

MAGNETIC EFFECTS OF ELECTRIC CURRENT

Permanent Magnets

- A solid of any shape or size which can attract pieces of materials like iron, cobalt, nickel is called magnet.

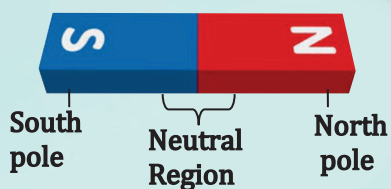
Magnetic poles

- The parts of a magnet where the magnetic force is strongest are called the magnetic poles.
All known magnets have two poles, a north pole and a south pole.



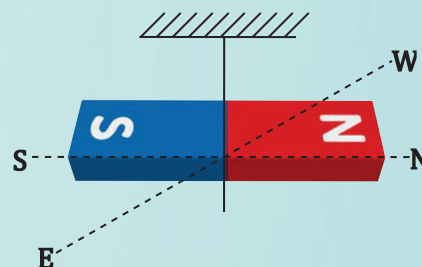
Properties of a magnet

Attractive nature



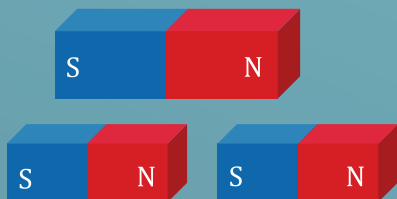
- A magnet has maximum attracting power at poles and minimum at center

Directive property



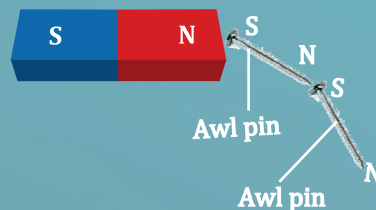
- A freely suspended bar magnet always points towards north and south direction

C Poles exist in pairs



- A magnet always have two poles north and south pole

C Inductive nature



- When magnetic material comes in contact with magnet, it also get attractive property of magnet

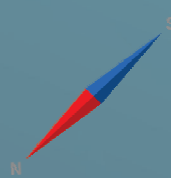
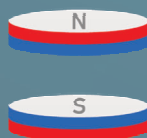
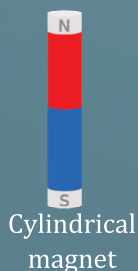
C Natural Magnets

Natural occurring minerals or ores having magnetic properties are called 'natural magnets'. Due to their irregular shapes and weak attracting power, natural magnets are rarely used now a days.

Types Of Magnets

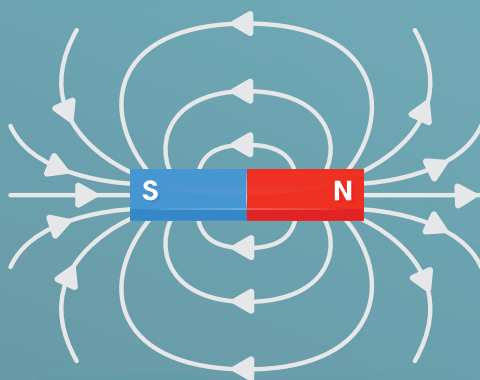
C Artificial Magnets

Now a days pieces of iron and many other materials of suitable shapes and sizes are made as magnets. Such magnets are called artificial magnets



Magnetic field

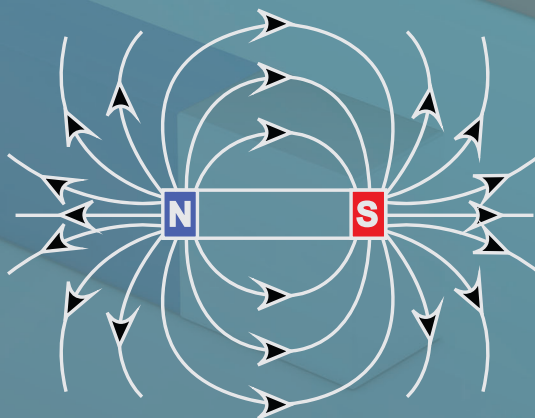
A region of influence surrounding a magnet, in which other magnets or materials like iron are affected by magnetic forces is called 'magnetic field'.



BAR MAGNET

Magnetic field lines

Magnetic field lines represent the magnetic field of a magnet. These lines describe the direction of the magnetic force.



