Magnetic Effects Of Electric Current

Assess Yourself

Q. 1. The magnetic force on a moving proton acts towards north in a horizontal plane. If the proton is moving vertically upward then what will be the direction of magnetic field?

Answer: The direction of moving proton is the direction of current. Hence according to question,

•The current is in the upward direction with respect to the horizontal plane

•Magnetic force is acting in the direction of north on the horizontal plane.

•Hence, from Flemings left-hand rule we can determine that the magnetic field is in the direction of East on the horizontal plane.

Q. 2. A charged particle moves in a clockwise direction in a magnetic field which is perpendicular to plane of paper directed downwards. What is the nature of charged particle?

Answer: In the presence of magnetic field, the force on a charged particle is given as:

$F = q \times v \times B$

Where, q is the charge of the particle

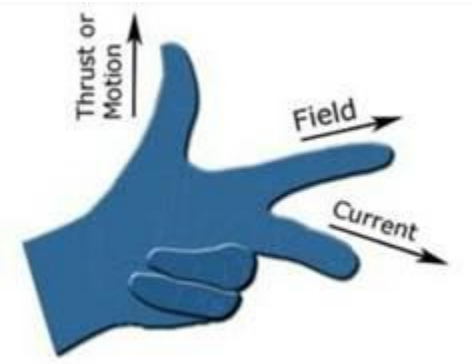
V is the velocity of the particle

B is the magnetic field.

Now, the direction of charged particle is clock wise.

And, the magnetic field is inwards (perpendicular to the plane of paper in downwards direction)

We apply Flemings left hand rule to find the direction for any charge:



The thumb represents the force acting or direction of motion.

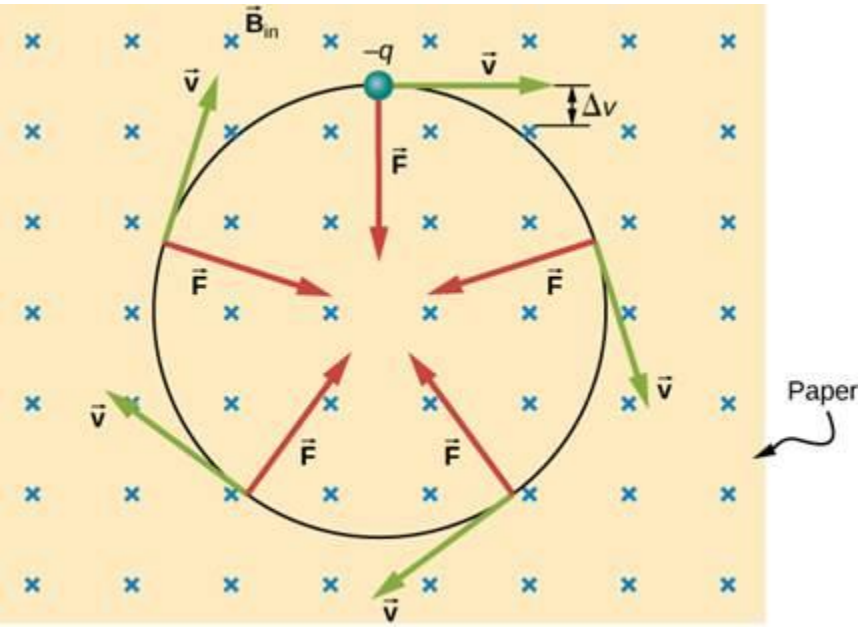
•The fore finger represents the direction of magnetic field.

•The central finger represents the direction of propagation of the charge.

And for negative charges (i.e. electrons) that the final force direction should be taken the opposite of what Flemings rule.

Therefore, here the charge is negative i.e. the particle is an electron.

Therefore, the diagram is given below:



Q. 3. Give one application of electromagnetic induction.

Answer: Electromagnetic induction is the generation of voltage /current across a conductor whenever the conductor is placed between a changing magnetic field. This generation/production of voltage/current across the conductor is very useful and has many industrial applications. Electric generator is one of them. An electric generator work on the principle of electromagnetic induction. In which a changing magnetic field across the loop generates a voltage/current in the loop.

Q. 4. Suppose a coil is place in a changing magnetic field and the circuit is not closed will the current induce in the coil?

