Magnetic Effects of Electric Current - Notes

Notes Previous Years Questions Important Questions

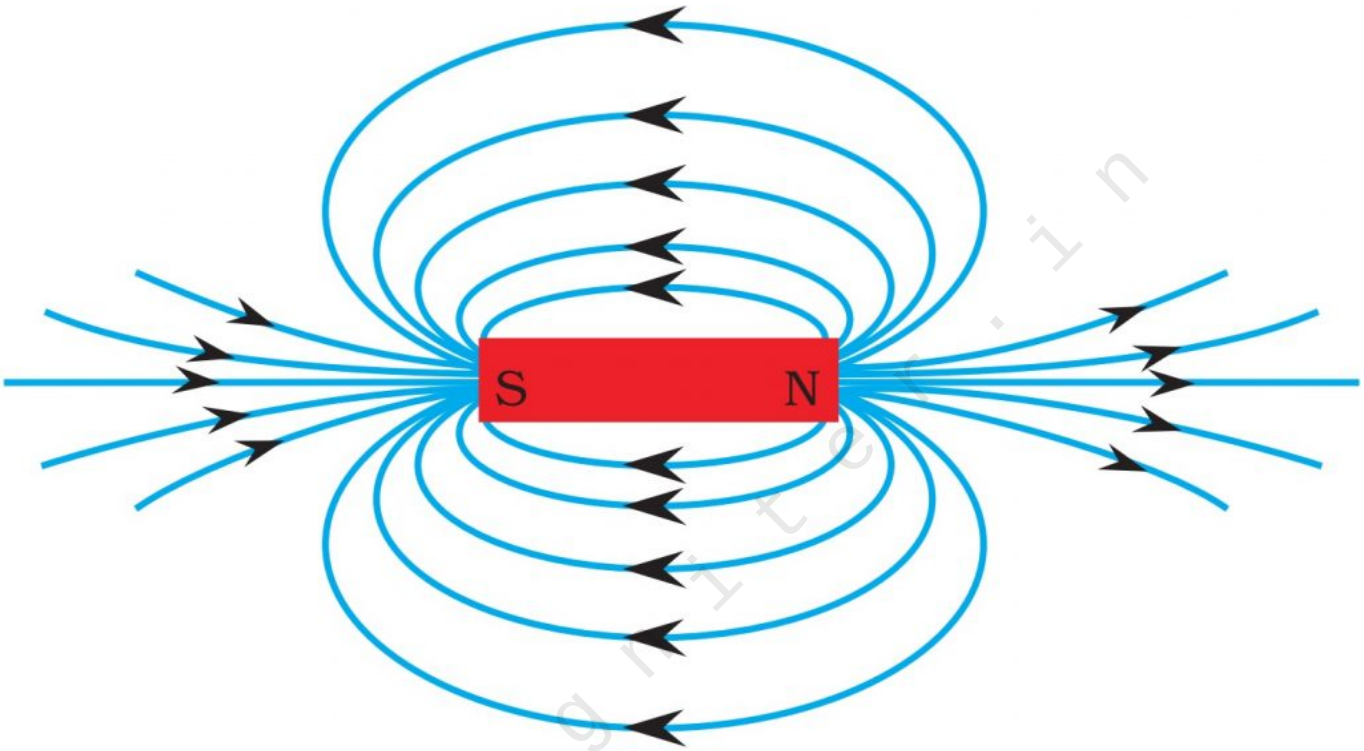
Magnetic Effects of Electric Current - Notes

Magnetic Field:- The reason surrounding the magnet in which the force of magnet can be detected is said to have magnetic field.

- S.I. unit:- **Tesla**
- It is a **vector** quantity.

Magnetic Field Lines:- The magnetic field lines are the lines drawn in a magnetic field along which a north magnetic pole of magnetic compass would move.

Or, If some iron filings are sprinkled uniformly in a magnetic field then the lines along which the iron filings align themselves represent magnetic field lines.



