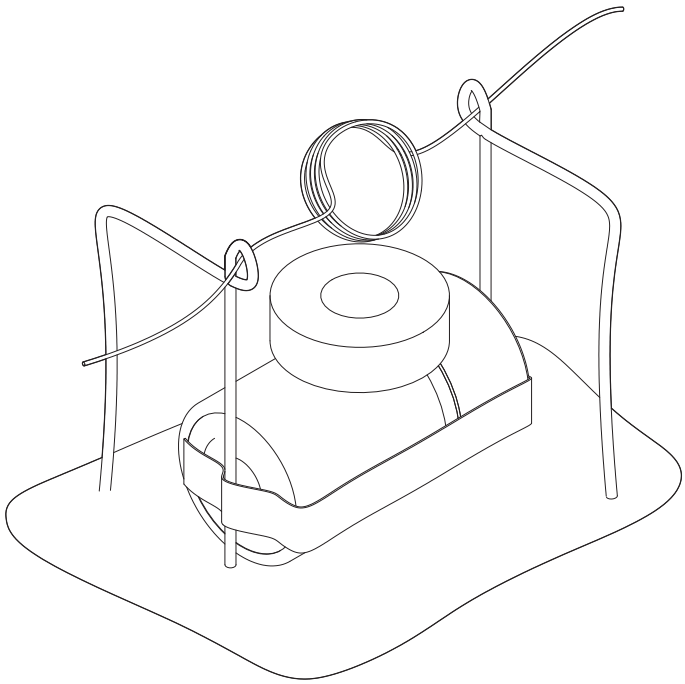


ELECTRIC MOTOR WORKSHEET

GETTING STARTED

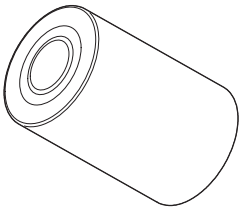
5-10m

Since its invention in 1834, the electric motor has transformed almost every industry and aspect of life imaginable. They are used in vehicles, such as cars, trains and even experimental planes. In the water industry, they can be used to pump millions of litres of water or turn the hands of a wristwatch. In short, electric motors are everywhere!

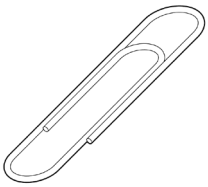
What's more, because they don't use fuel, as a petrol engine does, cities with higher usage of electric cars, will have lower air pollution and smog.

In this session, you will learn how to build a simple motor, powered by a battery. The motor will use the forces of attraction and repulsion between an electric current and a magnetic field to create a turning motion.

YOU WILL NEED

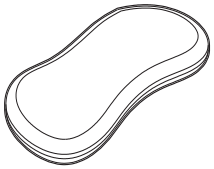


D cell battery
1

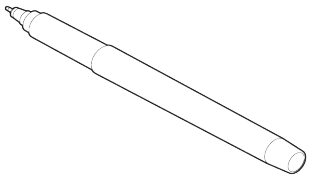


Large paper clips
2

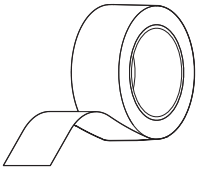
Coated copper wire
60cm



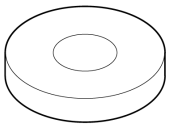
Modelling clay
(small fist size)



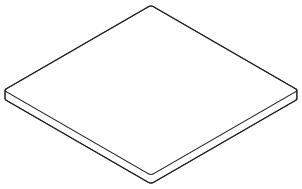
Felt tip pens
4



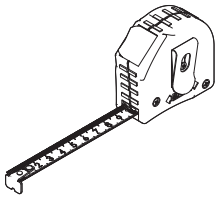
Electrical tape
50cm



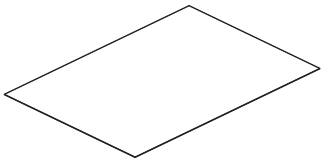
Ring magnets
4



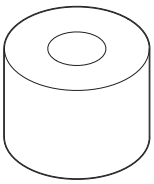
Cardboard base
20cm x 10cm



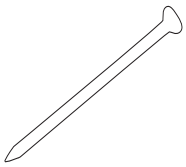
Measuring tape
1



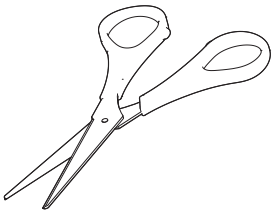
Sandpaper
1



Foam pipe lagging
15cm



Iron nail
1



Scissors
1

VOCABULARY

Electric Circuit - A complete path around which electricity can flow

Magnetic Field - The area around a magnet where there is a magnetic force

Insulator - A material that blocks the flow of electrical current

Conductor - A material that allows electrical current to flow through it

Electric Current - When a flow of electrons are moving in a loop around a circuit

