6 Magnetism and Electromagnetism

Magnetism and Electromagnetism - Units

6.1 use the following units: ampere (A), volt (V) and watt (W)

ampere — The unit of electrical current [A], equivalent to one coulomb of charge passing a point in an electrical circuit every second.

$$[1A] = \frac{[1C]}{[1s]}$$

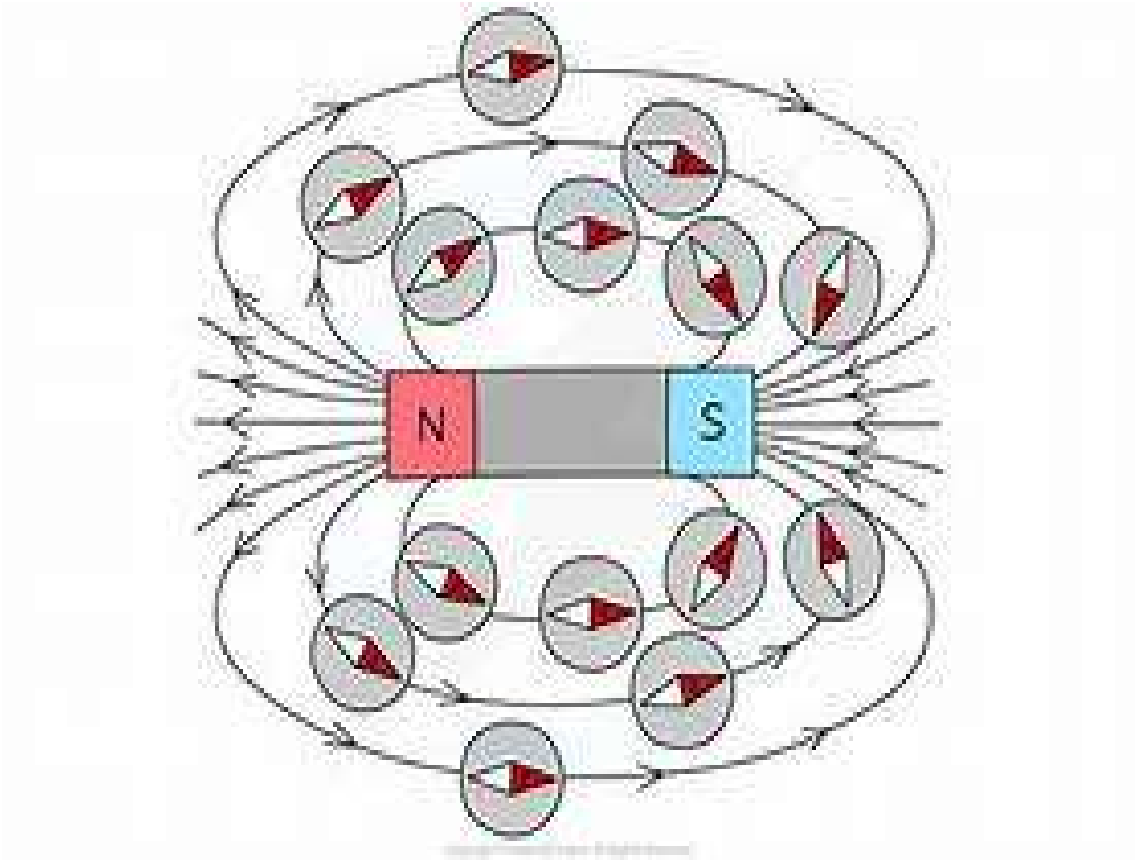
volt — The unit of potential difference, equivalent to the dissipation of one joule of energy per unit charge passing across two points in a circuit.

$$[1V] = \frac{[1J]}{[1C]}$$

watt — The unit of electrical power, equivalent to the dissipation of one joule of energy per second.

