Schools Roadshow 2022

MAGNETISM

AGE 8-14

Aligned to the National Curriculum
& The Curriculum for Excellence!

5 Great Activities Inside

Suitable for those who attended
our roadshow, or not

- **Magic Coins**
- **Levitating Magnets**
- **Sorting Machine**
- **Electromagnetic Strength**
- **Magnetic Treasure Hunt**

Developed in
partnership with

BAE SYSTEMS

ROYAL AIR FORCE

ROYAL NAVY

smallpeice
Dare to imagine

Introduction

This bundle of magnetism activities is for teachers to try with students.

These activities **support the curriculum** for students aged **8-14**

IF YOU'RE A TEACHER, please read through the activities carefully – they're designed so that you can use the common materials around you, but it's best to make sure you have them all before you start!

There is also plenty of career information at the back.

The activities get more difficult as you progress:
You may want to skip to a later activity or stick with the first few – it's entirely up to you.

For England and Wales
that's Key Stage 2 Science and Key Stage 3 Physics.

For Scotland
that's the relevant sections for science and physics in the Curriculum for Excellence.

IF YOU'RE A STUDENT, please be careful and sensible – we want you to have fun, learn about magnetism, and take good care of yourselves.

Strap in, hold onto your Norths and Souths, and get ready for a magnetic adventure!

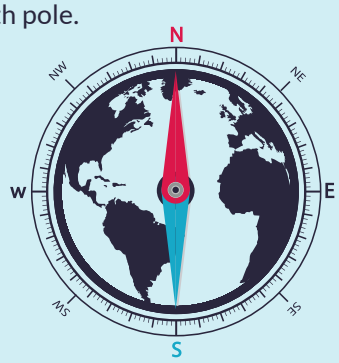
RECAP OF THE FUNDAMENTALS

Magnets are objects that can attract magnetic materials from a distance. They can also attract or repel other magnets.

The most common magnetic materials are these three metals: iron, nickel, and cobalt. Anything rich in any of these metals will probably be magnetic. For example, steel (which contains carbon as well as iron) is also magnetic.

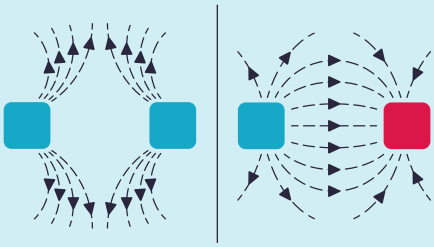
Why an object is magnetic is an advanced physics topic that you might learn about at university. However, you don't need to understand why they work to understand how they work.

Magnets generally have two ends – we call these ends North and South. This is because the Earth is a giant magnet. North poles of magnets are attracted towards the Earth's north pole. And South poles of magnets are attracted towards the Earth's south pole.



However, the effect is quite weak, so you need a light magnet, like the needle of a compass, to see it.

If we have two magnets and we put the North poles together, the magnets will repel each other. The same thing happens with the two South poles. However, if we put the North pole of one magnet near the South pole of another magnet, the two magnets attract one another.



In diagrams, the North pole is often red, while the South pole is often blue.

Magic Coins

ACTIVITY 1

Students will use a magnet and see how many coins they are able to pick up at once.

They will create a tally chart of how many of each coin (e.g., 1p, 2p, 5p, 10p, 20p, 50p, £1, and £2) and see if they can come up with any conclusions from this, i.e., which coins are more magnetic or weigh more than others.

BEWARE:

1p and 2p coins made before September 1992 are not magnetic.

The same is true for 5p and 10p coins made before January 2012.

20p, 50p and £1 coins are not magnetic.

EQUIPMENT

A selection of coins
preferably a mix of magnetic and non-magnetic coins

Magnets strong enough to lift at least five 2p coins each

IF YOU CAN'T FIND ENOUGH COINS, you could use any of the following instead: thumbtacks, paperclips, staples, pieces of aluminium foil.

