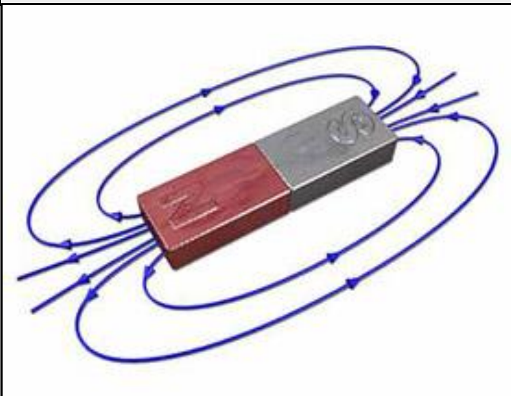
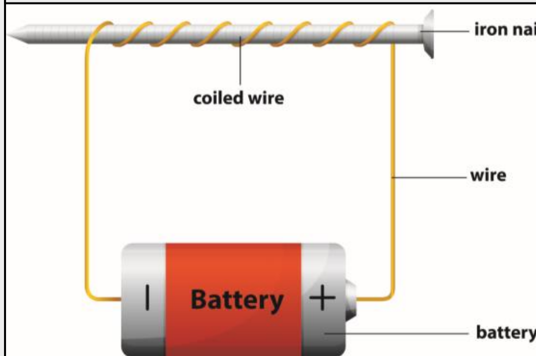
Magnets have been around for thousands of years, they were first discovered around 4000 years ago when people discovered **lodestones.** In the 11th century Chinese people wrote about using the mariners compass, a splinter of lodestone that, when placed in water, pointed in a **north-south** direction. With improving technologies and scientific process, we are now able to use rare-earth magnets are now used in many applications such as **computers**, **medical equipment** and **renewable energies**.

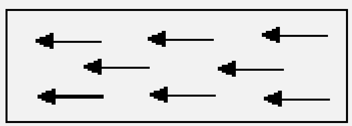


Magnets can be broadly categorised into two types, permanent and temporary. **Permanent magnets** can keep their magnetism for a long period of time, potentially for thousands of years. They have their own **magnetic field** due to the materials they are made from. **Iron, cobalt** and **cobalt** are the only elements that can show **permanent magnetism. Man-made alloys** such as **steel** can produce a stronger permanent magnetic field.

Fridge magnets, **compasses**, **computers** and **loudspeakers** all use **permanent magnets**.



Temporary magnets are **only magnetic** when in the **presence** of another **magnetic field** and no longer show magnetic properties when away from that source. As an example, if you were to attach a paper clip or an iron nail to a bar magnet, then that nail or clip would be able to pick up another nail etc. **Electromagnets** are special cases where they are only **magnetic** when an **electric current** passes through the object.

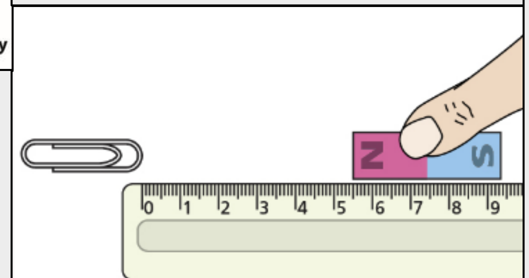


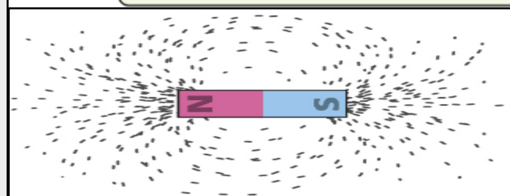
Magnetised (domains lined up)

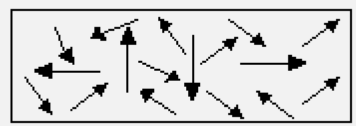
In materials such as iron, nickel and cobalt, groups of atoms are bound together in groups called **domains**. When these magnets are **aligned** in a **particular direction**, the material will become **magnetised**. If they are not in the same direction, they will be **randomly arranged** which **cancels** out any **magnetic** effect.

It is relatively simple to test the strength of magnets using the following methods;

- Measure the number of items that a magnet can hold
- You can use iron filings to visualise the magnetic fields, the closer the filings bunch together, the stronger the field.
- Investigate how far an object will need to be before the magnet will attract it.