$$[1W] = \frac{[1J]}{[1s]}$$

Plotting Field lines

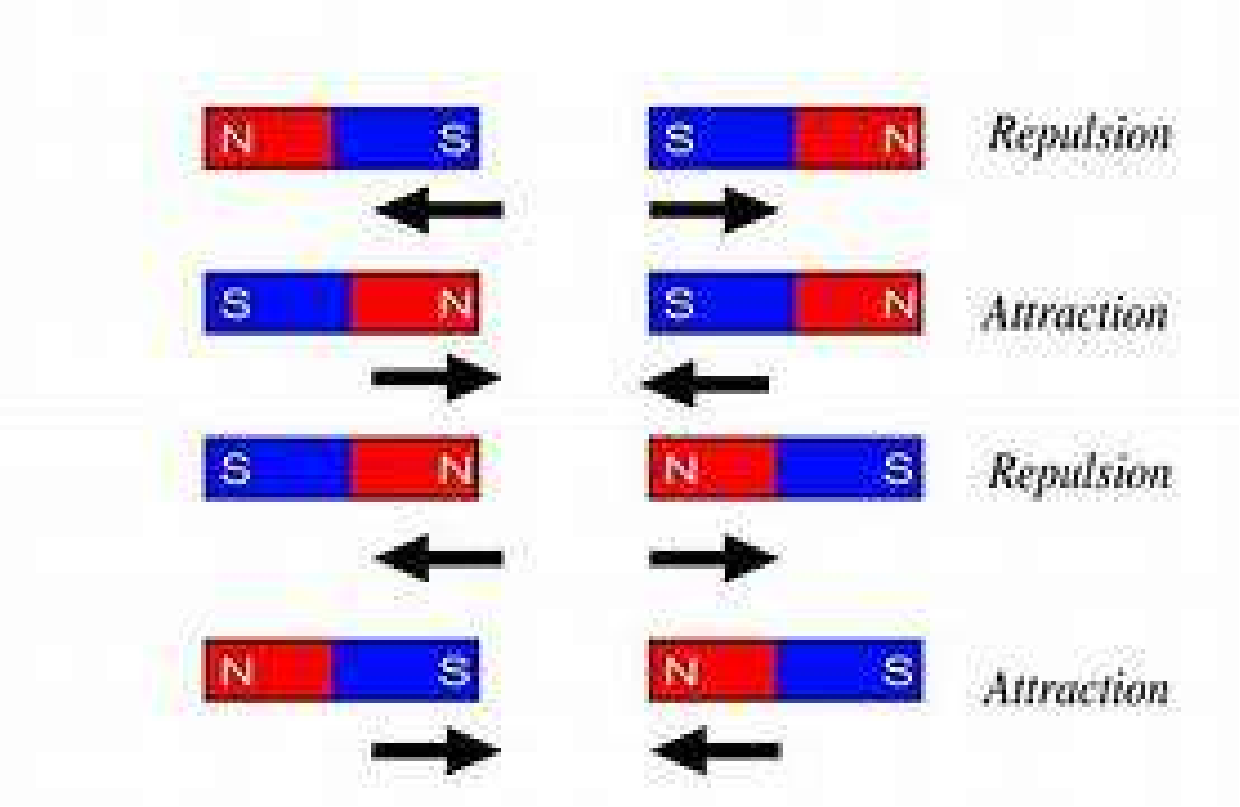


In order to obtain a diagram of the fiel; a small plotting compass can be placed in different positions around a bar magnet, the direction of deflection noted and then the field lines traced.

https://www.sciencemuseum.org.uk/objects-and-stories/lets-stick-together-history-permanent-magnets

Repulsion and Attraction

6.2 know that magnets repel and attract other magnets and attract magnetic substances



Like poles repel

Opposite poles attract

Magnetic Coercivity or Hardness

6.3 describe the properties of magnetically hard and soft materials

There are three magnetic elements; Nickel, Cobalt and Iron

Any material that contains these elements is a magnetic material.

The ease with which a material retains or loses its magnetism is its coercivity, or hardness.

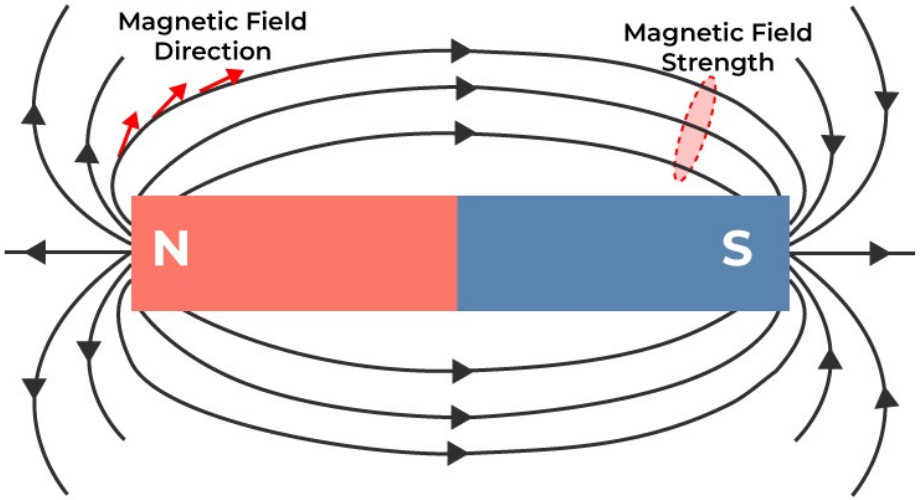
Hard magnetic materials retain their magnetism

Soft Magnetic materials lose their magnetism easily

We therefore chose a soft magnetic material for semi permanent magnets – electromagnets, and a hard magnetic material for permanent magnets.

Magnetic Field Lines

6.4 understand the term magnetic field line



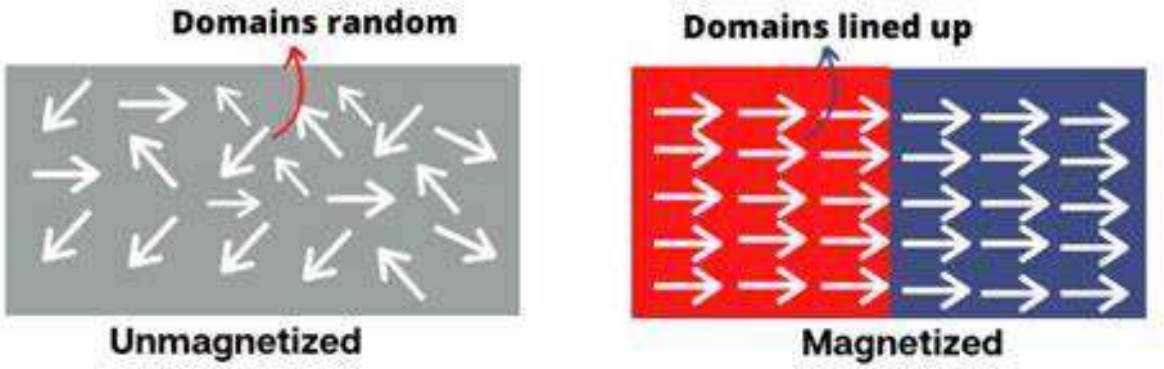
The magnetic field, B is usually represented pictorially using field lines.

It is defined as the direction a compass needle will point.

All field lines start on a north pole and end on a south pole.

The strength of the magnetic field is represented by the proximity of the field lines, it is also known as magnetic field strength, or magnetic flux density.

