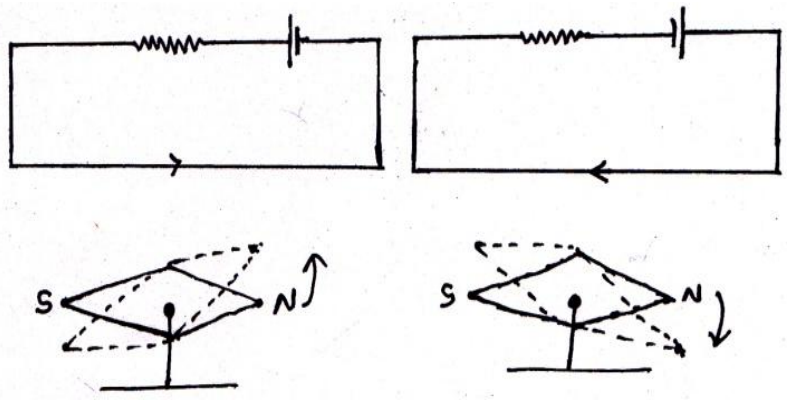
1. Electromagnetism

The branch of physics which deals with the study of magnetism due to electricity is called electromagnetism. The relationship between electricity& Magnetism was firstly given by Oersted which is as below

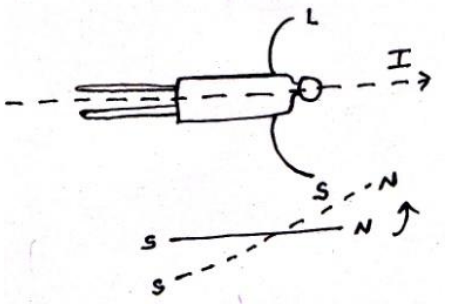
2. Oersted experiments:-

As shown in fig, Oersted found a relation between current & magnetism, when a magnetic niddle is placed parallel to direction of flow of current then the niddle suffer a deflection, when the direction of flow of current is reversed then the deflection is also reverses, the direction of deflection can be given by Ampere's swimming rule.



3. Ampere's swimming rule:-

According to this rule, if we assume that a man is swimming in direction of flow of current, such that current is flowing from his feet to head then the north pole of niddle will deflect towards his left hand.



Question1: Why does a compass needle get deflected when brought near a bar magnet?

Answer: Magnetic compass needle and bar magnet both have magnetic field. When they brought near to each other, these magnetic fields interact each other giving deflection in needle.

4. Magnetic field:-

The space around a magnet or a current carrying conductor in which its magnetic effect can be experienced is called magnetic field. It is a vector quantity & denoted by $\vec{B}$.

So $F_m = q v B \sin\theta$

Unit of magnetic field B: SI unit of B is Tesla or Weber/metre^2

5. Properties of Magnetic Field:

- The magnitude; of magnetic field increases with increase in electric current and decreases with decrease in electric current.
- The magnitude of magnetic field; produced by electric current; decreases with increase in distance and vice-versa. The size of concentric circles of magnetic field lines increases with distance from the conductor, which shows that magnetic field decreases with distance.
- Magnetic field lines are always parallel to each other.
- No two field lines cross each other.

6 Magnets and Magnetism :-

An iron ore [***black iron oxide*** **(Fe_3O_4)]** also called ***magnetite*** having the property of attraction of small piece of iron, nickel, cobalt etc is called a magnet & its property of attraction is called magnetism.

7 Artificial magnets:-

The natural magnet is weak in strength. So some artificial magnets are formed by the help of iron & some other magnetic materials. These may be of different shapes as

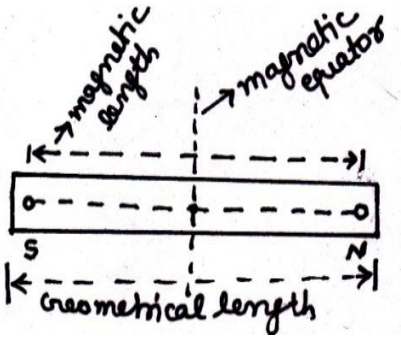
1. Bar magnet: - A magnet in the shape of bar.
2. Magnetic needle: - It is a needle made of magnetic material can rotate at its center.
3. Horse shoe magnet: - A magnet having shape like shores shoe.
4. Ball ended magnet: - A thin bar whose ends are circular.