Attract - To pull close

Repel - To push away

Solenoid - A coil of wire, usually in cylindrical form, that when carrying a current acts like a magnet

WARM-UP ACTIVITIES

A

10-15m

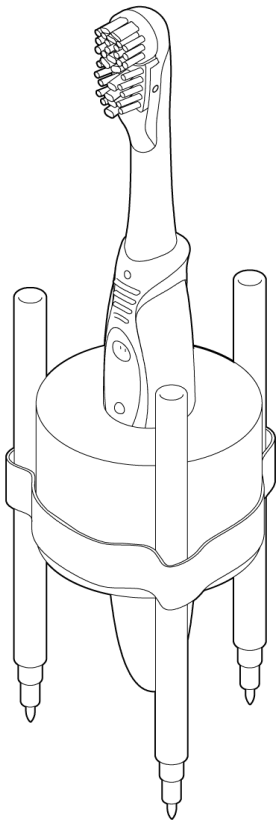
Use the movement created by the electric motors in everyday household items to create a fun scribbling robot!

Choose a household item that contains a motor, for example, an electric toothbrush. Then secure the item inside a short length of foam pipe lagging.

Next, place four felt tip pens around the outside of the foam pipe lagging and secure them in place with electrical tape.

To watch your scribbling robot draw, remove the lids of the felt tip pens, place your robot on a large sheet of paper and turn on your electrical item.It is the motion, created by the electric motor that moves the felt tip pens and creates the scribbly patterns.

You could continue to explore and find out if different household items make different scribble patterns when you turn them into scribbling robots.



B

10-15m

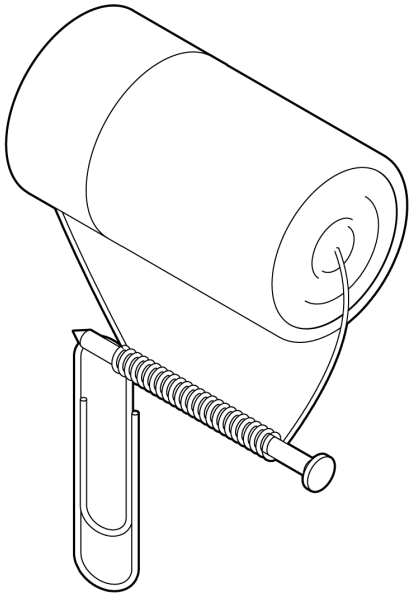
Use the battery, wire, tape and paper clips from the model, and an additional nail, to build an electromagnet.

First, coil a length of wire around the nail leaving a short length at each end. You will need to remove the enamel coating on the ends of the wire using sandpaper (as shown in Step C of the build instructions).

Before connecting the wire to the battery, test to see if you can pick up a paperclip using a magnetic force. You should find that there is no magnetic force at this stage.

Next, connect the sanded ends of the wire to the battery using the electrical tape and test again.

Now that there is an electric current flowing through the coil of wire, it has become a temporary magnet. Therefore, it is now possible to pick up paper clips and other magnetic objects using the magnetic force of the electromagnet.



MAIN CHALLENGE

20-30m

Building this model is a great way to explore how motors can convert electrical energy into mechanical energy.

The instructions below describe one method for making a simple motor.

You may find that variations in the magnets or wire you are using will mean you need to make small adjustments to the positions of the coil, magnets or battery.

Every time an engineer is faced with a problem, they approach it using the Engineering Design Process.

Ask - What's the problem?

Imagine - Choose a solution.

Plan - Design and choose materials.

Create - Make it.

Test - Test your creation.

Improve - Redesign as needed.

Keep testing and improving your creation to achieve the spinning motion. Good luck!

