equipment needed for magic? No, magnets.

Figure 4 - Magnet secured to underside of one container using tape.

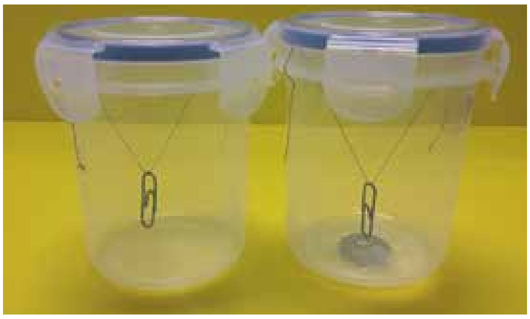

Figure 5 - Paperclips hanging in both containers.

Figure 6 - Both containers turned upside down.

How strong is the magnet?

One popular classroom investigation is to determine which magnet is the strongest. How can you test this? Examples of possible investigations may be:

How many paper clips can the magnet hold? See Figures 7a and 7b. Is this method a better test than the examples shown in Figures 8a and 8b?

Another way to test the strength of a magnet is to investigate through how many sheets of paper the magnet will attract a paperclip.

From what distance will the magnet attract an object? See Figures 8a and 8b for a suggestion as to how to investigate this.

The magnet's poles

If we look at the bar magnet in Figure 9 the ends are different colours. This is to allow us to easily recognise the different poles of the magnet. In some cases, magnets are labelled with "N" and "S" denoting the North Pole and South Pole respectively.

If you look closely at the horseshoe magnet in Figure 8b you may notice the label for the north pole.

What happens when you bring 2 different poles (colours) together? The magnets move towards each other i.e. they attract each other (Figure 10a). 2 similar poles? The magnets move away from each other i.e. they repel each other (Figure 10b). You will also observe that these pulling and pushing forces of attraction and repulsion ▶

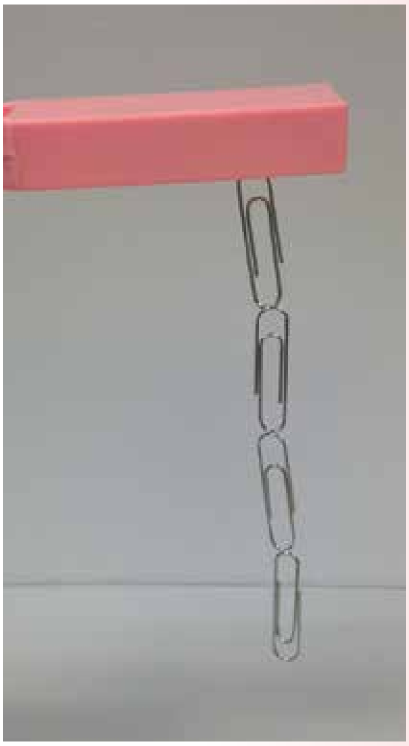

Figure 7a - Testing the strength of a magnet.

Figure 7b - Testing the strength of a magnet.

Figure 8a - Testing the strength of a magnet.

Figure 8b - Testing the strength of a magnet.

are evident without the need for the magnets to come into contact - they are forces which act over a distance or non-contact forces.

Using encased iron filings it is possible to see the magnetic field (Figure 11a). This is the area around the magnet(s) where the force can be felt. Note the area between the 2 like poles (Figure 11c).

Health and safety considerations

Avoid using very small magnets especially with young children as they could pose a choking hazard.

Children should be warned about the possibility of strong magnets moving together and pinching the skin. This is particularly important if you have the very powerful rare earth metal magnets (e.g.neodymium).

The use of loose iron filings should be avoided. They can cause irritation and possibly damage if they get into the eyes and they may irritate the skin of young children. Iron filings can be purchased in sealed containers from many school suppliers.

Strong magnets should not be used near anyone who has a pacemaker.

Coins

You or your learners may have noticed an anomaly with 1p, 2p, 5p and 10p coins in that some are magnetic whilst others are not.

This is because the metal used to produce coins was changed by the Royal Mint and it is possible to work out the years this happened.

Since 1992 1p and 2p coins have been made from copper plated steel rather than bronze (a copper alloy) and from 2011 5p and 10p coins have been made from nickel plated steel rather than cupronickel [2]. It should be noted that the alloy cupronickel, although it contains some nickel is mostly copper and is not magnetic.

In the collection of coins needed to do such a study you will need a number of the older, non-magnetic coins and you will need to collect them before they are withdrawn from circulation.

The main reason for these changes is the cost of raw materials.

Practical uses of magnets

Recycling centres need to separate metals by their type so that each type can be melted down and used again. The first step is to use a magnet to sort metals into 2 groups (ferrous and non-ferrous) [3]. This is a very important step in the recycling process and magnets provide the quickest way to separate types of metal. Try this in class by collecting aluminium drink cans and steel food tins. Place them all in a box and see if you can use a magnet to sort the metal recycling.

Maglev (Magnetic Levitation) trains use magnetic repulsion to lift the train up from the ground and reduce friction [4]. The Japanese bullet trains use this technology and one maglev train that is still in development has documented a record-breaking maximum speed of 603 km/h.

Using a compass

When a compass is held flat in the palm of a hand or placed flat on the ground the needle of the compass will always settle on a north-south line. In most compasses this needle is colour-coded with the black half of the needle being the side that points south and the red half of the needle being the side that points north (Figure 12).