Properties of Magnetic Field Lines:-

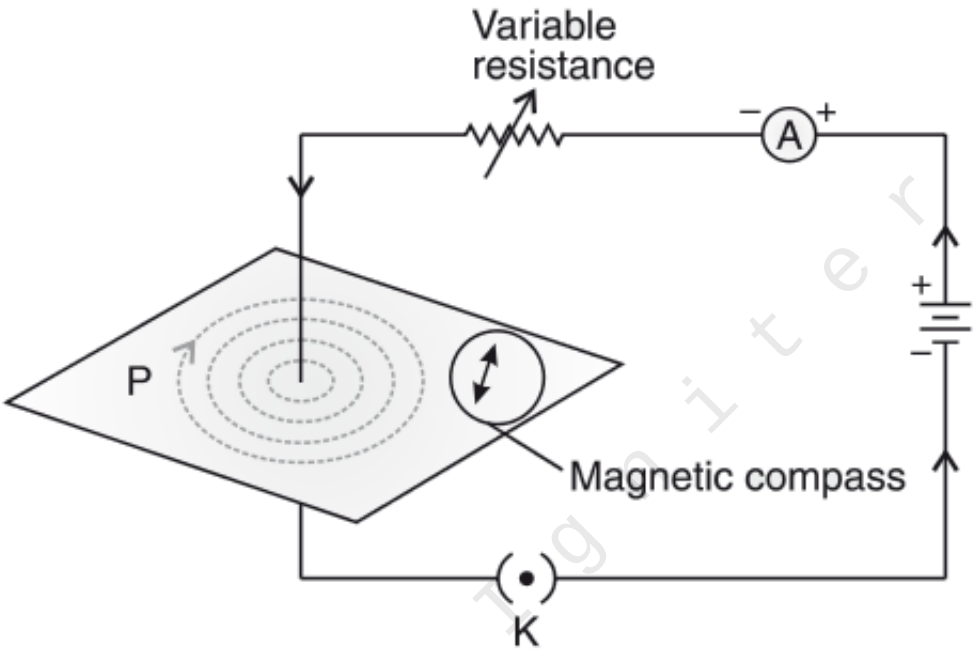
- Magnetic field lines are closed curves.
- Outside the magnet, the direction of magnetic field lines is from north pole to south pole and inside the magnet, south pole to north pole.
- The degree of closeness of magnetic field lines shows the relative strength of magnetic field.
- The two magnetic field lines never intersect each other.

Note:- The two magnetic field lines never intersect each other because if they did, it would mean that at the point of intersection the compass needle would point towards two directions, which is not possible.

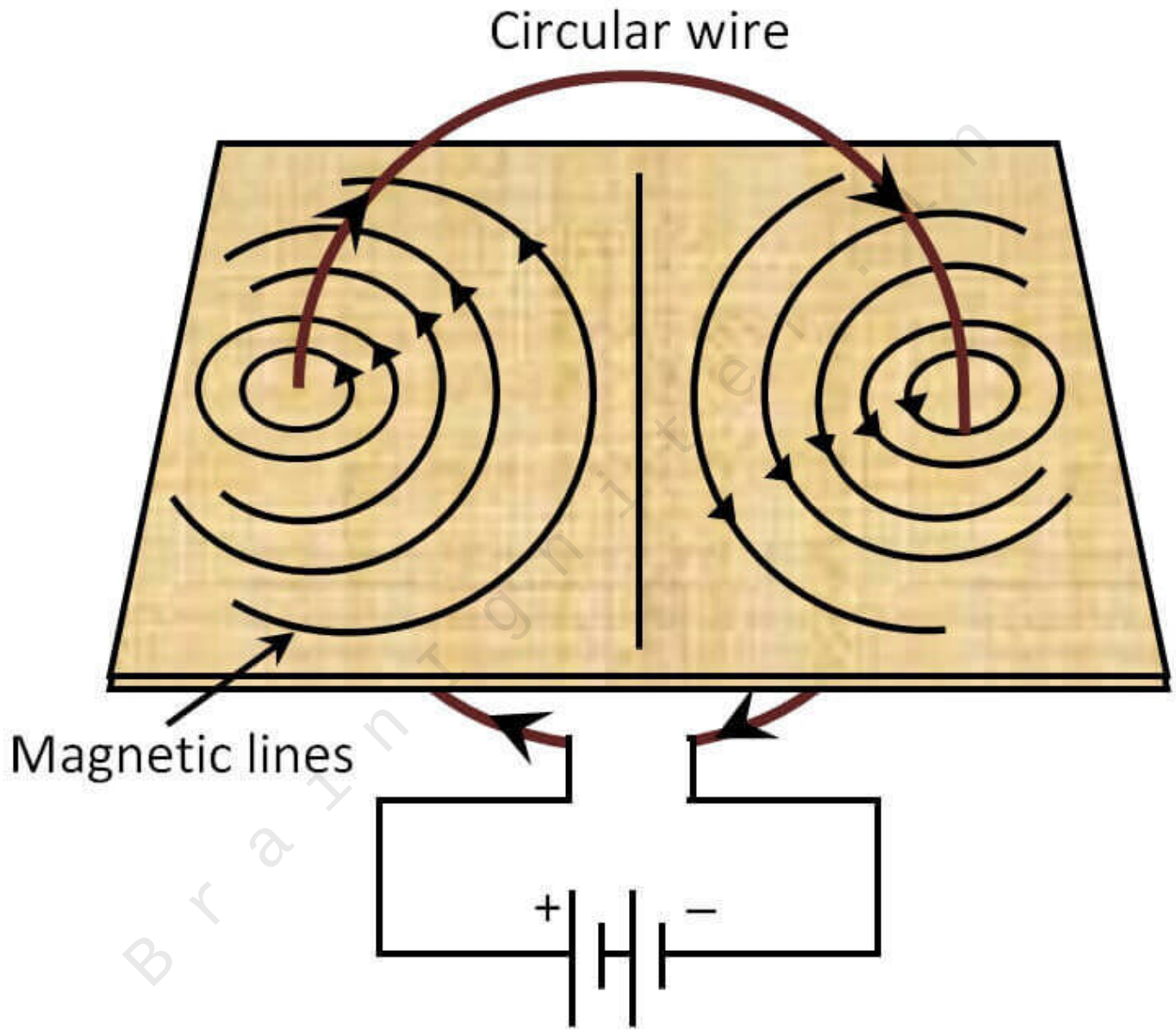
Factors on which magnetic field due to a current carrying straight conductor depends are:-

