Physics Knowledge Organiser

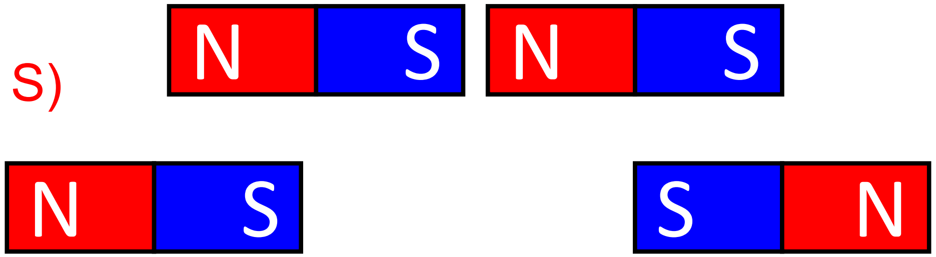
Magnetism and Electromagnetism (Triple Science)

1) Magnets have two poles. A north pole and a south pole.
2) Two magnets exert a force on each other (when they are brought close).

This forces exerted by magnets on other magnets and magnetic materials is a **non-contact force**.
This means that the magnet poles do not have to be touching each other to apply their force.

3) The two interactions are:
- Attraction (between two opposite poles, e.g N and S)
- Repulsion (between two like poles,

e.g N and N or S and S).



4) These interactions are strongest at the poles.

Types of Magnets

Permanent magnets (like bar magnets) produce their own magnetic field.
They can exert a force which is either attraction **or** repulsion.

Induced magnets are materials that become a magnet when they are placed in a magnetic field. They lose their magnetism once they leave this field.
They can only exert a force of attraction.

Magnetic Materials

- **Iron, nickel and cobalt are the only naturally magnetic elements.**
- **The force between a magnet and a magnetic material is always attractive.**
- **Magnets never repel magnetic materials.**

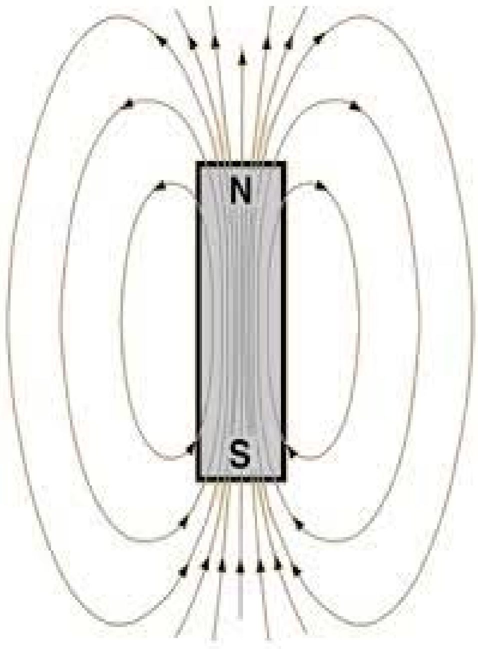
Magnetic Fields

A magnetic field is the region around a magnet where a force will act.

This force will act on other magnets or magnetic materials.

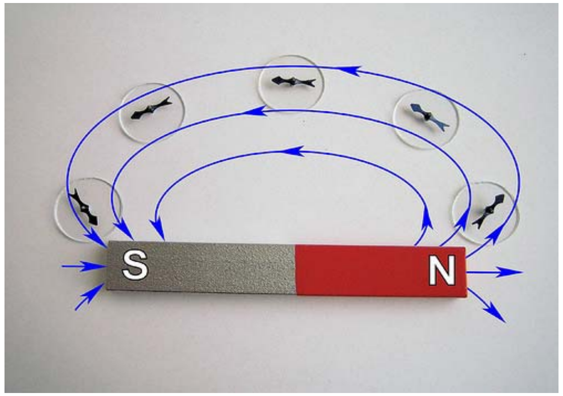
Magnetic field lines all flow from the north (seeking) pole to the south (seeking) pole.