Magnetic Domains



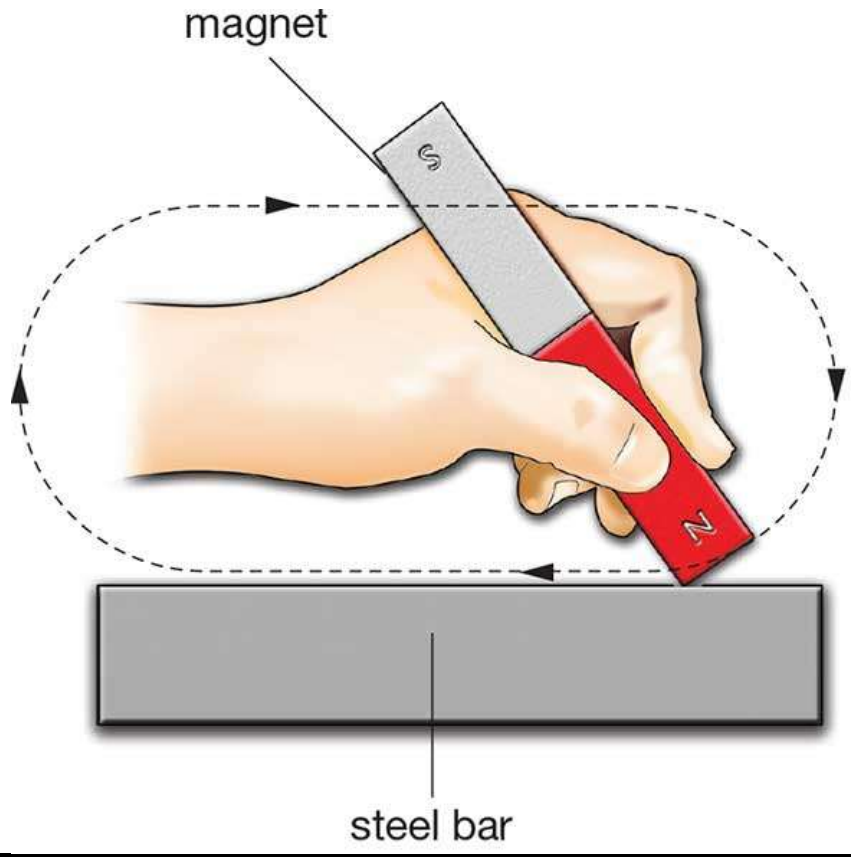
There are 3 magnetic elements – Iron, Cobalt, and Nickel.

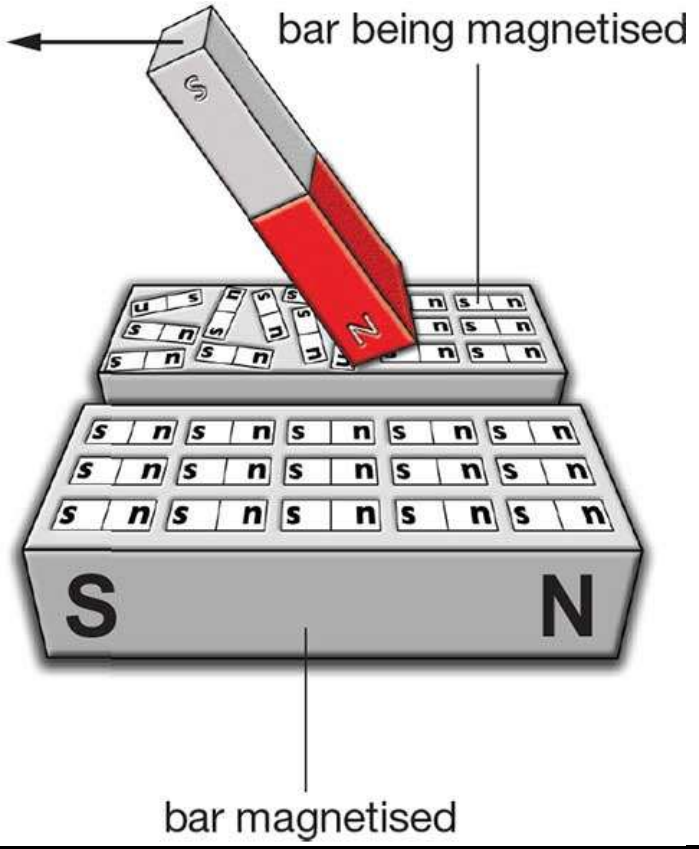
Magnetic domain theory is a model of magnetic materials.
Magnetic materials are crystalline and have a substructure of grains, within these grains, or domains the atoms that constitute the material are aligned so each domain acts as a tiny magnet.
Across the macroscopic material the domains are randomly orientated so the magnetic material is not a permanent magnet.
If we wish to create a permanent magnet then we need to cause the randomly orientated domains in this unmagnetized magnetic material to line up.

There are two ways of doing this…

Stroking Method

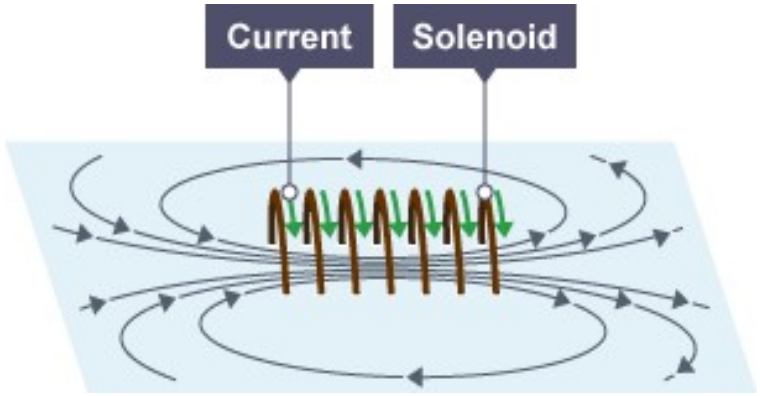
6.5 know that magnetism is induced in some materials when they are placed in a magnetic field