- **Amount of current:-** The magnitude of magnetic field at a point increases on increasing the amount of current and vice-versa.
- **Distance from the conductor:-** The magnitude of magnetic field decreases as the

distance from the conductor increases and vice-versa.

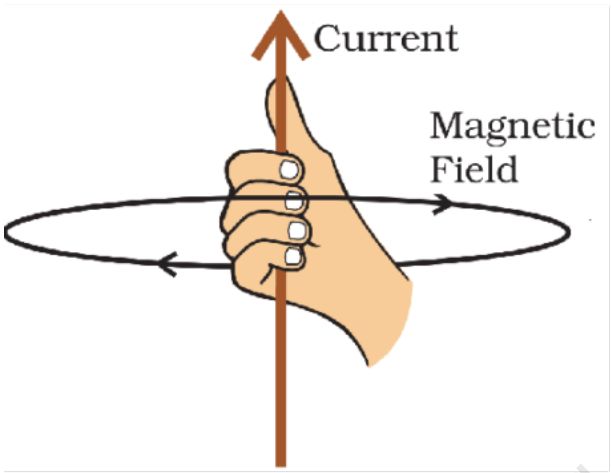


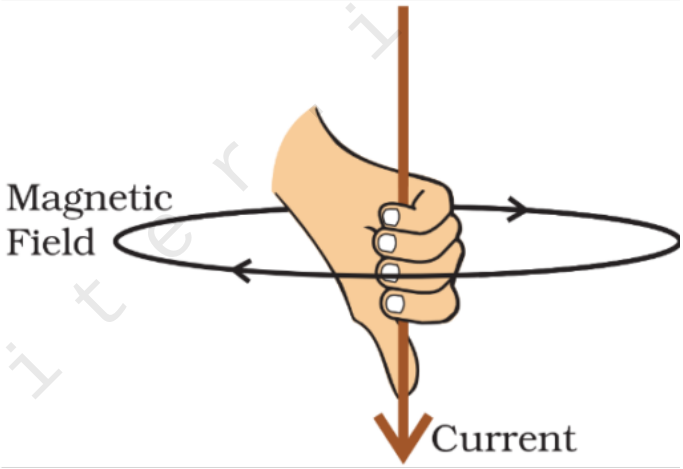
Note:- In a **circular coil**, magnitude of magnetic field also depends on **number of turns**.



Right-Hand Thumb Rule:- If we consider ourselves holding a current carrying straight conductor in the right hand such that the thumb points towards the direction of current, then the fingers wrapped around conductor show the direction of magnetic field lines.