Answer: Strictly speaking electromagnetic induction is a process in which changing magnetic field produces electric current. Because electrons have their own magnetic field when an external changing magnetic field is applied to them they move. The movement of those electron produces current. Hence, we can say that the current will produce. But we are not able to measure it or find out about it for instance as soon as we connect it to the galvanometer circuit is closed which is not allowed in question.

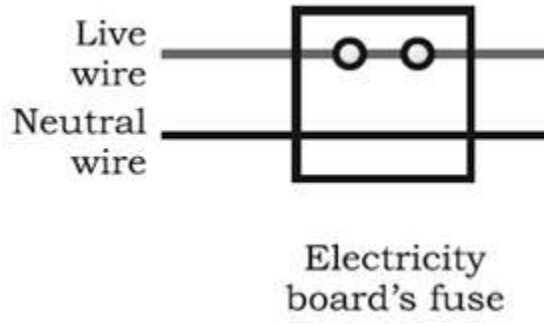
So, finally we will conclude that the current will not produce because:

•We do not have any evidence about it i.e. we cannot find out about it.

•A current will only flow through wire if the circuit is complete.

Q. 5. In domestic electric circuit, with which wire we connect a fuse?

Answer: The following picture is the starting of a circuit diagram of a house building. In which you can see that the live wire is connected to the fuse. A live wire is actually a positive wire. And Neutral wire is the negative wire. Current flows from positive terminal to the negative terminal. Hence it is first passed to the positive wire then it goes to the house and then negative terminal. So, to prevent the devices from electrical damages, fuse is connected before them. That is to live wire.



Q. 6. Core of an electromagnet must be of soft iron but not steel. Justify it.

Answer: The soft iron inside the coil makes the magnetic field

Stronger because it becomes a magnet itself when the current is flowing. That is, Soft iron is said to form a temporary magnet. In this way, the electromagnet can be switched on and off by turning the electricity on and off.

Q. 7. What happens to the force experienced by a current carrying conductor placed in a uniform magnetic field, when placed

(a) parallel to magnetic field?
(b) perpendicular to magnetic field?

Answer: Whenever a current carrying conductor is placed in a uniform magnetic field. It will experience a magnetic force. However, the magnetic force depends on various parameters. Hence the magnetic force depends on four things:

•Amount of current

•Strength of Magnetic field

•Length of the wire which remain in magnetic field

•And the angle between the current carrying conductor and magnetic field.

The most important criteria here is the angle between the current carrying conductor and the magnetic field. If the angle is 0° or 180° then there will be no force acting on the wire. But if the angle is 90° the force will be maximum. If you observe the pattern it goes on like that, at 0° the force is 0 but as the angle increases the force increases and at 90° the force reaches its maximum value. And then again it starts decreasing and it becomes 0 at 180°. Hence,

(a) Parallel to magnetic field

When the current carrying wire is placed parallel or anti-parallel to the magnetic field the magnetic field does not act on it.

(b) Perpendicular to magnetic field

When the current carrying conductor is placed perpendicular to the magnetic field then magnetic force acting on conductor is maximum.

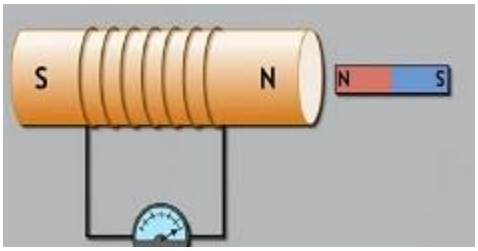
Q. 8. With the help of neat diagram describe how you can generate induced current in the circuit.

Answer: The generation of an induced current when a conductor is placed in the region of changing magnetic field is called Electromagnetic Induction. The current will only induce in the conductor coil if the magnetic field around the coil changes. This can only happen when:

•Magnet moves towards the coil or move away from it.

•Coil move toward the magnet or move away from it.

