1. Marvellous magnets

2 hours

Children look at the next stage in the recycling processes: removing steel or iron from waste materials. Children explore the characteristics of magnets and suggest ways to sort magnetic and non-magnetic household waste.

OBJECTIVES

- Compare and group together a variety of everyday materials on the basis of whether they are attracted to a magnet and identify some magnetic materials
- Compare and group everyday materials on the basis of their properties including their response to magnets
- To understand that iron and steel are magnetic materials but other metals are not
- To sort household waste into different materials
- To sort metal cans into steel and aluminium

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheets 5 - 7
- Selection of different types of magnets
- Collection of small non-metallic objects mixed with paperclips and paper fasteners
- 20cm thread
- A4 paper
- Sellotape
- Scissors
- Stopwatch
- Iron filings in a sealed transparent file pocket

INTRODUCING THE ACTIVITY

Read the email from industry (Activity sheet 5) to the class to focus on the recycling of aluminium, and discuss ways to answer the problems.

Give the children samples of different types of metal and look for similarities and differences: colour, weight, hardness, magnetic/non-magnetic, etc.

Using Activity sheet 6 to record ideas, ask the children to think of any ways they can to separate some of the metals. Diagrams could show moving belts, tunnels, mechanical grabs, positioning of magnets and destination of separated materials. Collect ideas and discuss the pros and cons of each method. Ask if the children think that magnets could be used to separate some metals. They may think that all metals are magnetic.

- Which metals are magnetic?

Steel and iron are the only magnetic metals.

Explain that all food and drinks cans are either made of steel or aluminium and that magnets are used in the recycling process to separate steel and iron from other types of waste.

MAIN ACTIVITY

Tell the children they are going to explore different ways to use magnets to separate iron and steel from other materials. Some are fixed in position while the material passes under them (however some materials are missed because they are too far from the magnet). Others use electro-magnets to pick up and drop the magnetic waste.

- What are the problems that can arise with more than one magnet being used at the same time?

You may want to use the iron filings at this point to show the magnetic field. Lie magnets on a table and place the pocket over them. Tap gently and watch the iron filings form into lines following the magnetic field. Do this first with one magnet then two laid end to end. The children could complete the force diagrams on Activity sheet 7, showing the forces. Magnets can be put in different positions, e.g. pole to pole, (N-N and N-S) and side by side.

Provide each group with two magnets and challenge them to sort out any magnetic materials in the shortest time.

They could do **one** of the following:

1. Drop a magnet down to pick up the material.
2. Pass the magnets over the top of the materials.
3. Put magnets by the side of the materials.

Set the challenge of designing an automated system to do this sorting. This may involve suspending the magnets or attaching them to cardboard side walls, etc.

Children draw design ideas for machines for a magnetic sorting process. Ask them to add arrows to show the directions of different forces. Allow the children time to try out their ideas.

Remind the children to carry out their investigation using fair test conditions. Ask them to record what these conditions should be (e.g. equal strength and quantity of magnets and the same mixture of material).

Each group use their own automated method to remove as many paperclips from the waste mix as they can in 30 seconds. They can use Activity sheet 7 to record their results.

PLENARY

Gather the children's results on the board, and discuss the various methods. Ask questions such as:

- Which forces helped to separate the materials?
- What difficulties could they envisage in this part of the process?

E.g. The variety in the size and shape of the materials will make attraction by magnets erratic. Objects made from other metals will be left behind and items made from more than one material are difficult to sort.

Ask the children to suggest ways to deal with plastic coating/ink/other impurities as magnetic forces work through other materials. Explain that when aluminium cans are recycled, unwanted materials are removed by passing the waste through intense heat to vaporise the inks and plastic.

Look at the beginning of the process on the Novelis Alcan website (https://thinkcans.net/)

EXTENSION ACTIVITY

Children could make an electro-magnet.

They need a large iron nail (8 cm approx.), thinly coated copper wire (1 m approx.), D size battery, some paper clips.

Wrap the wire around the nail, leaving about 20 cm of wire free at either end. With wire strippers remove 2 cm of the plastic coating from both ends of the wire. Attach one end of the wire to a battery terminal and the other end to a paper clip.

The nail will become magnetic when the paper clip is used to connect the other terminal.

Discuss the advantages of using an electro-magnet in the separation process to turn on and off to pick up and drop.

Connecting up the electro-magnet and allowing the current to run may result in the nail becoming magnetised. This will make it more difficult to turn the magnet off.

Safety note

Warning: the wire can get very hot.