8 Basic properties of magnet:-

1. *Attractive property:* - Magnet attracts small piece of iron nickel, etc.
2. *Directive property:* - Magnets rest in North south direction when suspended freely.
3. *Magnetic poles always exist in pairs;* a single North or South Pole may not exist.
4. Like pole repel each other & unlike pole attract each other.
5. *Magnetic induction:*-A magnetic substance becomes magnetized when placed near to a magnet this property is called magnetic induction.

9 Some basic definitions connected with magnetism:-

1. Magnetic field: - The space around a magnet in which its magnetic effect can be experienced is called its magnetic field.
2. Magnetic poles: - The region in a magnet where magnetic force is maximum is called magnetic poles.
3. Magnetic axis: - The line passes through the poles of a magnet is called magnetic axis.
4. Magnetic equator: - The line passes through the centre of magnet & perpendicular to magnet axis is called magnetic equator.
5. Magnetic length: - The distance between the two poles of a magnet is called magnetic length.



10 Magnetic dipoles & magnetic dipole moment:- m.imp

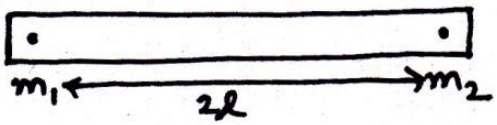
Magnetic dipoles: -

An arrangement of two equal & opposite poles separated by a small distance is called magnetic dipole.

Magnetic dipole moment:-

The product of either pole of a magnetic dipole & the distance between the poles is called magnetic dipole moment represented by m .It is a vector quantity having direction from South to North.

I,e. $\vec{M} = m \times 2\vec{l}$



S.I unit: Ampere metre^2.

11 Magnetic field lines:-

The path along which a hypothetical unit north pole moves gives the magnetic lines of forces. The tangent drawn at any point of the line gives the direction of magnetic field at that point.

Properties:-

1. The magnetic lines of forces move from South to north inside the magnet & North to south outside the magnet.
2. Magnetic lines of forces do not intersect each other.

3. The starts & end normally to the surface.
4. Closer the magnetic lines of forces, stronger are the magnetic field.
5. Electrostatic field lines originate at a positive charge and terminate at a negative charge or fade at infinity. Magnetic field lines always form closed loops.

Question 2: Why don't two magnetic lines of force intersect each other?

Answer: No two field-lines are found to cross each other. If they did, it would mean that at the point of intersection, the compass needle would point towards two directions, which is not possible**.**

12 Classification of magnetic materials:-

There may be three types of magnetic materials

1. Diamagnetic substances:-

   Those substances which are feebly (weakly) repelled by external magnetic field are called diamagnetic substance. E.g. -> Hg, H_2O, Av, Cu, Diamond, Zn, Quartz, Antimony, Bismuth, Air, H, N_2, All inert gasses etc.

2. Paramagnetic Substances:-

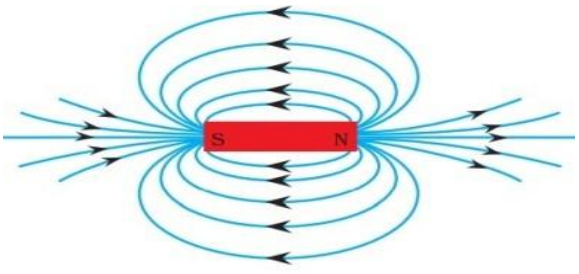
   Those substances which are feebly attracted by external magnetic field are called paramagnetic substances. E,g:-Al, Cr, Mn, Li, Mg, Na, K, O_2, etc.

3. Ferromagnetic substances:-

   Those substances which are strongly attracted by the external magnetic field are called ferromagnetic substances e.g. Fe, Ni, Co, etc.

Question 3: Draw magnetic field lines around a bar magnet.