Methods of showing magnetic field around a bar magnet



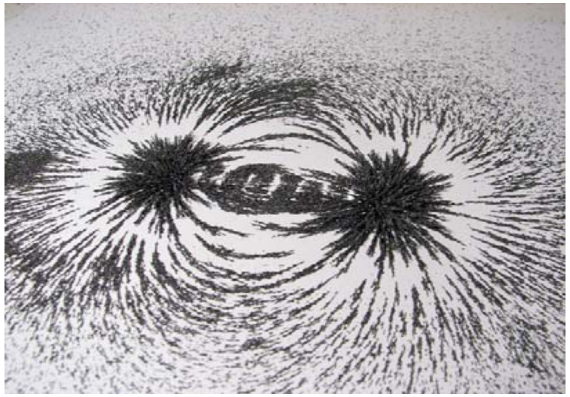
Method 1

1. Place your magnet on a sheet of paper and draw around it.
2. Place a compass at one pole.
3. Draw around the compass and draw an arrow indicating the direction the compass is pointing.
4. Move the compass in this direction in intervals marking the direction the compass points until you reach the other pole.
5. Link up the field lines and add arrows to your diagram.



Method 2

1. Place a piece of paper on top of a magnet.
2. Slowly sprinkle iron filings on to the paper.
3. Gently shake the sheet to get the iron filings aligned.
4. Sketch the pattern the iron filings made.
5. Use this sketch to draw on field lines to the magnet.



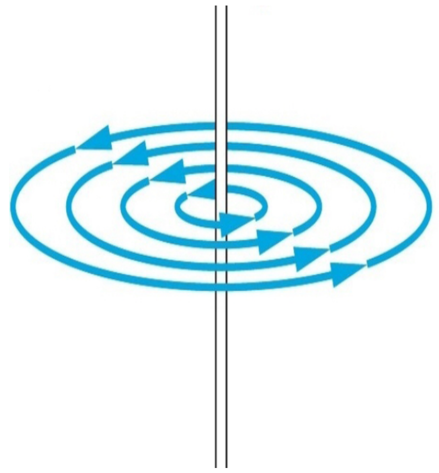
Magnetic fields around wires carrying current

The magnetic field around a wire consists of concentric circles centred around the wire.

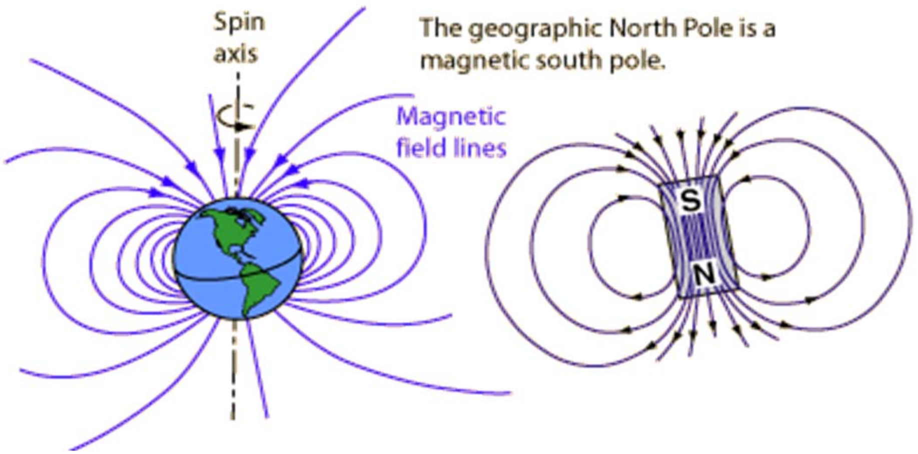
The magnetic field is strongest near the wire.

This is shown by the field lines being closest near to the wire.

The strength of the magnetic field increases if the current is increased.

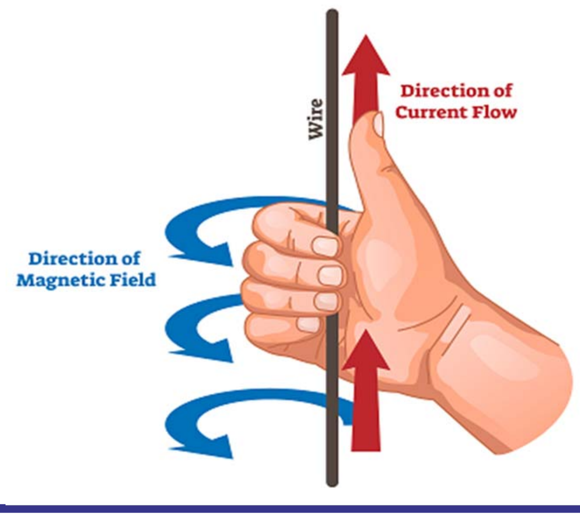


Earth's Magnetic Field



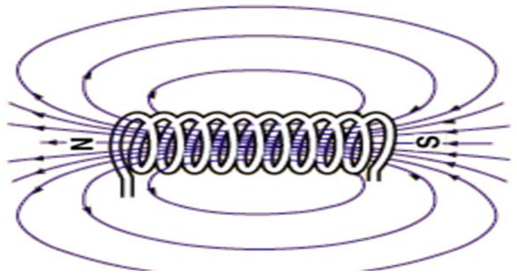
Right Hand Grip Rule

Thumb = Direction of the electric current
Fingers = Direction of the circular magnetic field