Maxwell's Right Hand Thumb Rule



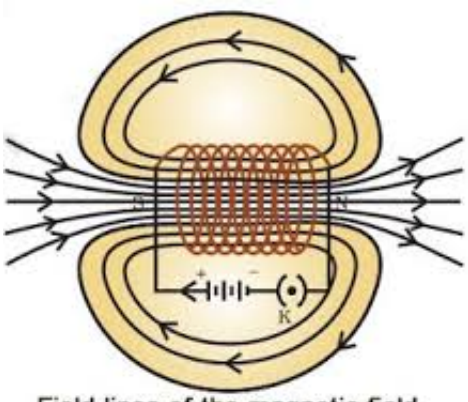


Maxwell's Corkscrew Rule:- If we consider ourselves driving a corkscrew in the direction of the current then the direction of corkscrew is the direction of magnetic field lines.

Properties of magnetic field lines due to a current carrying straight conductor:-

- They are concentric circles.
- The magnetic field lines are plane perpendicular to the conductor.

Solenoid:- A coil of many circular turns of insulated copper wire wrapped closely in the shape of a cylinder is called a solenoid.



Field lines of the magnetic field through and around a current carrying solenoid.

Note:-

- The magnetic field lines inside a solenoid are in the form of parallel straight lines.
- The magnitude of magnetic field is same at every point inside the solenoid.
- Solenoid is used in electromagnets, inductors etc.

Electromagnet:- The magnet formed by placing a magnetic material like soft iron core inside a solenoid is called an electromagnet.

Note:- When a current carrying conductor is placed in a magnetic field, it experiences a force.

Fleming's Left Hand Rule:- According to this rule, stretch the thumb, fore finger and middle finger of left hand such that they are mutually perpendicular. If the fore finger points in the direction of magnetic field and middle finger in the direction of current then the thumb will point in the direction of motion or force.

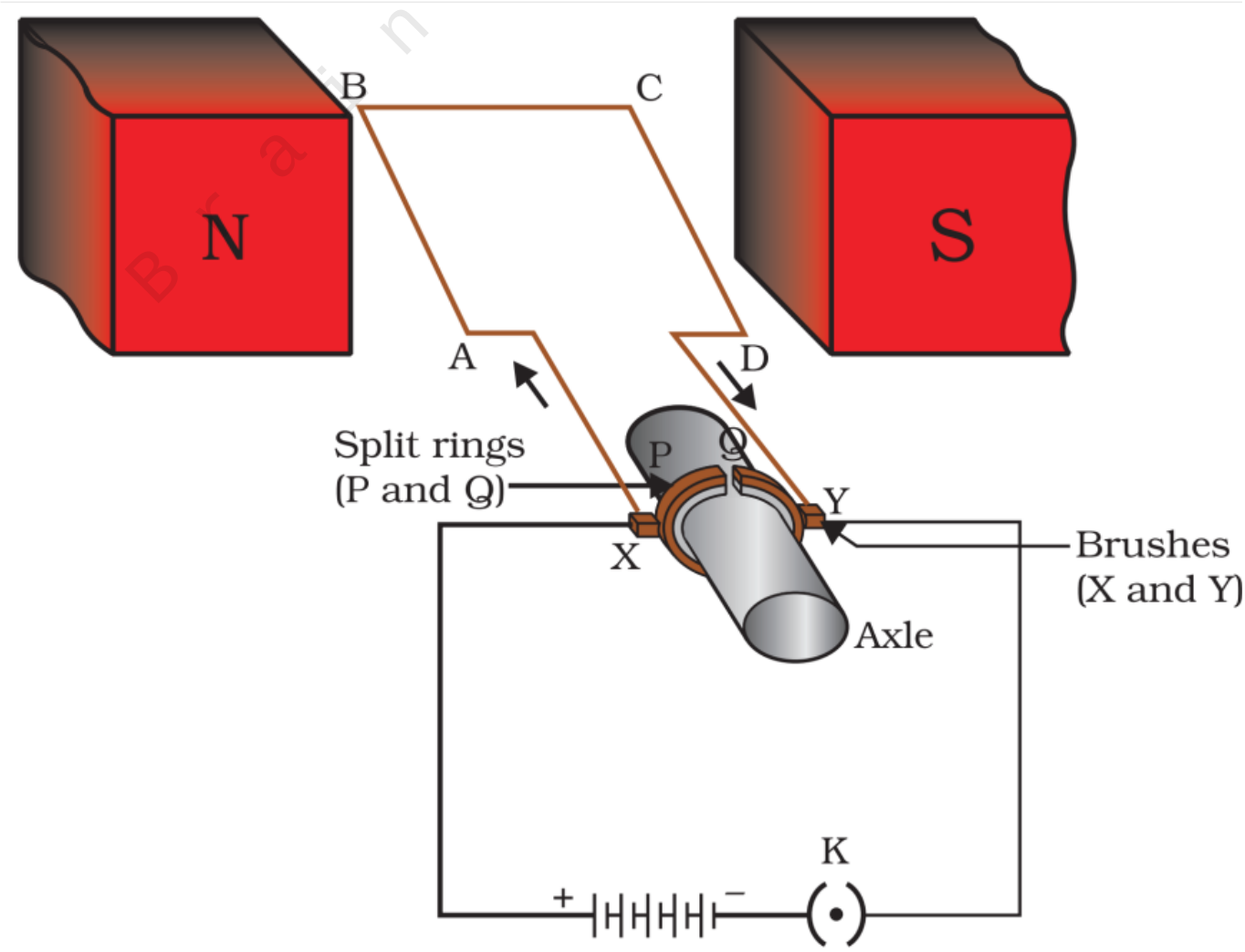
Note:- The devices that use current carrying conductor and magnetic field are electric motor, electric generator, loudspeakers, microphones and measuring instruments.