Answer: The magnetic field line around a bar magnet is from north to south outside the magnet and from south to north inside the bar magnet. Magnetic field line forms close loop around a magnet.

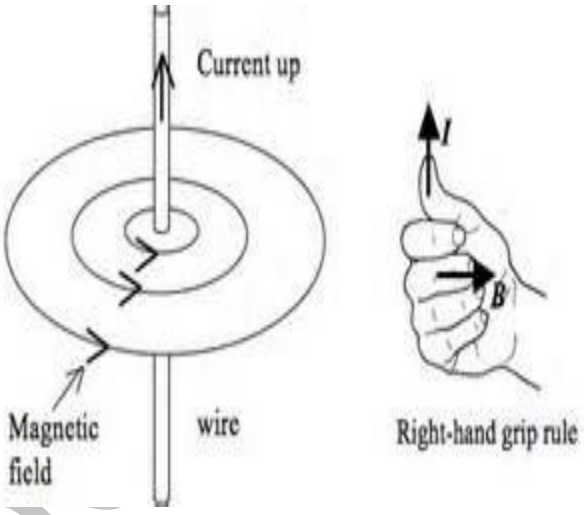


Field lines around a bar magnet

13 Magnetic Field due to Current through a Straight Conductor

Let a current carrying conductor be suspended vertically and the electric current is flowing from south to north. In this case, the direction of magnetic field will be anticlockwise. If the current is flowing from north to south, the direction of magnetic field will be clockwise.

A current carrying straight conductor has magnetic field in the form of concentric circles; around it. Magnetic field of current carrying straight conductor can be shown by magnetic field lines.



Magnitude of magnetic force depends upon three factors:

(1) $F \propto I$ (current I flowing in the rod)

(2) $F \propto B$ (Strength of magnetic field B)

(3) $F \propto l$ (Length of the rod l)

Where K is a constant and its value in SI unit is 1.

So, $F = IBl$

Question 4: When is the force experienced by a current–carrying conductor placed in a magnetic field largest?

Answer: The force experienced by a current-carrying conductor placed in a magnetic field is largest when the current-carrying conductor is placed in a direction perpendicular to that of magnetic field**.**

Question5: Which of the following correctly describes the magnetic field near a long straight wire?

(a) The field consists of straight lines perpendicular to the wire.

(b) The field consists of straight lines parallel to the wire.

(c) The field consists of radial lines originating from the wire.

(d) The field consists of concentric circles centered on the wire.

Answer: (d) The field consists of concentric circles centered on the wire.

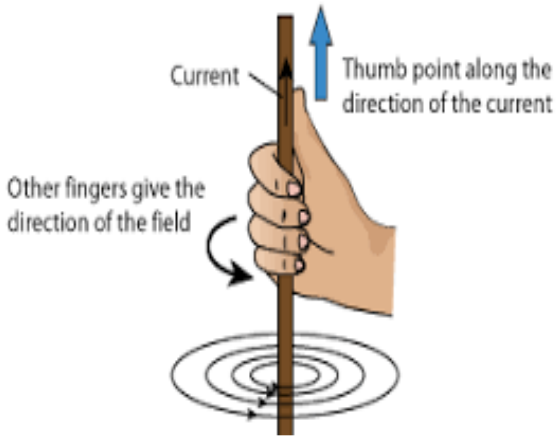
On applying right-hand thumb rule, we find the direction of magnetic field. The field is in the form of concentric circles centered on the wire carrying current.

Hence, the option (d) is correct

- A current carrying rod experiences a force when placed between two poles of strong magnets. The direction of force exerted on the rod is related with the direction of current.

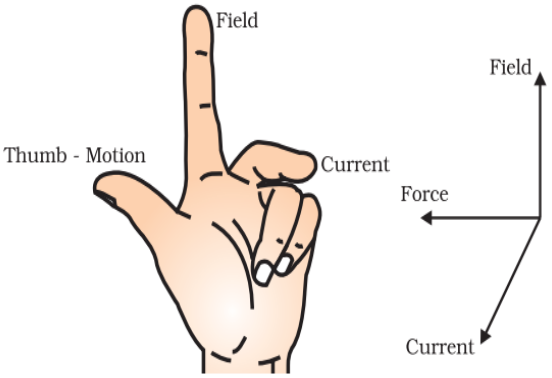
14 Right hand rule or right hand screw rules:-

According to right hand rule if we curl the finger of our right hand from $\vec{v}$ to $\vec{B}$ then thumb will give the direction of $\vec{F}_m$.