Uses of magnets and electromagnets

- ◆ They are used in radio and stereo speakers.
- ◆ They are used in almirah and refrigerator doors to keep them in closed position.
- ◆ They are used on video and audio cassette tapes.
- ◆ They are used on the hard discs and floppies for computers.
- ◆ They are used in different children's toys.

Electric current as a source of magnetism

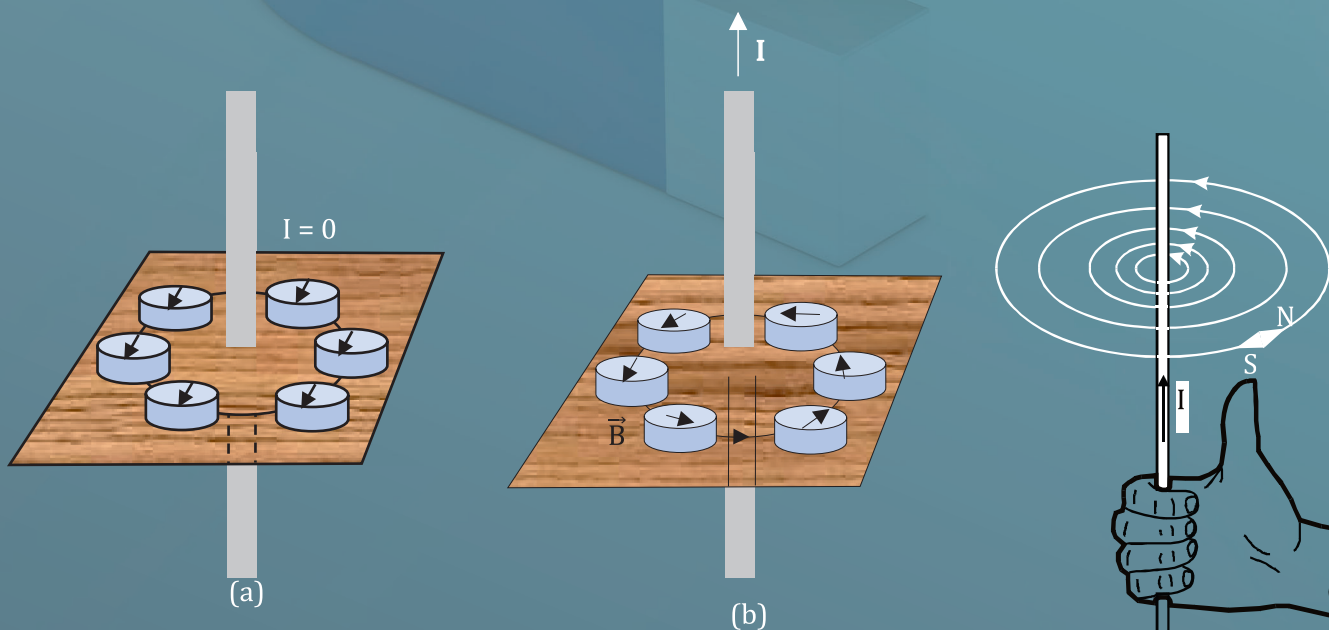
- C** Apart from permanent magnets, electric current is also a source of magnetism. Oersted, by performing experiments, concluded that 'moving charges or electric currents produce a magnetic field in the surrounding space'.

Magnetic field due to a current-carrying straight conductor

- C** The magnetic field lines around a straight current-carrying conductor are concentric circles with the conductor located at their centre. The plane of these concentric field lines is perpendicular to the conductor.
- 'moving charges or currents produce a magnetic field in the surrounding space'.

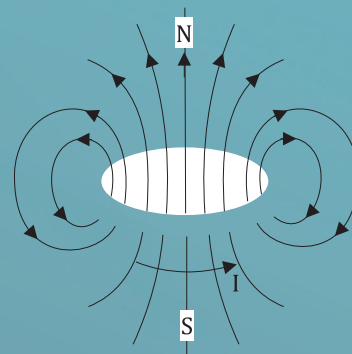
Right hand thumb rule

'Imagine that you are holding a current-carrying straight conductor in your right hand and the thumb is stretched along the direction of current, then your fingers will wrap around the conductor in the direction of the field lines of the magnetic field.'