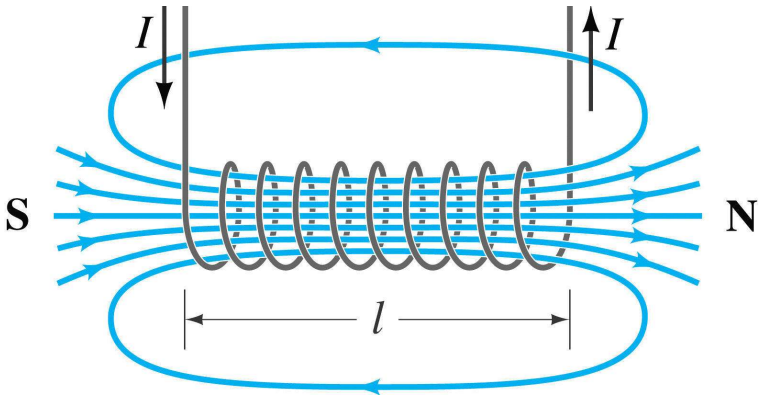


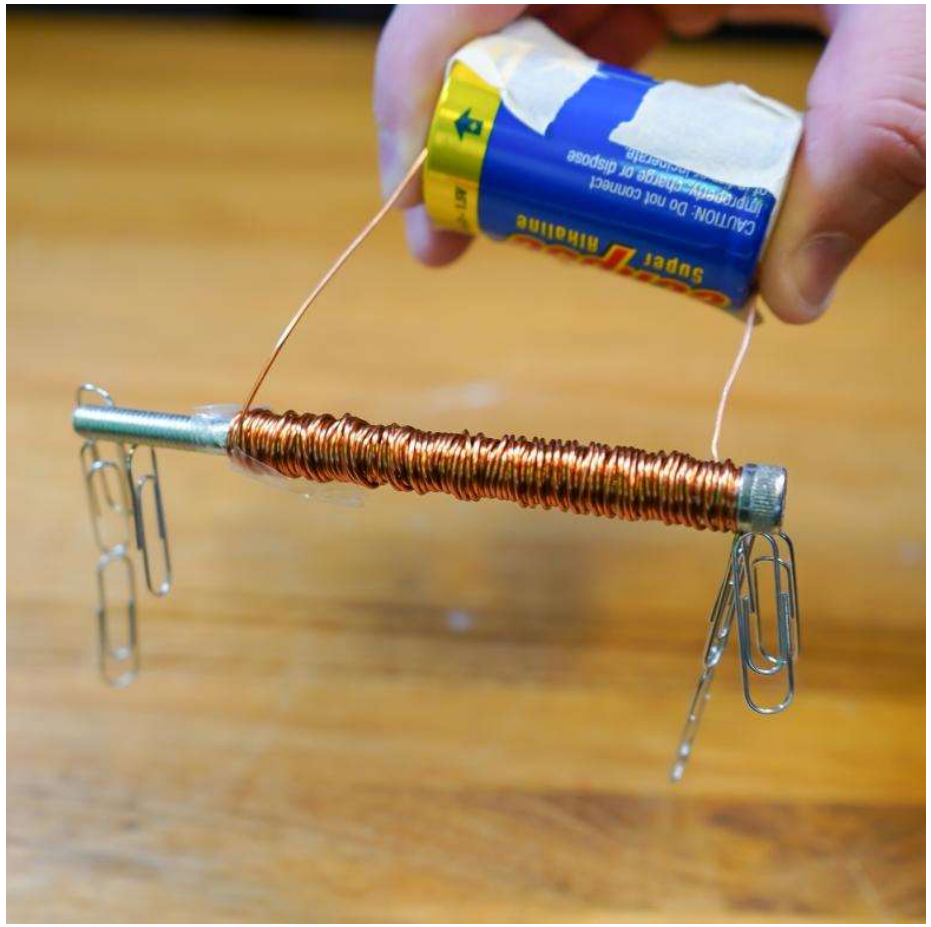


By bringing a strong permanent magnet near an unmagnetized material and dragging or stroking it across the surface of the unmagnetized bar the randomised domains can be caused to flip into alignment creating a permanent magnet.

Electrical Method

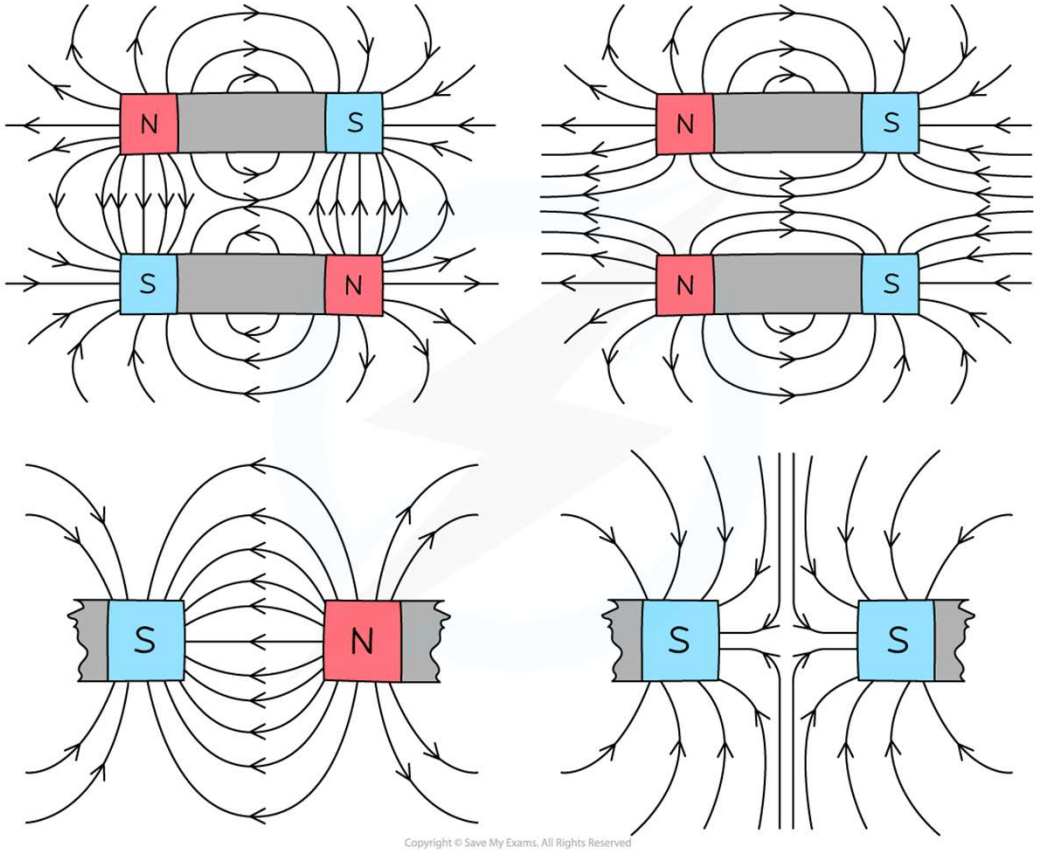






Magnetic Field Patterns

6.6 practical: investigate the magnetic field pattern for a permanent bar magnet and between two bar magnets
6.7 describe how to use two permanent magnets to produce a uniform magnetic field pattern