15 State Fleming's Left-Hand Rule.

Answer 1: According to Fleming's left-hand rule, stretch the thumb, forefinger and middle finger of your left hand such that they are mutually perpendicular. If the first finger points in the direction of magnetic field and the second finger in the direction of current, then the thumb will point in the direction of motion or the force acting on the conductor.



Fleming's left-hand rule

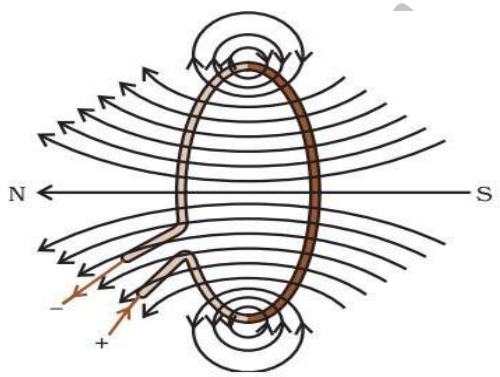
16 The direction of magnet field due to circular coil:- m.imp

As we can see the magnetic lies Form Close loop at the end of the circular coil & become straight line at the center of the loop. The direction of these magnetic lies can be given by Right hand rule.

Question 6: Consider a circular loop of wire lying in the plane of the table. Let the current pass through the loop clockwise. Apply the right-hand rule to find out the direction of the magnetic field inside and outside the loop.

Answer: The magnetic field lines have been shown in Figure given below. As per right- hand rule, we find that inside the loop, the magnetic field lines are directed perpendicular to the plane of paper in the inward direction. Outside the loop magnetic field lines are directed out of the plane of paper.

- The magnitude of the field lines produced by a circular loop at its centre is directly proportional to the amount of current



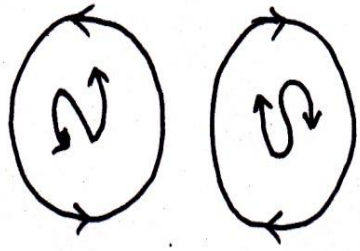
Magnetic field lines of the field produced by a current-carrying circular loop

17 **Right hand rule:-**

Suppose the current is flowing through a circular conductor, if we imagine the fingers of the right hand curling in the direction of current, then the thumb will point in the direction of magnetic field.

18 Clock rule:-

According to clock rule if current moves in anti clock wise direction, the upper face of loop or coil is behave as north pole & when current moves in clock wise direction, then upper face behave as south pole.



19 Solenoid:- m.imp

Solenoid means an insulated copper wire wounded closely in the form of a helix. The length of the solenoid is very large as compared to its diameter.

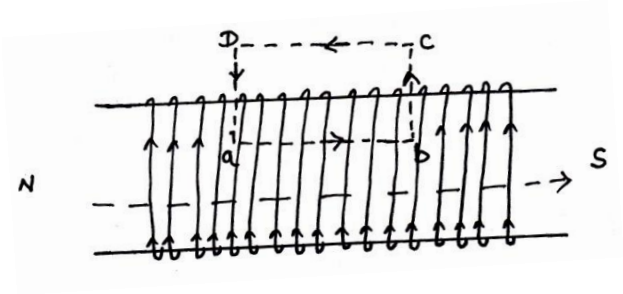
Calculation of magnetic field inside a long straight solenoid:-

If N is the number of turns in the length l,

then total current through the loop equal to NI.

The magnetic field due to a solenoid is $\mathbf{B} = \mu_0 nI$

Where n is the number of turns per unit length.



- Using R.H. Thumb Rule, we can draw the pattern of magnetic field lines around a current carrying 'Solenoid'.
- One end of the solenoid behaves as a magnetic north pole, while the other end behaves as the South Pole.
- The filed lines inside the solenoid are in form of parallel straight lines, that implies that magnetic field inside the solenoid is same at all points i.e. Field is uniform.