Unmagnetised (randomly orientated domains)

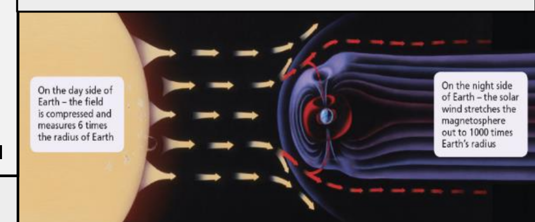
When lined up, these **domains** will point in the same direction, giving the object a **north** and a **south pole.** Items can be magnetised in a variety of methods, a couple are;

- Stroke it with a permanent magnet
- Placing near a permanent magnet for a period of time.

Every **compass** points in a **geographical north** direction no matter where it is located. This means that the geographical north pole is actually the **magnetic south** pole (as opposite poles attract). We also know that the **Earth's magnetic poles reverse** every few thousand years.

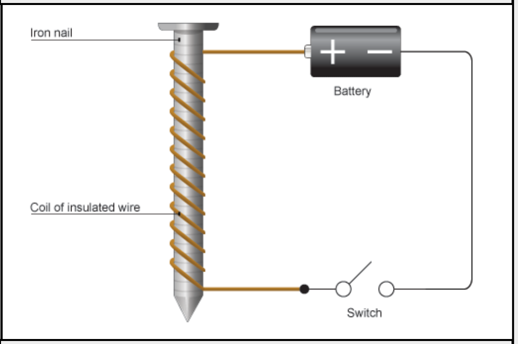
The theory behind the Earth acting as a magnet is called the **geodynamo** theory. It is believed the **core** of the Earth is made up largely of **molten iron**, surrounded by a mixture of molten iron and nickel. As the Earth spins, this molten core also spins, **generating** small **electrical currents**. Electrical currents generate magnetic fields creating **magnetic domains** within the Earth, producing its **magnetic field**.

The Earth's magnetic field extends out into space, as it is shaped by the Sun's solar activity it becomes the **magnetosphere.** Without this, there could not be life on Earth as it protects and deflects deadly cosmic rays and highly charged solar winds.

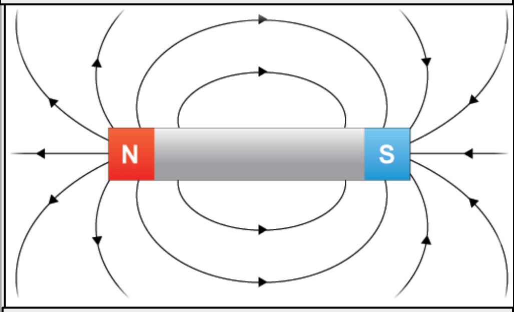


Any **wire** will produce a **magnetic field** when a **current** is passed through it, that **magnetic field** will **disappear** when the current is turned off. Magnets that use an electric current to produce the magnetic field are called **electromagnets**, The first **electromagnets** were quite weak, as they only used a small current and a single wire. To **increase** the **strength** of an electromagnet, you can;

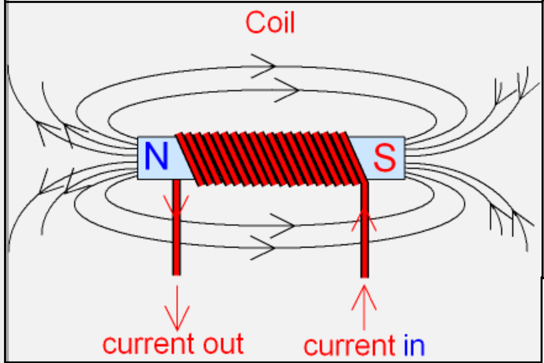
- **Increase** the **current** passing through the wire.
- **Coiling** the **wire** into a loop.
- Increasing the **amount** of **coils** in the wire.
- Using an **iron core** in the electromagnet.



The **magnetic field** around an electromagnet is very **similar** to that of a **bar magnet**:



On an **electromagnet** at one end of the coil there will be a **north pole** and vice versa. If you **reverse** the flow of the **current**, the poles will **switch**.