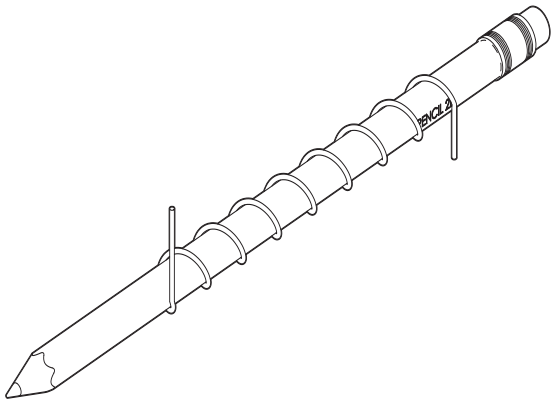
BUILDING THE ELECTRIC MOTOR

Follow these steps to build your simple motor model!

A

To make the coil, measure a 50cm length of enamelled copper wire and cut using sharp scissors.

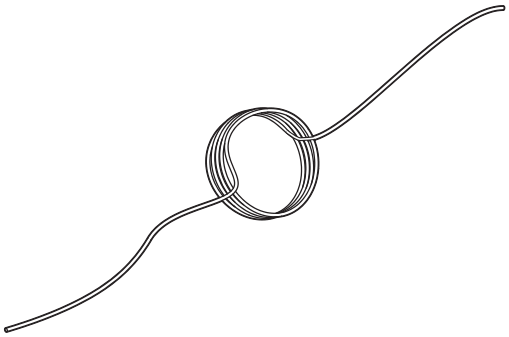
Wrap the copper wire tightly around a pencil. Leave 8cm of wire at each end.



B

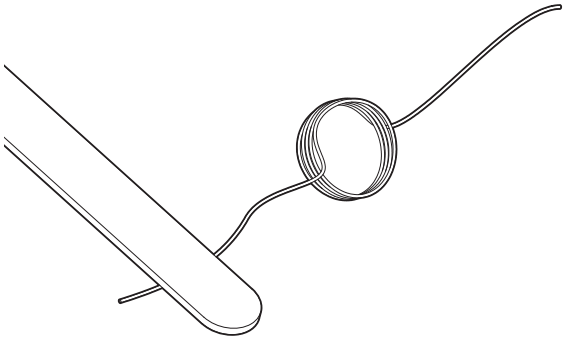
Slide the coil of wire off the pencil. Flatten it into a circle, then wrap the two ends around the coil at opposite sides of the circle to hold the coil together.

Straighten the long pieces of wire sticking out so they form arms coming from the centre of the circle.



C

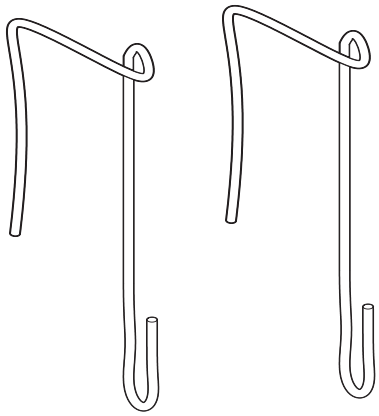
The enamelled copper wire has a coating that prevents electricity from passing through it. To ensure an electrical connection can be made between the arms of the wire coil and the paperclip stand, remove one side of the wire coating from each arm using sandpaper.



D

The paper clips will create a stand for the coil to spin on. Paperclips are made from steel, which is an electrical conductor. This means the electric current from the battery can flow through the paper clips to reach the coil.

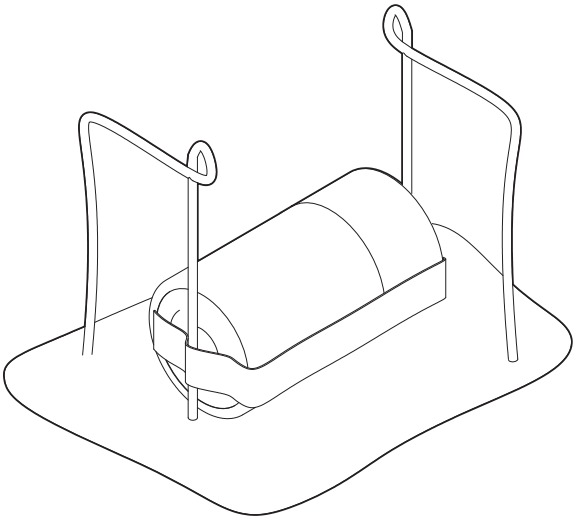
To build the stand, straighten one end of each of the paper clips to create a hook shape. Then twist it halfway along the straightened length to create a small loop for the arms of the coil to slot into.