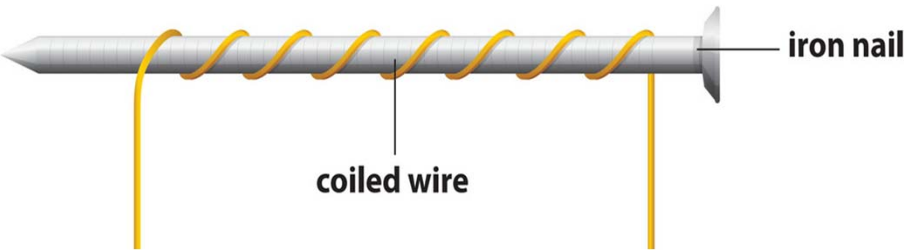


Increasing the strength of a magnetic field around a wire

1) Increasing the current around a wire increases the strength of the magnetic field.
2) Increasing the number of the coils increases the strength of the magnetic field.
When the wire is coiled up as shown, it is called a solenoid.

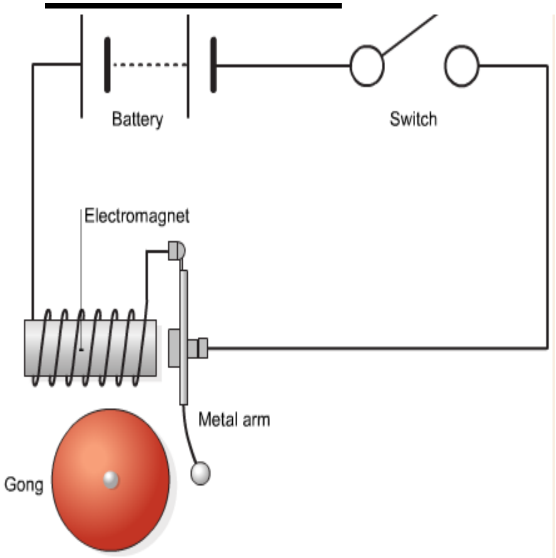


3) By adding an iron core, this also increases the strength of the magnetic field.
An electromagnet is a solenoid with an iron core.



Uses of electromagnets

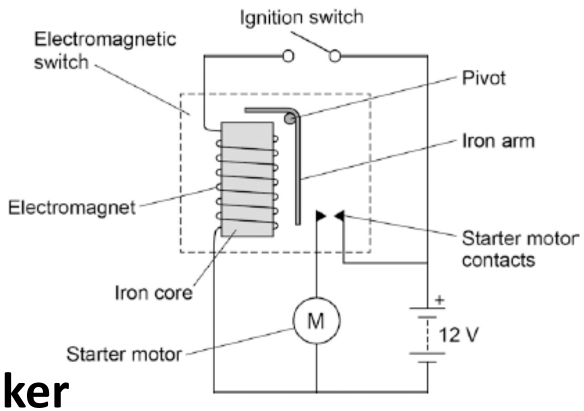
Electric Bell



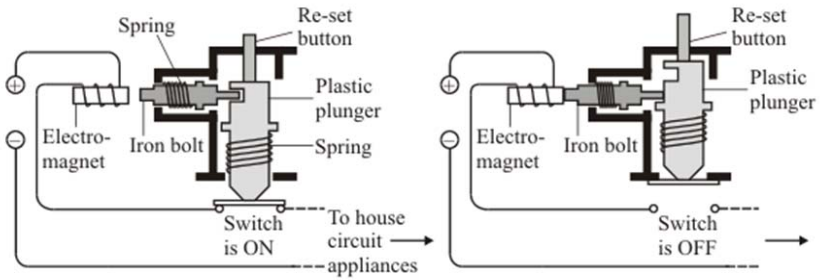
Electric Bell Explanation

- A current flows through the circuit when the switch is closed.
- The electromagnet turns on.
- The electromagnet exerts an attractive force on the metal arm.
- This causes the metal arm to hit the gong.