Figure 9

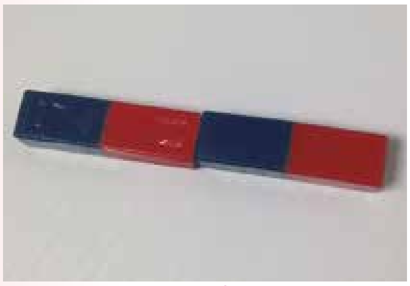

Figure 10a - Opposite poles attract.

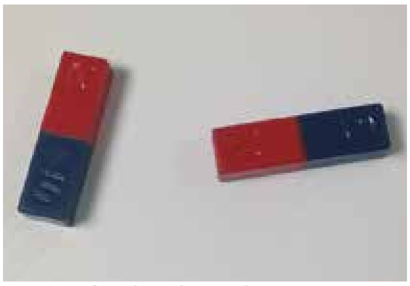

Figure 10b - Like poles repel.

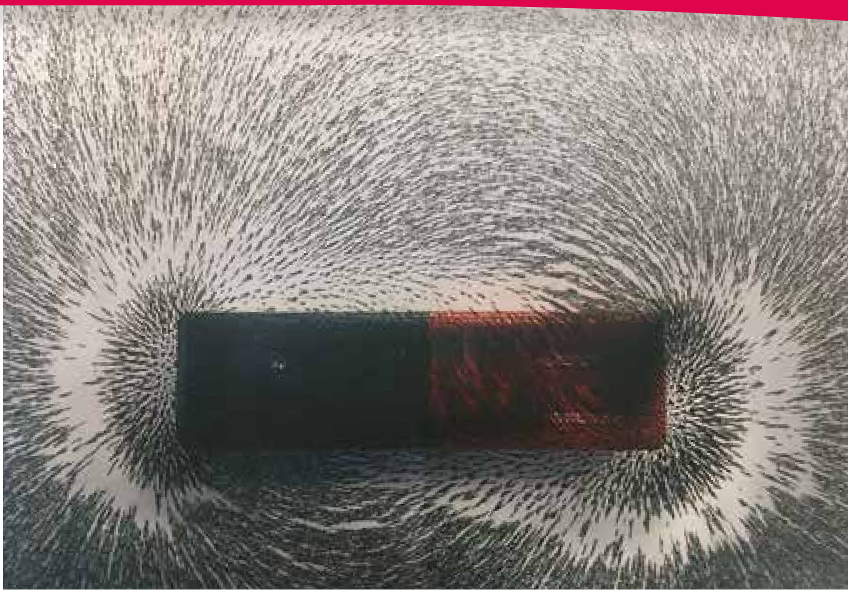

Figure 11a - Iron filings show field line around a magnet.

Figure 11b - Iron filings show field line around 2 magnets with opposite poles facing.

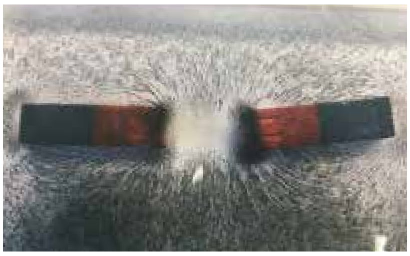

Figure 11c - Iron filings show field line around 2 magnets with like poles facing.

This happens because the Earth is a huge magnet and has two magnetic poles that are located in the Arctic and the Antarctic. Your compass needle is a little magnet which can swing around [5] so the needle settles on a north-south line because it lines up with the magnetic field of the earth.

Can another magnet interfere with a compass? Hold your compass flat in the palm of your hand and then gently move your hand over a magnet on the jar used in the previous activity.

What do you notice?
How close did you have to get to the magnet to see this?
Do you think you would need to be this close if you used a stronger magnet?

Fun with Magnets

Playing with magnetic trains sets such as Brio trains [6] is a good way for children to explore the properties of magnets and experience the effects of magnetic attraction and repulsion in relation to building or moving a train set.

A fishing game is always a fun way to use magnets and can be used to support literacy and numeracy outcomes by setting up the game so that the children 'fish' for specific letters to make up a word, specific words in order to make up a story, specific numbers relating to counting exercises or as answers to maths problems.

Magnet painting is another engaging way to use magnets. Simply fix a sheet of paper to a sheet of cardboard or a table then place a few 'blobs' of coloured paint on the paper. Place a paperclip in one 'blob' of paint then place the magnet under the sheet. As the paperclip is attracted to the magnet, it will move when the magnet moves and thus spread the paint across the paper.

Designing a magnet maze is a great way for children to get creative and show their understanding of magnets. Drawing out the route options for the maze and choosing the material for the object that will travel through the maze all illustrate their understanding of magnets and how easy or difficult it can be to use magnets to guide an object around tight corners.

Figure 12 - Compass with red needle pointing north and black needle pointing south.

References

[1] https://www.education.gov.scot/Documents/sciences-eo.pdf (accessed January 2018).

[2] http://www.royalmintmuseum.org.uk/FAQRetrieve.aspx?ID=49896 (accessed January 2018).

[3] https://sciencing.com/about-6398727-magnets-used-recycling-.html (accessed January 2018).

[4] https://science.howstuffworks.com/transport/engines-equipment/maglev-train.htm (accessed January 2018).

[5] http://www.iop.org/activity/outreach/resources/pips/topics/forces_magnets/index.html (accessed January 2018).

[6] http://www.brio.uk/products/by-age/12-months/magnetic-train (accessed January 2018).