E

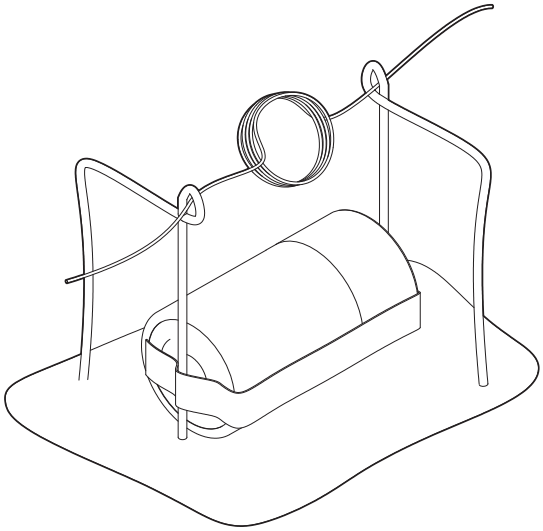
To keep the battery in position, stick it to the cardboard base using modelling clay.

Connect one of the hooked ends of the paper clip stand to each end of the battery using electrical tape. It is important to ensure there is a good connection between the paperclip and the battery because the electric current must be able to flow freely to create a full circuit once the coil is added.



F

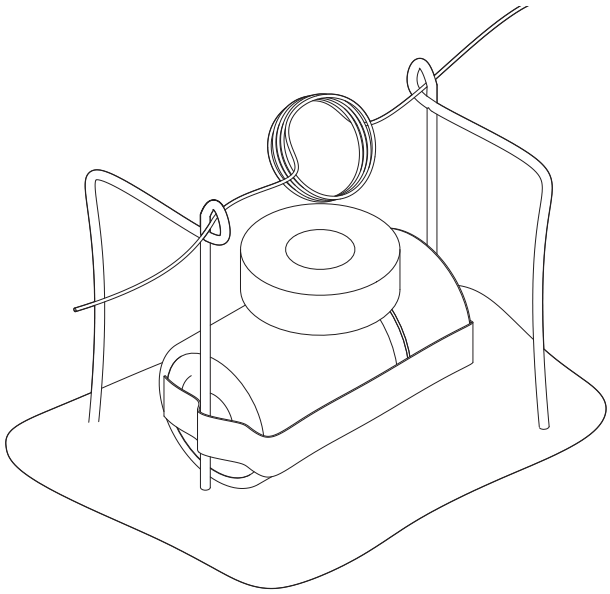
Gently feed the ends of the copper wire through the loops in the paper clips so that the coil is suspended. Check that the coil can rotate freely in the loops and make adjustments to the height of the loops if necessary.



G

Place the magnets on top of the battery. They will stay there without any glue because the battery case is made from steel, a magnetic material.

Now give the coil a spin, if the motor is working the coil should continue spinning on its own.



CAUTION

Do not leave the motor running for long periods because it can heat up. Take the coil out of the paper clip stands to stop the motor turning.

ELECTRIC MOTOR

10-15m

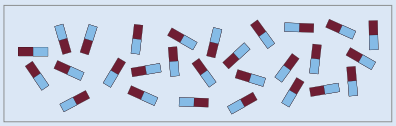
HARNESSING THE POWER OF MAGNETISM

KS2/3
UNDERSTAND THE SCIENCE

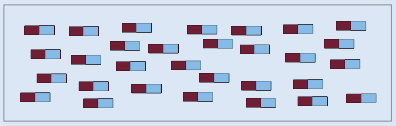
What is Magnetism?

Magnetism is a hidden force, caused by electrons inside the atoms from which all things are made.

Humans stick to the ground partly because we are a little bit magnetic, and the Earth is like a giant magnet. We don't notice the magnetism between Earth and our body because gravity is much stronger. However, for smaller objects, magnetism can be much stronger than gravity which is why magnets will stick to your fridge.



Not magnetised

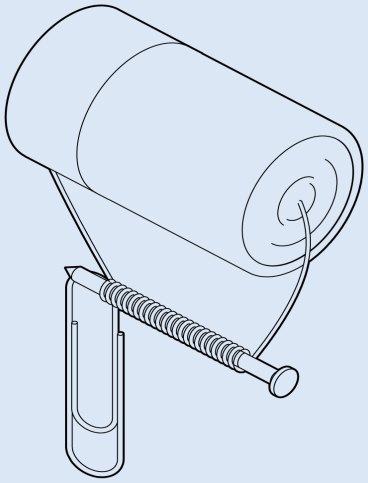


Magnetised

In magnetic materials, areas called domains behave like tiny magnets. When not magnetised, these are jumbled up and point in different directions, but when placed in a magnetic field or stroked repeatedly by a magnet, the domains all line up so that all the north poles point in one direction and the south poles in the opposite direction, making the material magnetic.