METHOD

- If you attended the show, discuss with the students how the magician performed their trick of hiding the coin
- If you did not attend the show, hide a magnet between your fingers and make a coin on your other hand 'vanish' as you pass one hand over the other
- Arrange a selection of coins on each table, with a magnet
- Students will use the magnet to pick up the coins, counting how many of each coin they are able to pick up and which are magnetic
- A tally chart can be made to see how many of each coin can be picked up at once. You can add a column for "Magnetic?", which students can tick or cross.
- Discuss the findings with the whole class (who picked up the most coins?, etc)
- As an extension activity, students can place a coin on top of different surfaces; by moving the magnet below this surface they can see how the coins move differently on different surfaces

QUESTIONS FOR STUDENTS

Why could you pick up more of [coin A] than [coin B]?

Which coins were more magnetic? Which were less magnetic?

Do you think the weight of the coins affects how many you can pick up?

Why can't we pick up that [non-magnetic coin]?

ENRICHMENT

CHECK OUT - www.science-sparks.com/disappearing-coin-trick for another neat coin activity!

RELATED CAREER

A Mechanical Engineer
Many of your toys probably have motors inside, which contain magnets that need to be carefully designed to hold things together but not pinch your skin.

A Metallurgical Engineer
Quite a mouthful! Coins are made using more than one metal. Engineers find the right mix and make sure it can still be shaped into a coin.

DIFFICULTY RATING =

Levitating Magnets

ACTIVITY 2

Students will learn about the different poles of a magnet and how these can attract and repel each other.

The aim of this project is to create a levitating stack of magnets to show the students' understanding of repulsion.

EQUIPMENT

A large, marked bar magnet (North/South) – any strength will do

2 marked bar magnets (North/South) – any strength will do but it is better if they match each other

Unmarked bar magnets - any strength will do but it is better if all students have similar-strength magnets

Ring magnets (magnets with poles on the top and the bottom, with a hole in the middle) - any strength will do, as long as the ring magnets are similar in strength to each other

Rods for sliding the ring magnets onto

A compass

IF YOU DON'T HAVE RING-MAGNETS, use horseshoe magnets. The students can lean the rod at 45°, stack the horseshoe magnets on the rod, alternating their orientations, and see the ends attract/repel.

METHOD

- Lay out 2 marked bar magnets, with the north pole of one pointing at the south pole of the other
- Slowly slide them together until they attract
- Repeat, with one of the magnets rotated 180°; they will repel each other
- Discuss the findings of this with class: talk about the polarity of magnets, the relationship to the Earth (North and South poles), and the rules (N-N or S-S will repel, but N-S will attract) – you may find the resource introduction helpful here
- Use the compass to show how the needle points North
- Give 2 unmarked magnets to each team of students (preferably teams of 2)
- Students can experiment with the un-marked magnets to discover their polarities (which side is North and which is South), and check their work against a large marked magnet at the front of the class.
- Give each team a set of ring magnets and a rod. Students can slide the magnets onto the rod, being careful to go N-N and S-S, so they repel. See how many they can get levitating on their rod.

QUESTIONS FOR STUDENTS

What are the polarities of magnets? (North and South)

How can we predict if magnets will attract or repel each other?

How far away can the magnets be before they attract/repel each other?

ENRICHMENT

Levitating train – Maglev trains are used in transportation. They consist of a huge magnet on the bottom of the train and another huge magnet on the tracks. These magnets repel each other allowing the train to glide along the tracks.

CHECK OUT - www.mombrite.com/levitating-paper-clip for a gravity-defying trick with a paperclip.

RELATED CAREER

A Physicist studys how magnets push and pull on each other, using very powerful magnets to smash tiny particles together and help us learn more about the universe.

A Train Engineer designs levitating magnetic trains that can travel at over 200 miles per hour. That takes a lot of engineering.

DIFFICULTY RATING =

Sorting Machine

ACTIVITY 3

Students will learn how magnets can be used in sorting machines, separating magnetic material from the rest.

Students can get creative with their design for a sorting machine, considering the best placement and number of magnets to separate the paperclips most efficiently.