Electric Motor



Circuit Breaker

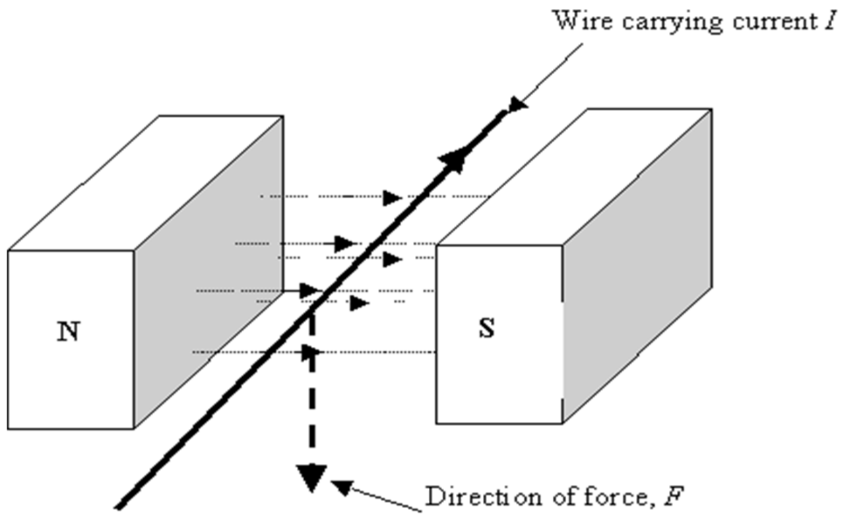


The motor effect

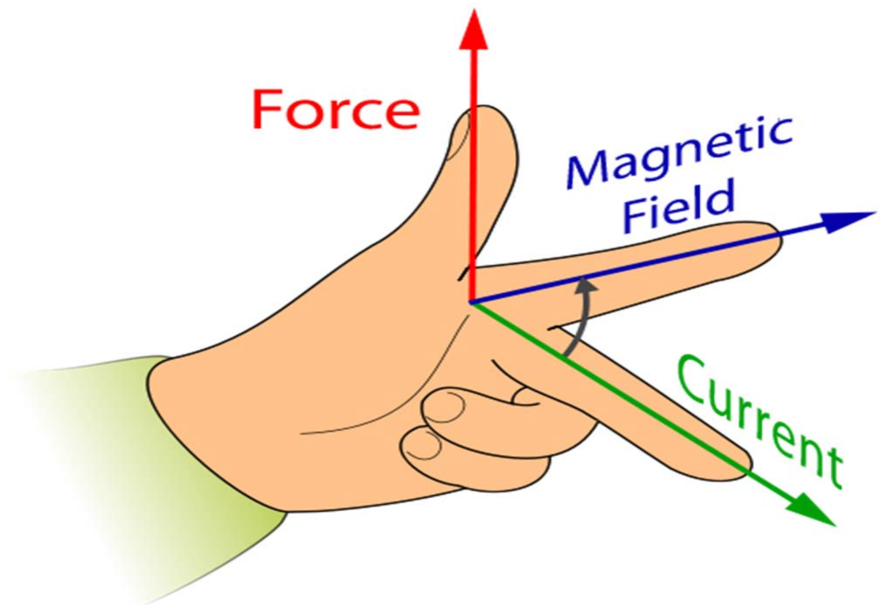
A conductor with a current has a magnetic field around it.

When this conductor is placed in a magnetic field, they exert a force on each other.

This causes the wire to move in a certain direction as there is now a resultant force acting on the wire.



Fleming's Left-hand rule



Thumb = Force = F
First Finger = Field = B
Second Finger = Current = I

Remember the field is from north to south pole.

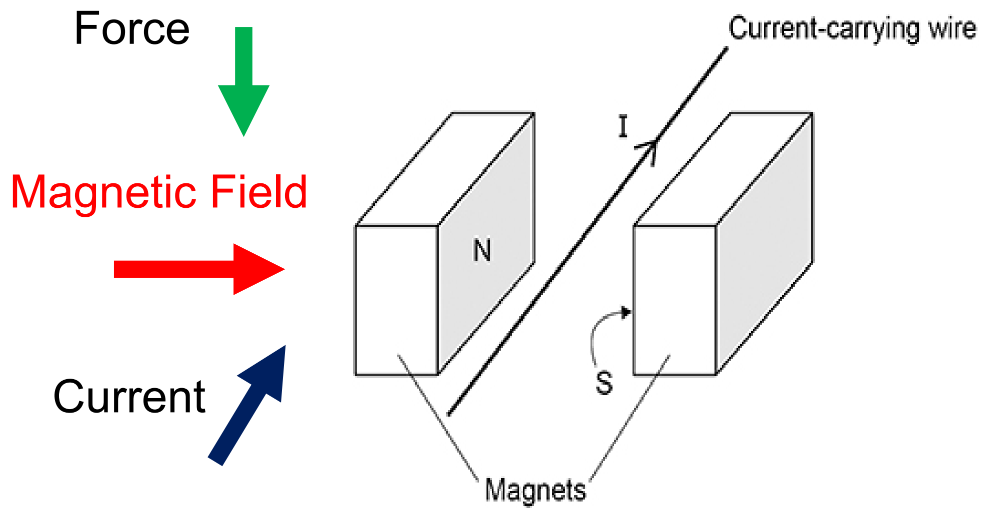
Remember the current is from positive to negative.