What are Electromagnets?

Electricity and magnetism are linked.



An electric current creates a magnetic field around it and a coil of wire (also known as a solenoid) can be used to strengthen this magnetic field. Adding an iron core to the solenoid makes it even stronger, forming a powerful electromagnet.

Electromagnets are useful because unlike permanent magnets they can be switched on and off and the strength of the field can be controlled by increasing or decreasing the current in the wire or changing the number of turns.

Electromagnets have many applications, including motors, loudspeakers and powered door locks, such as those used in the central locking systems of cars.

KS2/3
DEEPER LEARNING

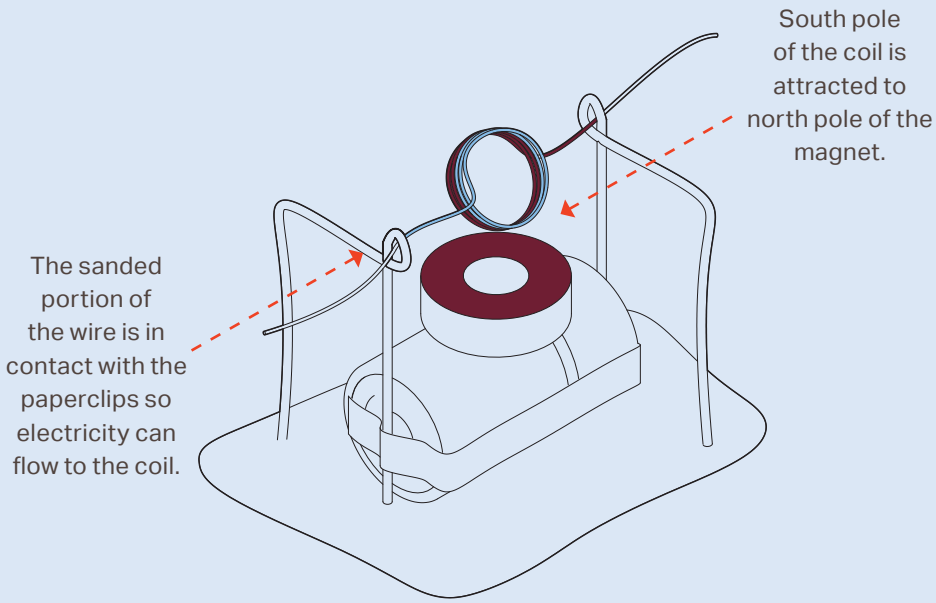
Why does the Coil Spin?

When electricity flows through the coil, it creates a magnetic field around it.

The ring magnet and the magnetised coil each have a north and a south pole. Like poles (north and north or south and south) repel, while opposites attract.

The coil starts to spin when the non-insulated section of the wire makes contact with the paper clips. When this happens current flows through the wire coil turning it into a temporary magnet. The south magnetic pole of the coil is attracted to the north pole of the magnet. This causes the coil to make a half rotation.

After this first half rotation, the insulated section of the wire (the part that wasn't sanded off) comes in contact with the paperclips, and the flow of electricity stops and allows gravity to pull the coil around until the sanded portion of the wire is again in contact with the paperclips. This means that electricity again flows through the coil, and the process starts again.



DID YOU KNOW?

It was English scientist Michael Faraday who proved that magnetism could produce electricity by pushing a magnet in and out of a coil of wire to create current. He went on to invent the first basic motor and electric generator.

QUIZ

10-15m

Name a household item that contains a motor.

.....

Why is the magnetism between Earth and our bodies not noticeable?

.....

.....

What do the domains of an unmagnetised material look like?

.....

.....

What is a solenoid?

.....

.....

Why was it important to sand the ends of the copper wire when making the model motor?

.....

.....

QUIZ

Will the north pole of a magnet attract or repel the south pole of another magnet?

.....

Name some uses for an electromagnet.

.....

.....

Why is it important to not leave the electric motor model running for long periods of time?

.....

.....

Why is steel a good material to use for the stand in the model motor?

.....

.....

Which English scientist first proved that magnetism could produce electricity?

.....