EQUIPMENT

Magnets – the magnets will need to be stronger than a fridge magnet to have a chance of making an effective sorting machine

Masking tape

Centre tubes of kitchen or toilet rolls (or any tubes that can be easily held in the hand)

Paper, torn into confetti

Paperclips

METHOD

- Discuss recycling with the students – how are items sorted at a recycling plant?
- Give each team a handful of shredded paper and paperclips
- Ask students how they could separate the paper from the paperclips? Discuss the different options (e.g., by hand is time consuming)
- Give the students magnets and the centre tubes of kitchen or toilet rolls
- Students will create their own recycling sorting system to separate the paperclips from the paper using magnets, experimenting with the placement and number of the magnets (inside the tube, outside the tube, etc.)
- Students can now engineer their own recycling centre: paper and paperclips will flow down a chute, near the magnets, where the paperclips will get stuck, and the paper will fall into the final container
- Students should test and further improve their machines, working out how to 'dump' the paperclips into another container by removing the magnet, and thinking about how to remove the paperclips from the mix without getting paper stuck in the paperclips

QUESTIONS FOR STUDENTS

How could you further improve your creation?

Does the sorting machine work as well if the mixture falls through faster (or slower)?

Are there any common mistakes that the groups made?

What could you do if there were other materials in the machine to sort that weren't magnetic (e.g., coloured card)?

RELATED CAREER

A Recycling Engineer would calculate the most efficient ways to sort through your recycling.

A Packaging Engineer would work out how to reduce the amount of stuff that has to be thrown away in the first place.

ENRICHMENT

Medical uses, MRI – in medicine, an MRI is used to see inside your body. Using strong magnets to force protons in the body to align with the magnets (like how we are forcing the paperclips to separate from the shredded paper).

Scale up the sorting machines with this guide:
www.learner.org/series/project-playbook-educator-edition/ultimate-recycling-machine

DIFFICULTY RATING =

Electromagnetic Strength

ACTIVITY 4

Electromagnets are magnets that can be turned on and off using electrical current.

This allows items to be picked up and put down as you like.

Students will be able to conduct their own experiments to determine how certain variables affect the strength of an electromagnet.

EQUIPMENT

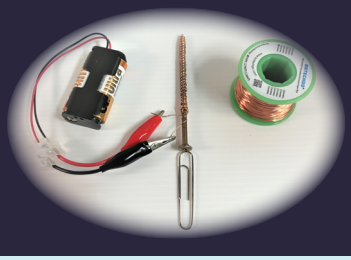
Thin, insulated copper wire

Benchtop power supplies

Crocodile clips

Large nails

Paperclips



METHOD

- Each team will create their own electromagnet by coiling copper wire around a nail and passing electricity through the coil
- Students will then compete to see which team can carry the most paperclips
- Improvements can be made on how to increase the electromagnetic strength of the system through increasing number of coils, increasing the current, etc.
- Students can create a table and graph to determine how specific parameters affect the strength of the electromagnet. You may want to predefine the independent and dependent variables for your teams.
- Students can experiment with changing the polarity of the electromagnet by changing the direction of the current

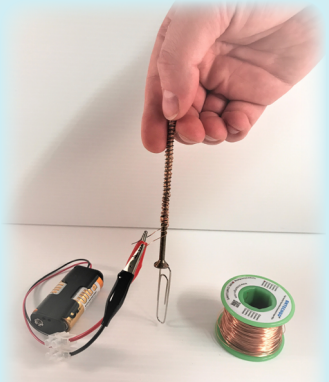
QUESTIONS FOR STUDENTS

How did changes in your variables affect the strength of the electromagnetic?

Why do these changes affect the electromagnet's strength?

Who was able to carry the most paperclips?

How did you improve your electromagnet?



RELATED CAREER

An Electromagnetic Crane Operator uses an electromagnet to move debris around a junkyard.

A Design Engineer figures out how much the crane needs to carry and designs it to be safe and reliable.

ENRICHMENT

Electricity generation – Motors can be made in the same way to how you have coiled your wire around the nail. By using the magnetic field you have created using your coiled wire and strategically placed magnets, you are able to create a system that rotates. This rotational energy can be transferred to another system (i.e., wheels on a car, fairground rides, turbines, etc.).

CHECK OUT - www.spark.iop.org/collections/electromagnets-work-teaching-approaches for more about electromagnets.

DIFFICULTY RATING =

Magnetic Treasure Hunt

ACTIVITY 5

In this activity, students will become treasure hunters.

Allowing them to use their creative side to design a boat which a magnet will be attached to.

Their boat will be used to find the treasure (another magnet or something magnetic) in a reservoir.

From this, the students can make further improvements to their vessel by changing parameters of their system.