•Both move towards each other {or we can also say loop and magnet move in opposite direction with same speed. For example, magnet moving in +x direction and coil moving in -x direction.}

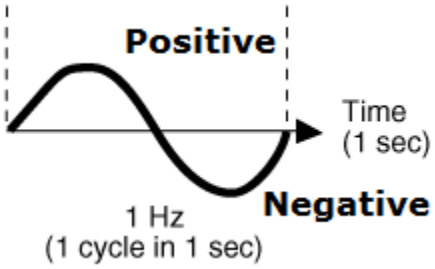


In the given diagram all those five conditions can be shown. And the galvanometer will detect the presence of electric current in the conductor loop. Those five conditions are the only condition when current will induce in the conductor coil.

Q. 9.A. How many times, the current produced by AC Generator reverses its direction in one complete revolution of its coil?

Answer: AC generator supplies AC current. To determine how many times the direction of an Alternating Current changes we have to find out about its frequency. Frequency of

an AC current implies number of complete waves present in a second. If the coil completes one revolution in one second then the frequency of the AC generator is said to be 1 hertz. The given picture will clear the concept,



In the picture there is only one complete wave in a second, hence its frequency is 1 hertz. Which means that the coil has completed one revolution. Hence we can that in one revolution the current change its direction twice first positive than negative.

Q. 9.B. How many times AC supply in India reversed its direction in one second.

Answer: Frequency of an AC current implies number of complete waves present in a second. In India, the Ac current has a frequency of 50 Hertz. 50 Hertz frequency means that there are 50 waves present in a interval of one second. And we know from the previous question that in one wave current changes its direction twice, so in 50 waves it will change its direction 100 times.

Q. 10. State the disadvantage of direct current.

Answer: A Direct Current (DC) is a constant value of current which does not change with the time. It flows in one direction only, that is from positive to negative. The current here does not change its direction at all. It is always from positive terminal to negative terminal.

Disadvantage of Direct current:

Generally, the electricity is produced in a power plant which is far away from the main city. To supply the electricity to houses we have to transport it into the city. Electricity is transported through wire. Now in the previous chapter you have studied about Joule's law of heating. If we transport electricity in form of Direct Current through wires, a major portion of the electricity is already lost and wasted in form of heat which will cause nothing but loss. This is the major disadvantage of the Direct Current. It is prevented by transporting Alternating Current instead of direct current. Which does not really have heating problem.

Q. 11. List four characteristic features of circuits used in the residential buildings.

Answer: Four characteristic features of circuits used in the residential buildings:

•For safety purpose, a fuse is attached to the beginning of the circuit. Which immediately stops the current or breaks the circuit if there is overloading or any chance of fire which is quite a characteristic of residential circuits.

•All the houses in a building are connected in parallel connection which supplies same voltage to each house. Hence, a steady and uniform voltage is provided to all the houses in a single circuit.

•All the appliances in houses are connected with an earthing wire. Which is also a safety measure to protect from any fire or electricity damages. If there is any current leakage it will transport that current to the ground hence there will be no shock from that loose extra current.

•All the houses connected in buildings are in a parallel connection which has one more benefit that if any house got short-circuit there will be no effect on the other houses. Because in a parallel connection breaking one connection won't effect another.

Q. 12. State the three factors on which the magnitude of magnetic field due to current carrying solenoid depends?

Answer: A solenoid is a device which is formed when an insulated current-carrying wire is bent into a coil with an N number of loops or turns. It is like wrapping of a wire on a cylindrical object. The individual magnetic field of each turn contribute and it results into a magnetic field which is like the magnetic field of a bar magnet.

The magnitude of magnetic field depends on following factors:

•Number of loop/turns.

•Amount of current.

•Material inside the cylinder.

In these factors amount of current and number of turns play the major role. Both are directly proportional to the magnetic field produced and can be used as a factor to produce strong electromagnetic field.

Q. 13. Write one application of each of the following:

(a) Right-Hand Thumb Rule
(b) Fleming’s Left-Hand Rule
(c) Fleming’s Right-Hand Rule

Answer: (a) The direction of the induced magnetic field from a current carrying conductor is given by The Right-hand thumb rule.

Application: The direction of the magnetic field inside the solenoid is determined by Right-hand thumb rule.

(b) The direction of magnetic force acting on a current wire placed in a magnetic field is given by Flemings left hands rule.