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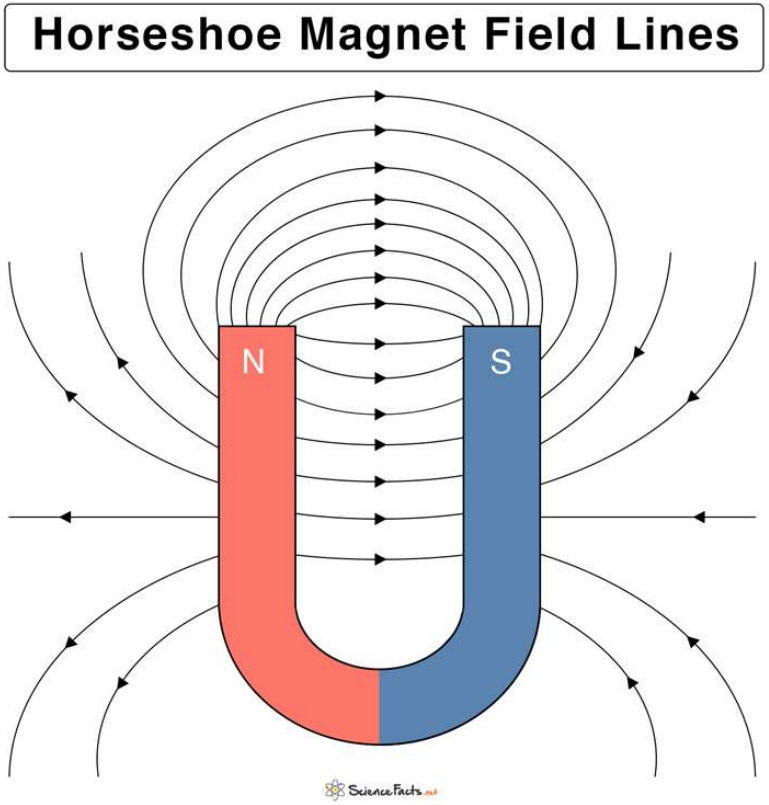
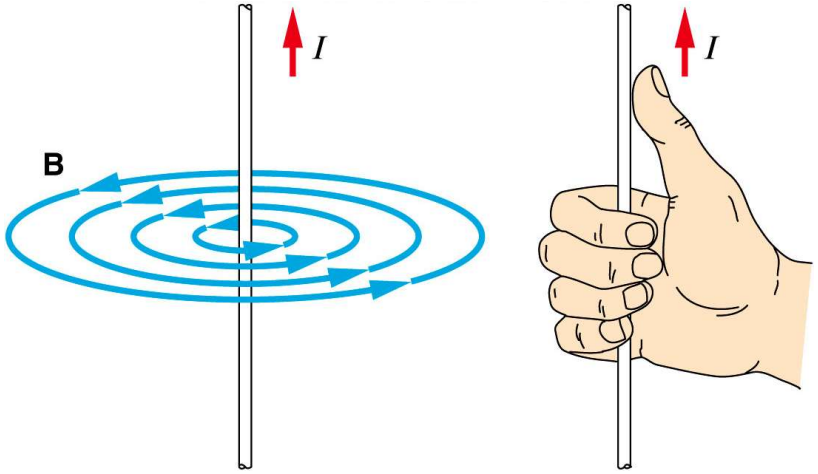


Electromagnetism

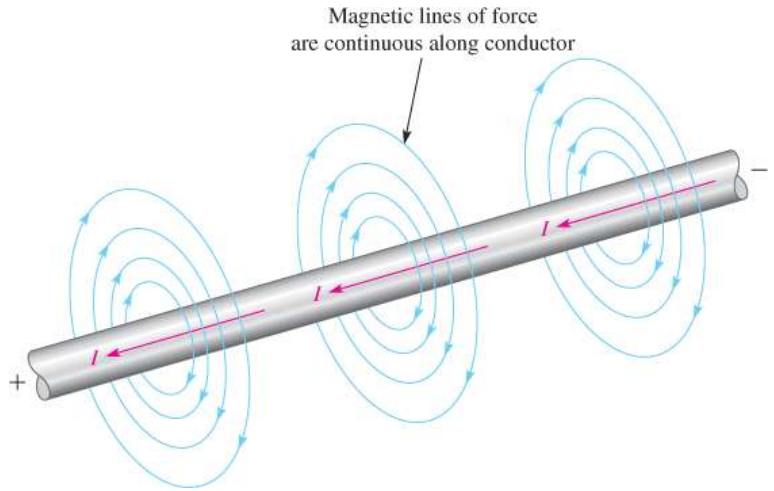
6.8 know that an electric current in a conductor produces a magnetic field around it

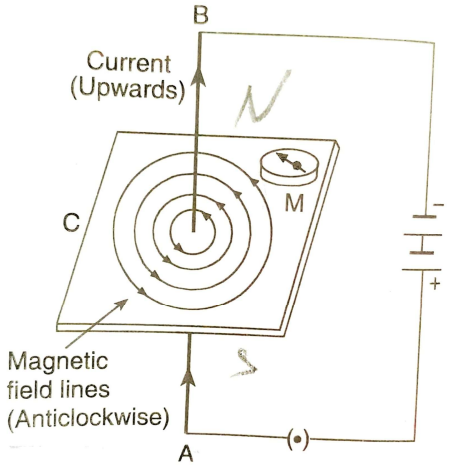


When conductor has a current flowing in it, a magnetic field is created in the space around it.