Students will learn about practical uses of magnets and consider the role of design in making a magnet useful in the real world.

EQUIPMENT

Coins

A water container

Sand (optional)

METHOD

- Spread some 'treasure' along the bottom of a water-tight box. Magnetic coins will work well. You can make it more difficult by adding a layer of sand over the coins.
- Make a boat, or use a plastic box that will float
- Add a magnet to the boat and add water to the box
- Add just enough water so that the boat does not 'detect' (pick up) the treasure – it'll take a few tries to get this right
- Explain to the students they are now hunting for treasure that was lost at sea.
- Students should create a boat themselves or use plastic boxes as boats
- Students should add magnets to the boats and investigate the response; encourage them to discuss what they might need to change
- Students could detect the coins using a variety of methods:
  - o Using more magnets
  - o Adding weights to the boat to bring the magnet closer to the coins
  - o Suspend the magnet from the bottom of the boat using string
- Discuss with students how they can improve their boat/how to find the treasure easier
- The students could explore how to collect the coins and what modifications the boat might need to hold more coins at once
- Using non-magnetic coins in amongst the magnetic coins, such as a £1 coin, can be a useful conversation-starter

QUESTIONS FOR STUDENTS

Why didn't it work the first time?

What improvements could be made?

RELATED CAREER

Geophysical Engineering is the scientific method behind locating and extracting different natural resources from the earth. Some of these resources can be found in a similar way to how you found your treasure.

A Marine Engineer designs, builds, and maintains ships and submarines.

ENRICHMENT

Leisure uses – magnet fishing is the activity in which people use very strong magnets in outdoor water to find magnetic objects. Things that have been found while magnet fishing include a diamond bracelet, a safe, a car and even a real box of treasure.

CHECK OUT - en.wikipedia.org/wiki/Magnetic_anomaly_detector to learn about how magnets are used to detect submarines, using a magnetic anomaly detector

DIFFICULTY RATING =

Careers

Hi! I'm Khadijah… I am an Aerospace Engineering Degree Apprentice at BAE Systems.

My apprenticeship is a mix of **on-the-job experience** and getting a **degree**. I have worked in different parts of the business, like **aircraft planning**, **research & technology** and **maintenance**. I have **travelled to Spain and America** to work with other companies.

Do you like to solve problems?

If the answer is yes, why don't you consider a career in engineering? Engineers solve problems every day!

Do you like to work with others?

If so, engineering is all about teamwork. Engineers support each other to design, build, and test.

I use my problem-solving skills to focus on what is important for the day, and I support my team to achieve our goals.

I've had an amazing apprenticeship. One highlight was fitting solar panels onto a drone, which will fly above the clouds and harvest energy all day. It's exploring a bright and sustainable future.

Still unsure? That's ok – focus on what you enjoy, and the skills you care about. Remember, there are many different skills that make a good engineer.

If I could give my younger self advice I would say...

"Dream big – you can change the world and achieve great things. Take the opportunities, continue taking them and enjoy the journey with people you meet along the way."

www.baesystems.com/apprentices
www.rafyouthstem.org.uk
www.royalnavy.mod.uk/careers
www.raf.mod.uk/recruitment/apprenticeships

STUDYING AT SCHOOL

If you study physics, you'll learn about magnets – and you'll learn a lot more than what we had time to teach. Maths is also a really useful skill, because magnets behave in interesting ways that are easier to understand using maths.

A-LEVELS & SCOTTISH HIGHERS

Being 16 years' old might feel like a long way away, but that doesn't mean you can't plan for it.

Physics, Maths, and even Chemistry, are great choices if you want to be an engineer.

APPRENTICESHIPS

You can do an engineering apprenticeship once you're 16 or older. This gets you right into the wider world, learning everything from how to service an RAF aircraft to writing the software that guides the Royal Navy aircraft carrier underneath it.

DEGREES & DEGREE APPRENTICESHIPS

Degrees, just like apprenticeships, will give you a wider view of the world, focusing more on the theory. Degree apprenticeships are a blend of the two: you have a hands-on job and also do university work.

Throughout the activities, you've seen just a few of the careers connected with magnets. There are so many more…

We hope you learned a lot about magnets and what can be done with them.

Engineers use all the skills below. If you enjoy these, maybe **you'd** like to be an engineer.