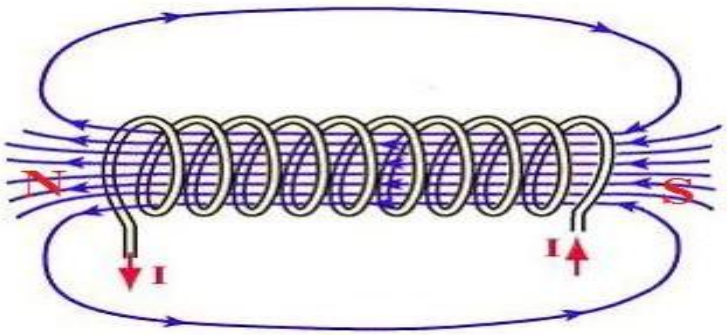
- The strength of the magnetic field produced by a current carrying a solenoid
  1. is directly proportional to the number of turns in the solenoid
  2. is directly proportional to the strength of the current in the solenoid
  3. depends upon the nature of the core material.

20 Electromagnet:

Strong magnetic field inside the solenoid can be used to magnetize a magnetic material for example soft iron, when it is placed inside the coil. The magnet so formed is called electromagnet. It is a temporary magnet.

Question 7 :How does a solenoid behave like a magnet? Can you determine the north and south poles of a current–carrying solenoid with the help of a bar magnet? Explain.

When current is passed through a solenoid coil, magnetic field produced due to each turn of solenoid coil is in the same direction. As a resu1t, the resultant magnetic field becomes very strong and uniform. The field lines inside the solenoid are in the form of parallel straight lines along the axis of solenoid. Thus, the solenoid behaves like a bar magnet. One end of solenoid behaves as a magnetic North pole while the other end behaves as the South Pole.



21 Toroid or Toroidal Solenoid:- m.imp

A solenoid bent into the form of a closed ring is called a Toroidal solenoid.

Question 8: List three sources of magnetic fields.

Answer: Three methods of producing magnetic field are as follows:

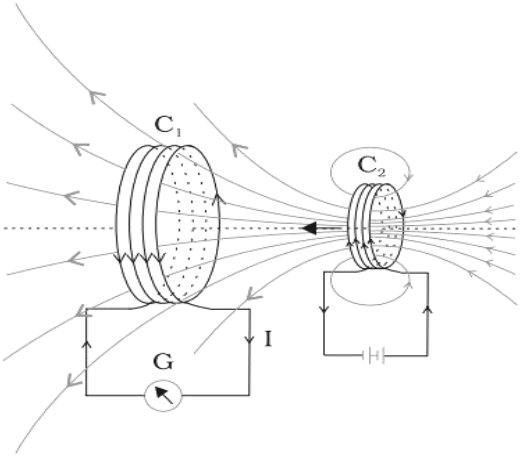
- Magnetic field can be produced by placing a permanent bar magnet or a horse-shoe magnet at the place, where magnetic field is required.
- Magnetic field is produced around a current-carrying straight conductor or a current carrying circular coil.
- A very good method to produce magnetic field is due to flow of current in a solenoid.

22 Electromagnetic Inductions:

The phenomenon of production of ***emf*** due to a change magnetic flux linked with a circuit is called electromagnetic induction. The generators and transformers are based on the principle of electromagnetic induction.

Question 9 : Explain different ways to induce current in a coil.

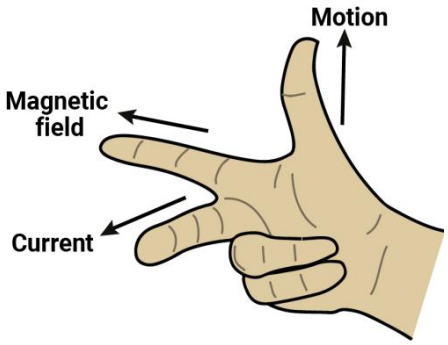
Answer: Different ways to induce current in a coil are as given below:



- If a magnetic field is changed around a coil then an induced current is set up in the coil. It can be done by taking a bar magnet and bringing it closer to the coil or taking it away from the coil.
- If a coil is moved in a magnetic field, then again an induced current is set up in the coil.
- If a coil is rotated in a uniform magnetic field, it may also produce an induced current in the coil.