Electric Motor:- An electric motor is a rotating device that converts electrical energy to mechanical energy.

Principle:- It is based on the principle that when a current carrying conductor is placed in a magnetic field perpendicular to it, it experiences a force.

Construction:- Consider a rectangular coil ABCD placed in a magnetic field such that AB and CD are perpendicular to the direction of magnetic field. The ends of coil are connected to two halves split rings. The inner sides of split rings are insulated and attached to an axle. The external conducting edges of split rings touch two carbon brushes. The opposite sides of brushes are connected with battery and key as shown in figure.

Electric Motor



Working:- According to the figure, the current in the coil ABCD enters from brush X. Since current carrying coil ABCD is placed in a magnetic field perpendicular to it. So by Fleming's left hand rule, we can say that AB moves in downward and CD moves in upward direction. In next half rotation, CD comes towards north pole and AB comes towards south pole. Again by applying Fleming's left hand rule, we see that AB moves in upward and CD moves in downward direction. This process continues and the coil starts rotating.

Commutator:- A device that reverses the direction of flow of current through a circuit is called a commutator.

Note:- In electric motor, split rings act as commutator.

Armature:- The soft iron core, on which the coil is wound, plus the coils is called an armature.

In commercial motors,

- an electromagnet is used in place of permanent magnet.
- large number of turns of coil is used.
- a soft iron core is used on which the coil is wound.

Uses of Electric Motor:- It is used in electric fans, refrigerator, mp3 player, washing machine etc.

Electromagnetic Induction:- When the magnitude of magnetic field is changed around a conductor then, a current is induced in it. This phenomenon is called electromagnetic induction.

Fleming's Right Hand Rule:- According to this rule, stretch the thumb, forefinger and middle finger of the right hand so that they are mutually perpendicular. If the forefinger indicates the direction of magnetic field and the thumb shows the direction of motion of conductor, then the middle finger will show the direction of induced current.