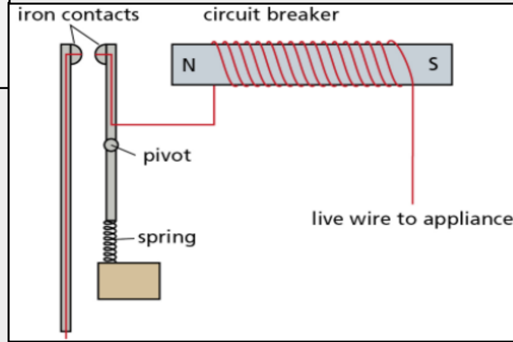
There are **many common** uses of electromagnets;

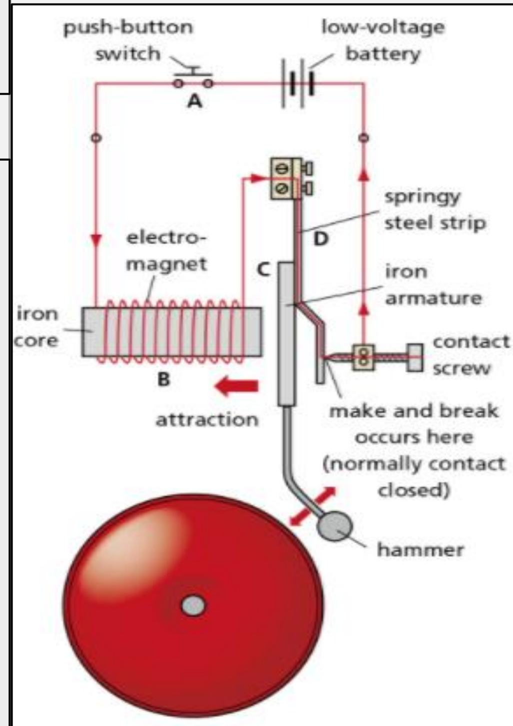
- In loudspeakers, magnetic fields moves a diaphragm which amplify the sound waves.
- In a computer hard drive, electromagnets are used to store information.
- Separating iron and steel from other, non-magnetic, materials. The ability to switch the current off allows for good control during this process.

In the **electric bell circuit** on the right, as the switch is pressed (and the circuit is complete) the following happens;

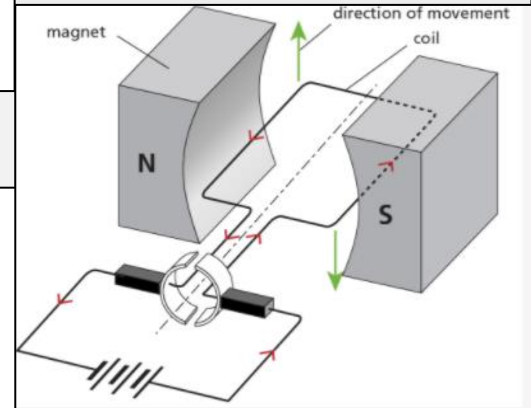
- The current magnetises the coil
- The coil attracts the armature
- The armature strikes the gong
- As the armature moves towards the gong, the steel strip moves as well.
- This causes the steel strip to break contact with the contact screw.
- The circuit is now incomplete, causing the coil to lose its magnetism.
- The armature springs back to its original position
- The process repeats.

The **circuit breaker** is designed for safety. The electromagnet in the circuit is too weak to attract the iron contact with the correct current. If an appliance malfunctions and too much current is passed through, the magnet attracts the contacts, breaking the circuit.





Electric motors use **electromagnets** or permanent magnets to **create movement** and complete useful work. They are in **many common appliances** such as food mixers, hoovers, cars and washing machines. It was discovered that when a wire with a current passing through it, was placed into a magnetic field, it moved. Specifically, it moved in a direction that was at a right angle to both the field and the current. When the current was reversed, the movement reversed as well, this is called the **motor effect.**



To **increase** the **movement** of the wire, you can do the following;

- **Increase** the **current**, which will increase the magnetic field. Therefore this will then increase the level of repulsion/attraction.
- **Increasing** the **strength** of the permanent **magnet**.
- **Coiling** the **wire**, increasing the strength of the field around the wire.

As the wire moves, the **polarity** of the current **reverses**, in order for the coil to **spin**. Otherwise the wire would just move up and down.