23 Fleming's Right Hand Rule:-

According to right hand thumb rule, Stretch, thumb, forefinger, and middle finger of right hand, so that they are perpendicular to each other. The forefinger indicates direction of magnetic field, thumb shows the direction of motion of conductor, and then the middle finger will shows the direction of induced current.



24 Faradays laws of electromagnetic induction:

First Law:-

When the magnetic flux linked with the current changes, an emf is induces which remains till there is change in magnetic flux in circuit. This phenomenon is also called electromagnetic induction.

Second Law:-

According to this law, the emf induced in a circuit is directly proportional to rate of change of magnetic flux linked with the circuit.

Question 10: Two circular coils A and B are placed closed to each other. If the current in the coil A is changed, will some current be induced in the coil B? Give reason.

Answer: Yes, a current is induced in the coil B. When the current in the coil A is changed, the magnetic field associated with it also changes. As coil B is placed close to A, hence magnetic field lines around this coil also change. Due to change in magnetic field lines associated with coil B, an induced current is also induced in it.

Question 11: The phenomenon of electromagnetic induction is

(a) The process of charging a body.

(b) The process of generating magnetic field due to a current passing through a coil.

(c) Producing induced current in a coil due to relative motion between a magnet and the coil.

(d) The process of rotating a coil of an electric motor.

Answer :(c) producing induced current in a coil due to relative motion between a magnet and the coil.

In electromagnetic induction phenomenon an induced current begins to flow in a coil whenever there is change in magnetic field in and around a coil.

Hence, the option (c) is correct.

25 Advantages and Draw Back of AC Over DC:

Advantage of AC:

(i) It can be transmitted to a long distance.

(ii) It can be easily changed using transformer.

(iii) It can be easily changed into D.C.

(iv) Its magnitude can be easily changed using chock coil.

(v) It is easy and cheaper to generate.

Drawback of A.C.:

(i) It is more dangerous to work with AC then DC.

(ii) The shock of AC is attractive whereas that of DC is repulsive.

(iii) Several insulated wires are required to transmit AC.

- AC can be converted into DC by rectifier and DC can be converted into AC by inverter.

Question 12: Which sources produce alternating current?

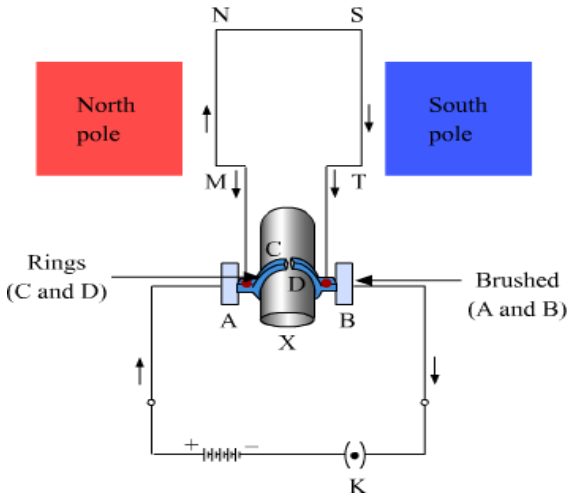
Answer: A.C. generator and invertors (used in house for emergency power supply) produces alternating current.

26 Electric motor:-

An electric motor is a rotating device that converts electrical energy into mechanical energy.

Motor principle:

The basic principle on which the electric motor works is the magnetic effect of current. A current carrying rectangular coil starts rotating when placed in a magnetic field.



Construction and Working:-

In an electric motor, a rectangular coil is suspended between the two poles of a magnetic field. The electric supply to the coil is connected with a commutator. Commutator is a device which

reverses the direction of flow of electric current through a circuit.