The larger the current, the stronger the magnetic field, and the closer the field lines are to one another.

The same is true of a moving charge.

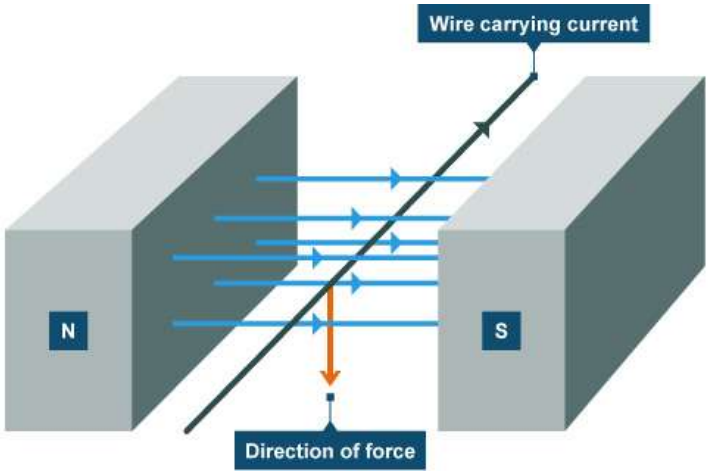


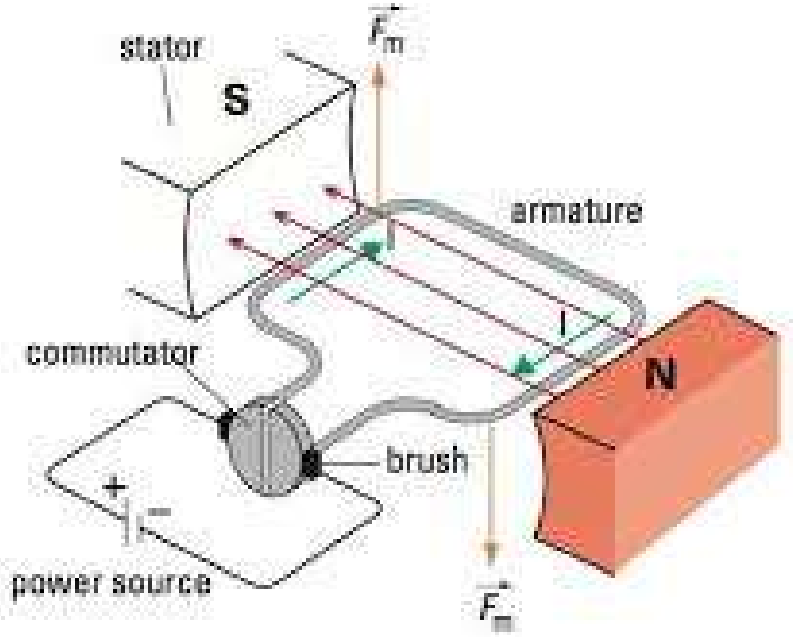


DC Motor

6.12 understand why a force is exerted on a current-carrying wire in a magnetic field, and how this effect is applied in simple d.c. electric motors and loudspeakers

When an electric current ‘cuts’ a magnetic field line the moving charges constituting it experience a force. This force acts at right angles to both the magnetic field and the electric current.