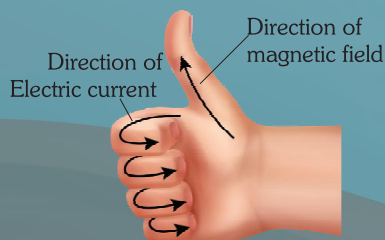


Magnetic field due to a current-carrying circular loop

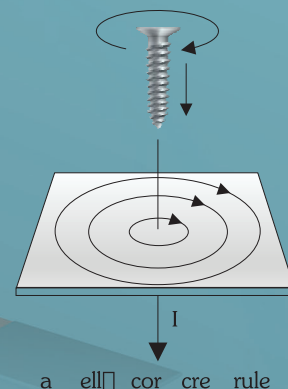
- Let us take a conducting wire in the form of circular loop and an electric current is flowing through it. At every point of the loop, the magnetic field lines are in the form of concentric circles surrounding the loop.



- The right hand thumb rule is also called Maxwell's corkscrew rule (or right hand screw rule). If a right-handed screw moves forward in the direction of the conventional current then the direction of rotation of the screw gives the direction of the magnetic field lines.



Right hand rule for a current carrying circular loop

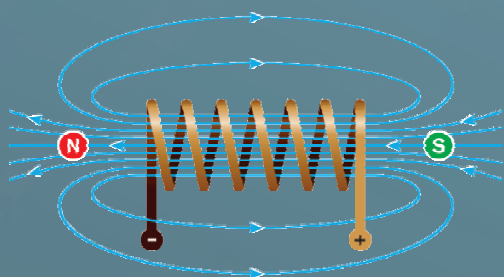


Maxwell's corkscrew rule

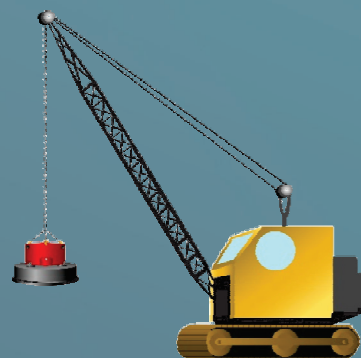
Magnetic field of a current-carrying solenoid

If a long, straight conducting wire is bent into a coil of several closely spaced loops, the resulting device is a solenoid. This device acts as a magnet only when it carries a current.

A solenoid is a long insulated wire wound in the form of a helix where neighbouring turns are closely spaced.



Magnetic field due to a solenoid



A Crane using electromagnets.

Force on current-carrying conductor in magnetic field

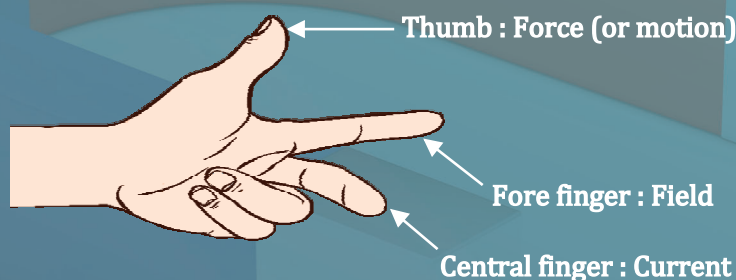
An electric current flowing through a conductor produces a magnetic field in a surrounding space and exerts a force on a magnet placed near it. French scientist Andre Marie Ampere suggested that the magnet must also exert an equal and opposite force on the current-carrying conductor.

- **Magnetic force on a current-carrying straight conductor is given by,**

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

- **Fleming's left-hand rule**

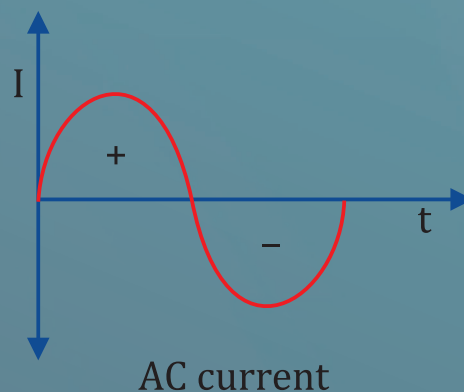
According to this rule, 'stretch the thumb, forefinger and central finger of your left hand such that they are mutually perpendicular. If the fore finger points in the direction of magnetic field and the central finger in the direction of current, then the thumb will point in the direction of motion or the force acting on the conductor.'