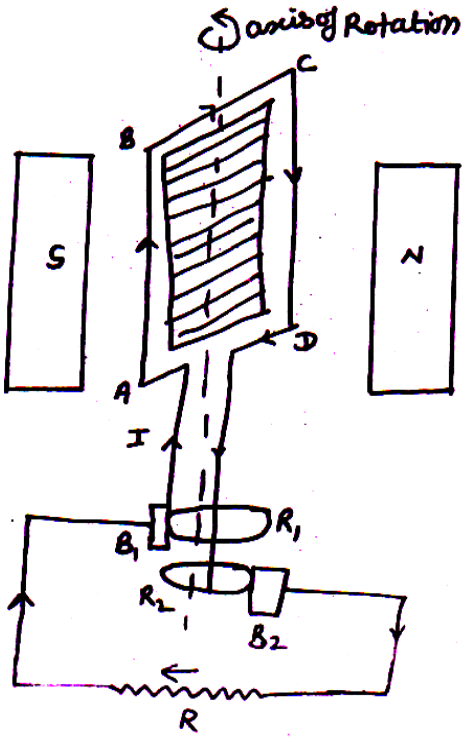
When electric current is supplied to the coil of electric motor, it gets deflected because of magnetic field. As it reaches the half way, the split ring which acts as commutator reverses the direction of flow of electric current. Reversal of direction of current reverses the direction of forces acting on the coil. The change in direction of force pushes the coil; and it moves another half turn. Thus, the coil completes one rotation around the axle. Continuation of this process keeps the motor in rotation.

In commercial motor, electromagnet; instead of permanent magnet; and armature is used. Armature is a soft iron core with large number of conducting wire turns over it. Large number of turns of conducting wire enhances the magnetic field produced by armature.

Question 13: Name some devices in which electric motors are used.

Answer :Electric motors are used in all such devices where we want to convert electrical energy into mechanical energy so as to drive that machine. In our houses, electric motors are being fitted in electric fans, coolers, air conditioners, mixer grinders, washing machines, refrigerators, juicers, computers etc. In factories, motors are used in almost all machines.

27 AC Generator or AC Dynamo:



It is a device which converts mechanical energy into electrical energy.

Principle:

It is based on the phenomenon of electromagnetic i.e. whenever amount of magnetic flux linked with the coil, and emf is induced in the coil.

Constructions:

The main parts of a AC generator are as shown in fig.

(i) Armature:-

A rectangular coil ABCD consist of large number of turn of insulated copper wire wounded over a soft core rotating at central axis called armature.

(ii) Field Magnet:-

A north and south pole of strong electromagnet is fixed $\perp$ to armature. It is of order of 1 to 2 Tesla.

(iii) Slip Rings:-

R_1 *and* R_2 Are two hollow metallic rings, to which two ends of armature coil are connected. These rings rotate with the rotation of coils.

(iv) Brushes:-

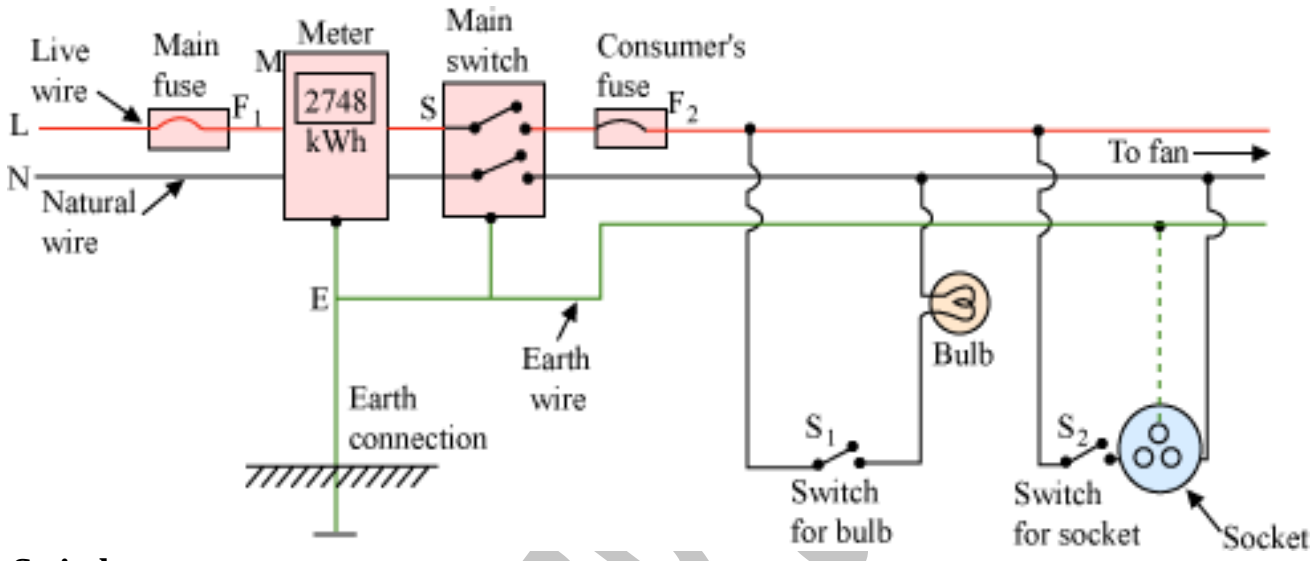
These are two flexible metal plates of carbon rod which are kept in light contact with R_1 *and* R_2. the purpose of brushes is to pass current from coil to external load resistance R.