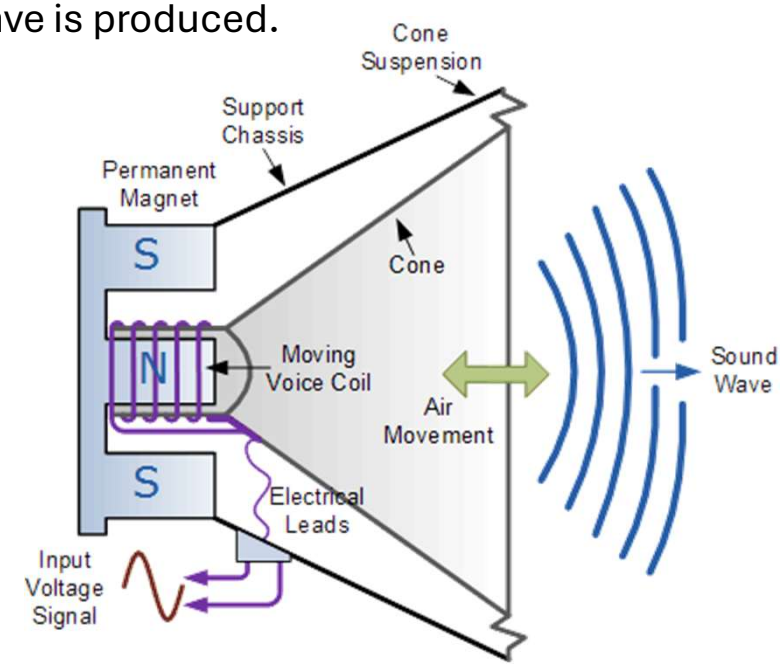


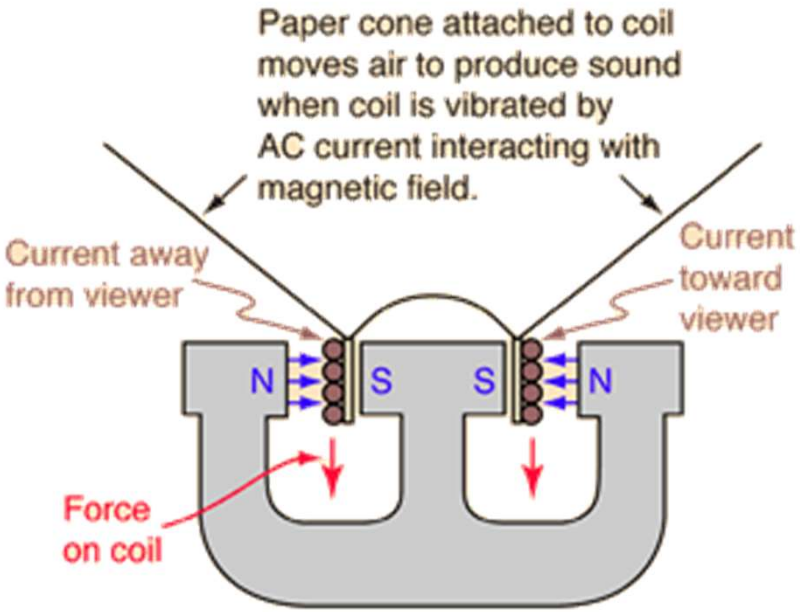


Loudspeaker

In a loudspeaker:

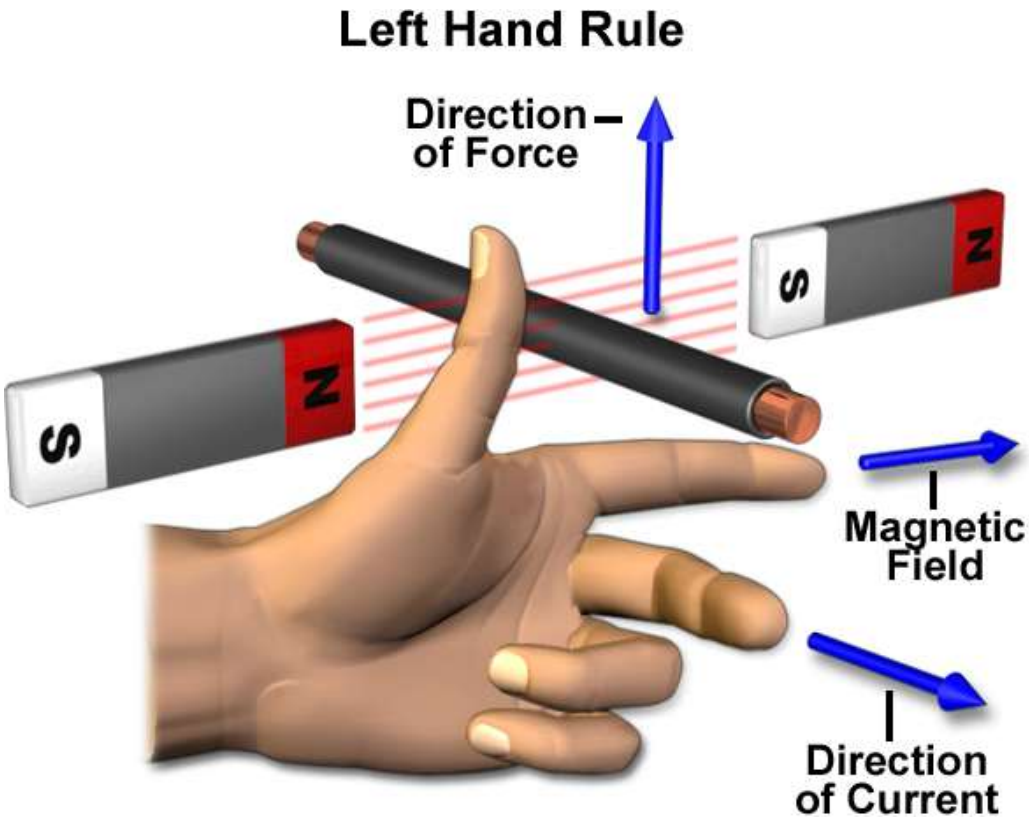
- An alternating potential difference, or voltage, is applied across the ends of a coil of wire wound around the pole of a magnet.
- Each time the potential difference changes **polarity**, the current changes **direction**.
- Consequently, the force on the coil also changes direction.
- The paper cone which is attached to the coil therefore begins to oscillate.
- Rarefactions and compressions in the air directly in front of the cone are created.
- A sound wave is produced.

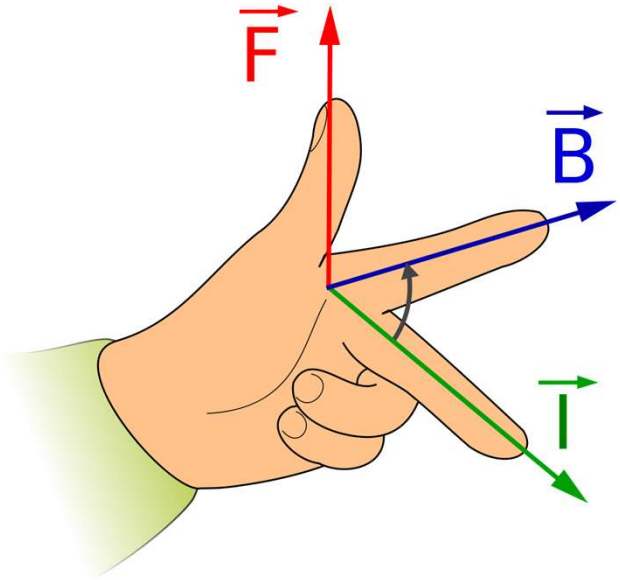




Flemings Left Hand Rule

6.13 use the left-hand rule to predict the direction of the resulting force when a wire carries a current perpendicular to a magnetic field