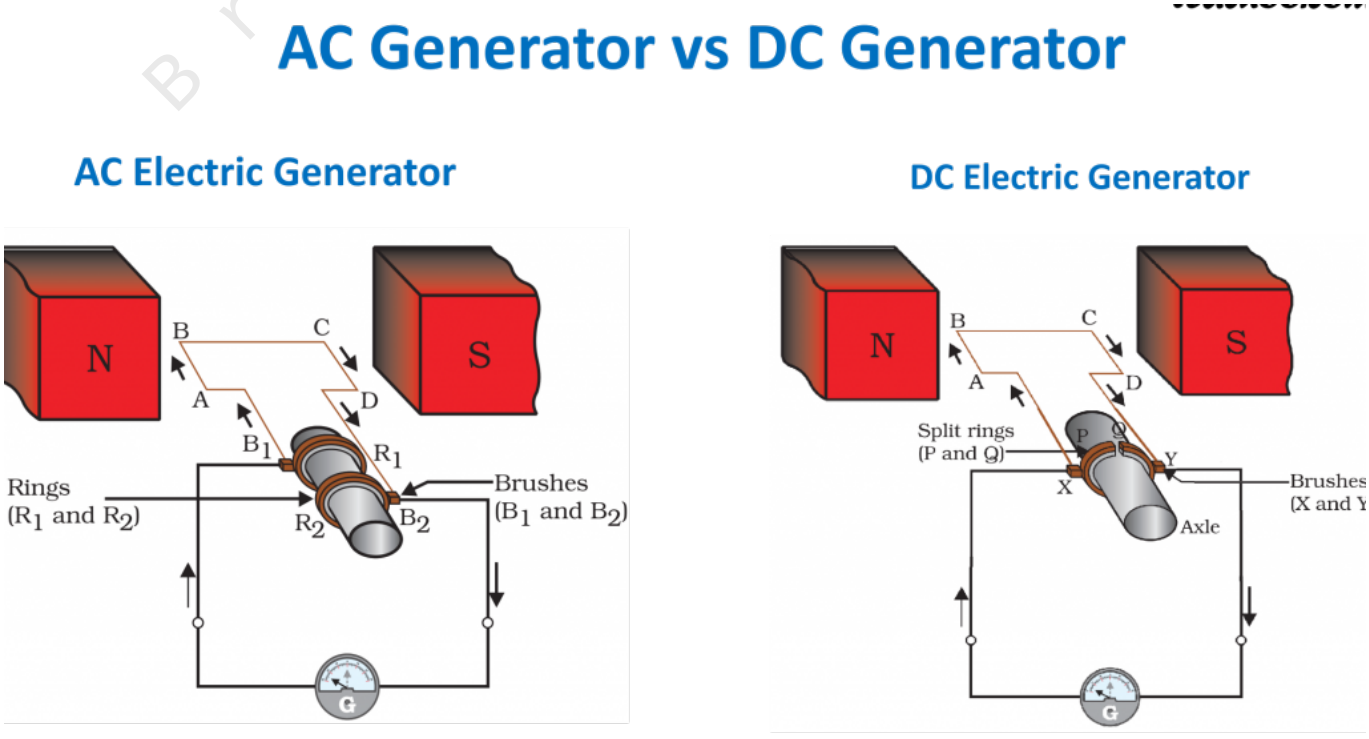
Galvanometer:- It is an instrument that can detect the presence of current in a circuit.

Electric Generator:- An electric generator is a device that converts mechanical energy to electrical energy.

Principle:- It is based on the principle of electromagnetic induction.

Construction:- Consider a rectangular coil ABCD placed in a magnetic field such that AB and CD are perpendicular to the direction of magnetic field. The ends of coil are connected to two rings. The inner sides of rings are insulated and attached to an axle. The external conducting edges of rings touch two carbon brushes. The opposite sides of brushes are connected with galvanometer to show the flow of current as shown in figure.

Note:- In AC generator, two complete rings are used while In DC generator split rings type commutator is used.



Working(AC Generator):- When the armature coil ABCD is rotated such that AB moves up and

CD moves down in the magnetic field. By Fleming's right hand rule the direction of induced current is from A to B and C to D. This means that the current in external circuit is clockwise. In next half rotation, CD moves up and AB moves down. By Fleming's right hand rule, the direction of induced current is from D to C and B to A and the current in external circuit is anticlockwise. This process continues and an alternating current is produced.

Difference between AC and DC:-

S. No.	AC	DC
i.	AC changes its direction after each half rotation.	DC doesn't change its direction.
ii.	Loss of electrical energy is very less.	Loss of electrical energy is more.
iii.	AC is preferred to transmit electric power over long distances.	It is not preferred to transmit power over long distances.

In India:-

- Frequency of AC is 50 Hz.
- AC changes its direction after every 1/100 sec.
- Potential difference is 220 V.

Use of earth wire in electric circuit:- Earth wire is used as a safety measure for the appliances having metallic body. The metallic body is connected to the earth wire that ensures that any leakage of current to the metallic body gets transferred to the earth and the user may not get a severe electric shock.

Fuse:- A fuse is a safety device that prevents damage to the appliances and the circuit due to overloading.

- It is based on the principle of heating effect of electric current.

Causes of Overloading:-

- Due to the direct contact of live wire and neutral wire
- Due to sudden increase in supply voltage
- Due to connecting too many appliances in a single socket

Short Circuit:- When the live wire and neutral wire come in direct contact, the current in the circuit increases abruptly. This is called short circuiting.