Theory and Working:

When armature coil is rotated in the magnetic field, then angle θ between the field and normal to the coil changes continuously due to which magnetic flux linked with the coil changes continuously due to which emf is induced in the coil.

28 Domestic wiring:

Electricity is transferred to our homes through a pair of wires consists of a red color wire (called **live wire, L),** and a black color wire (called **neutral wire, N).** In addition to these wires, a green color wire known as the **Earth wire, E** is also connected with the circuit. In India, 220 V potential is supplied through live wire, while neutral wire has ground potential of zero volts.



29 Switches:

It is a device which is connected in the live wire so as to turn 'ON' or 'OFF' the current in the circuit.

Types of switches:

1) Single pole switch:

2) Double pole switch:

30 Fuse:-

Fuse is the most important safety device, used for protecting the circuit due to short-circuiting or overloading of the circuit.

Characteristic of electric fuse

- Fuse wire has low melting point. It is generally made up of an alloy of lead and tin.
- Fuse wire is always connected in the series with the live wire. Its resistance is higher than that of the copper wires. So it gets heated up much faster than the copper wire when excessive current flows through it.
- Current rating of the fuse wire decides its thickness. More the current rating of the fuse wire, more will be its thickness

Question 14: When does an electric short circuit occur?

Answer: If either the insulation of wires used in an electrical circuit is damaged or there is a fault in the appliance, live wire and neutral wire may come in direct contact. As a result, the current in the circuit abruptly rises and short-circuiting occurs.

Question15: What is the function of an earth wire? Why is it necessary to earth metallic appliances?

Answer: The metallic body of electric appliances is connected to the earth by means of earth wire so that any leakage of electric current is transferred to the ground. This prevents any electric shock to the user. That is why earthling of the electrical appliances is necessary.

Question16: Name two safety measures commonly used in electric circuits and appliances.

Answer 1: Two safety measures are:

- Use of earth wire and proper earthling.
- Use of fuse (now a day's fuse wire is replaced by MCB).

Question17: An electric oven of 2 kW power rating is operated in a domestic electric circuit (220 V) that has a current rating of 5 A. What result do you expect? Explain.

Answer: Power rating of electric oven P = 2 kW = 2000 W

Supply voltage V = 220 V

So, the current drawn by electric oven I=p/v as the current rating of domestic electric circuit is only 5 A and the oven draws a current 9 A, which is more than the current rating, hence the circuit will be damaged due to overheating/overloading.

Question18: What precaution should be taken to avoid the overloading of domestic electric circuits?

Answer: The precautions that should be taken to avoid the overloading of domestic circuits are as follows:

- Too many appliances should not be connected to a single socket.
- Too many appliances should not be used at the same time.
- Faulty appliances should not be connected in the circuit.
- Fuse should be connected in the circuit.