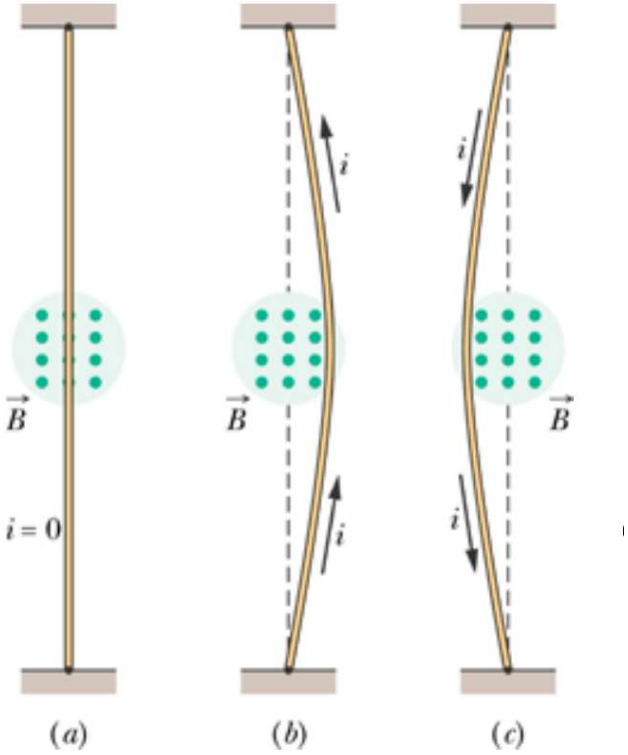


Force on a Current Carrying Wire

6.14 describe how the force on a current-carrying conductor in a magnetic field changes with the magnitude and direction of the field and current

The following cause an increase in the force on a current carrying wire:

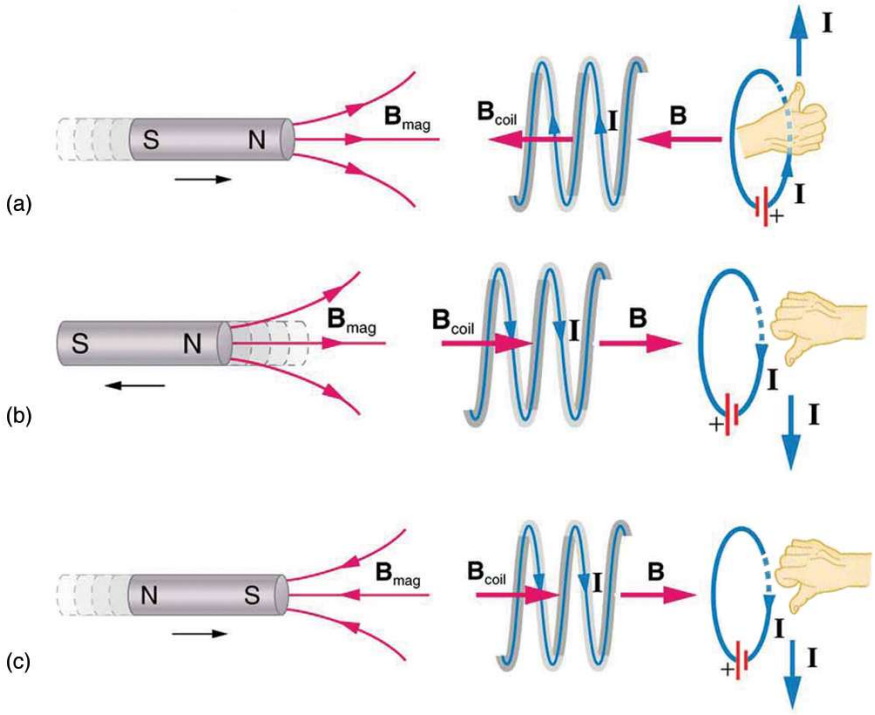
1. Stronger magnetic field, bigger **B**
2. Larger Current, bigger **I**
3. **Direction -** When either the current or the magnetic field is reversed so is the force.



Electromagnetic Induction

6.15 know that a voltage is induced in a conductor or a coil when it moves through a magnetic field or when a magnetic field changes through it and describe the factors that affect the size of the induced voltage

6.16 describe the generation of electricity by the rotation of a magnet within a coil of wire and of a coil of wire within a magnetic field, and describe the factors that affect the size of the induced voltage



It is possible to create or **INDUCE an** electromotive force, by the relative motion of a magnetic field and a conductor.

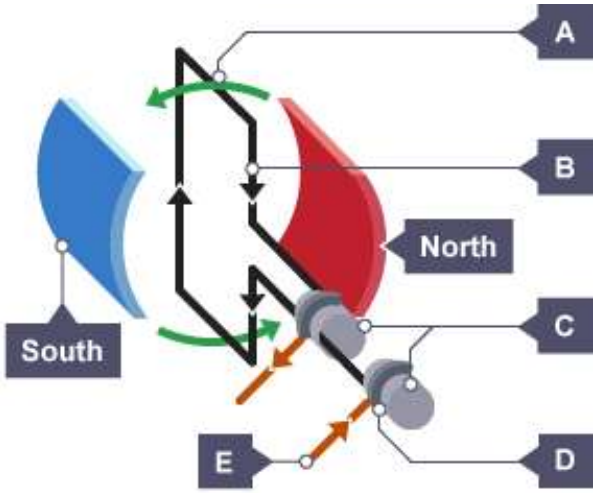
This is best illustrated in terms of a generator.

A magnet and a coil of wire can be used to produce an electric current.

A voltage is produced when a magnet moves into a coil of wire. This process is called electromagnetic induction . The direction of the induced voltage is reversed when the magnet is moved out of the coil again.

It can also be reversed if the other pole of the magnet is moved into the coil.

Electromagnetic Induction



A	The coil is rotated in the magnetic field
B	Current is induced in the rotating coil
C	Slip rings connected to the coil
D	Brushes make continuous contact between the external circuit and the slip rings
E	Current flows in external circuit

When a wire is moved in the magnetic field of a generator, the movement, magnetic field and current are all at right angles to each other.
If the wire is moved in the opposite direction, the induced current also moves in the opposite direction.

In a generator, one side of a coil moves up during one half turn and then down during the next half turn.

This means that as a coil is rotated in a magnetic field, the induced current reverses direction every half turn.

This is called alternating current (a.c.).

It is different from the direct current (d.c.) produced by a battery, which is always in the same direction.