Alternating current (AC)

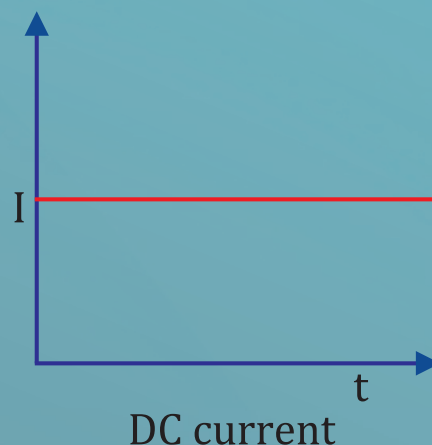
- The electric current, whose magnitude varies with time and direction reverses periodically, provided its amplitude is constant is called 'alternating current'.

In India, the frequency of AC is 50 Hz.



Direct current (DC)

- The electric current, whose magnitude and direction do not vary with time is called 'direct current'. Usually DC is produced by a cell or a battery. The frequency of pure DC is zero always.



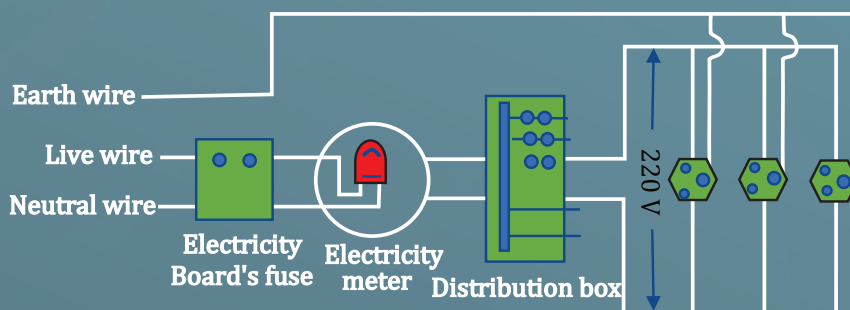
Advantages of AC over DC

- AC voltages can be easily increased (step up) or decreased (step down) with the help of transformers.
- Long distance transmission takes place at high voltage (i.e., less current) to minimise heat losses. This is done easily by using AC voltage because an AC voltage can easily be increased by using a transformer.
- The cost of generation of AC is less than that of DC.
- AC devices are simple, robust and require less care as compared to DC devices.

Disadvantages of AC over DC

- AC is more dangerous than DC.
- A device operating at 220 V AC has to sustain a peak value of approximately 310 V.
- For processes like electrolysis or electroplating, AC cannot be used, only DC can be used.

Domestic electric circuits



A domestic electric circuit.

Domestic electric circuits

(1) One wire of power supply is called live wire (or positive) which has usually a red insulation cover. wire, with black insulation cover is called neutral wire (or negative).

Overloading

Overloading is a condition in which excessively high current flows through a circuit.

Overloading can occur in many ways :

(1) When the live wire and the neutral wire come into direct contact, the resistance in the circuit becomes very low and the current in the circuit abruptly increases.

This is called short-circuiting..

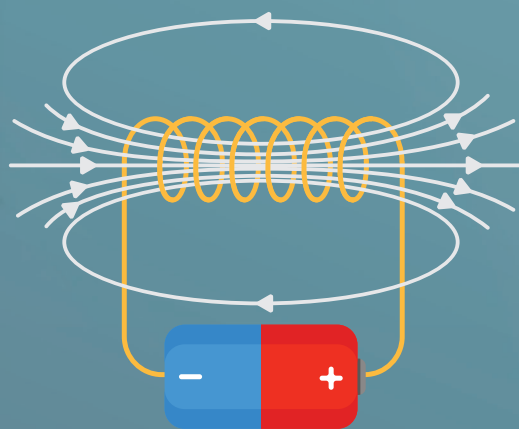
(2) Overloading can also occur due to an accidental hike in the supply voltage.

(3) Sometimes, overloading is caused by connecting too many devices to a single socket.

An electric fuse prevents the electric circuit and the appliance from a possible damage by stopping the flow of unduly high electric current.

Electromagnet

An electromagnet is a coil of wire wrapped around a soft iron core. When an electric current flows through the coil, it creates a magnetic field.



● Factors affecting strength of electromagnets

► Current in the coil

The greater the current flow, the greater the field strength. Strength varies directly as the current in the coil.

▶ **Number of turns in the coil**

The greater the number of coils, the greater the field strength.

▶ **Size of coil**

The smaller the diameter of the coil, the stronger the magnetic field.

▶ **Type of material in the coil or solenoid**

The more ferromagnetic the material within the coil, the greater the magnet's strength. Iron is one of the best materials to use.