Application of Fleming's Left-hand rule Example 1

The magnetic field is going from the north pole to south pole. Therefore, your first finger is pointing to the right.

The current through the wire is going away from us. Therefore, your second finger is pointing away from us.

Finally, your thumb should be pointing downwards. Therefore, the force on the wire should be downwards.

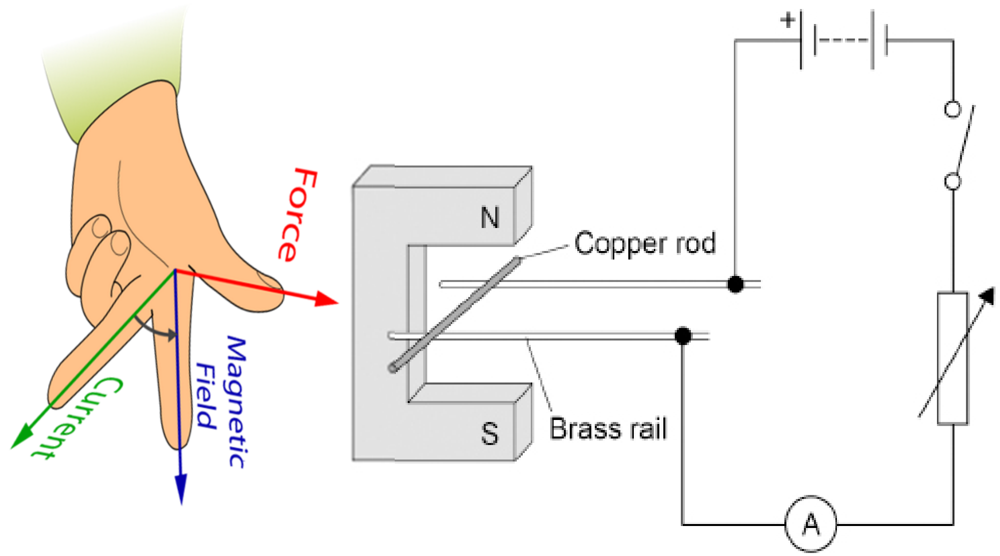


Application of Fleming's Left-hand rule Example 2

The magnetic field is going from the north pole to south pole. Therefore, your first finger is pointing downwards.

The current through the wire is towards us. Therefore, your second finger is pointing towards us.

Finally, your thumb should be pointing to the right. Therefore, the force on the copper rod is to the right.



Force on a wire equation

$$F = B \times I \times l$$

Given on equation sheet.

F = Force in Newtons, N
B = Magnetic flux density in Tesla, T
I = Current in Amps, A
l = Length of the wire in the field in metres, m

Example of using the equation $\mathbf{F = B \times I \times l}$

Calculate the force produced on a wire for a magnetic flux density of 0.03T, a wire length of 100m and a current of 2A.

$$F = B \times I \times l$$
$$F = 0.03 \times 100 \times 2$$
$$F = 6N$$

Example of rearranging the equation

$$\mathbf{F = B \times I \times l}$$

Calculate the current in a wire if 5cm of wire has a force on it of 0.28N in a 0.5 T field.

$$F = B \times I \times l$$

Length = 5cm = 0.05m

$$0.28 = 0.5 \times I \times 0.05$$
$$0.28 = 0.025 \times I$$
$$\frac{0.28}{0.025} = I$$
$$I = 11.2\ A$$

Electric Motors

In a magnetic field, a force acts on each arm of the coil carrying a current.

One force acts upwards on the coil and the other acts downwards. This causes the coil to rotate.

The split ring commutator keep the motor rotating in the same direction by swapping the contacts (changing the polarity of the current) every half turn.