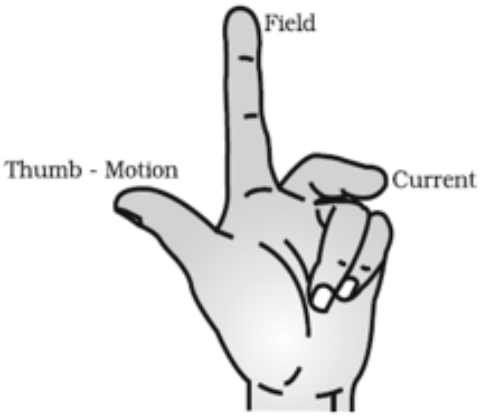
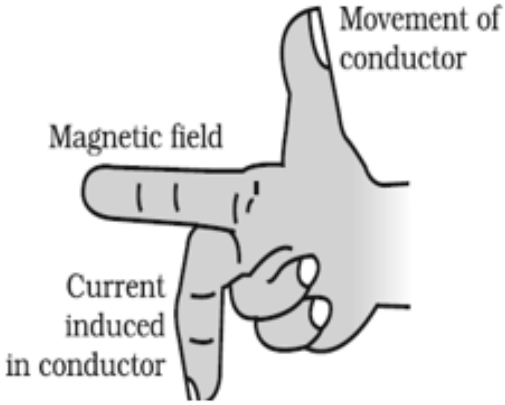
Application: The direction of movement of the coil/loop inside an electric motor is determined by Fleming's left-hand rule.

(c) Fleming' right-hand rule is used to find out the direction of the induced current within a conductor when the conductor is moving in a magnetic field.

Application: The direction of induced current within a electric generator is determined by Fleming's right hand rule.

Q. 14. State the difference between Fleming's Left-Hand Rule and Fleming's Right-Hand Rule. Name the electrical devices where these rules find an important application.

Answer:

Fleming's Left-Hand Rule	**Fleming's Right-Hand Rule**
This rule is used to determine the direction of magnetic force.	This rule is used to determine the direction of induced electric current.
Centre finger/ middle finger signifies for electric current.	Centre finger/ middle finger signifies induced or generated current within the conductor.
Thumb signifies the direction of the magnetic force.	Thumb points in the direction of the motion of conductor.
Application: The direction of the magnetic field inside the solenoid is determined by Right-hand thumb rule.	**Application:** The direction of induced current within an electric generator is determined by Fleming's right-hand rule
	

Q. 15.A. State the rule to determine the direction of a magnetic field produced around a straight conductor carrying current.

Answer: The direction of the magnetic field from a current carrying conductor is given by the Right-hand thumb rule. Explanation: According to Right-hand thumb rule:-

•When we place our right hand's thumb in the direction of the current and as we wrap our finger around the current carrying conductor.

•Wrapped finger will show the direction of the magnetic field.

•It is noticeable that the wrapped finger from a closed loop which is also the most important property of the magnetic field.

Q. 15.B. State the rule to determine the direction of a force experienced by a current carrying straight conductor placed in a magnetic field which is perpendicular to it.

Answer: When a current carrying conductor is placed in a magnetic field then the conductor will experience a magnetic force. The direction of magnetic force acting on a current wire placed in a magnetic field is given by Flemings left hands rule.

According to Flemings Left-hand rule:-

•If we arrange our left hand's thumb, index finger and middle finger mutually perpendicular to each other.

•And then if we put our index finger in the direction of magnetic field applied and middle finger in direction of electric current.

•Then the thumb will point in the direction of the magnetic force

Q. 15.C. State the rule to determine the direction of a current induced in coil due to its rotation in a magnetic field.

Answer: Fleming' right-hand rule is used to find out the direction of the current induced in coil due to its rotation in a magnetic field.

According to Fleming's right-hand rule:

•If we put our thumb, index finger and middle finger mutually perpendicular to each other.

•Such that thumb points in the direction of the motion of conductor and index finger point in the direction of the applied magnetic field.

•Then middle/centre finger will show the direction of the induced or generated current within the conductor.

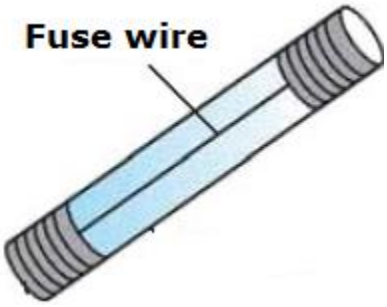
Q. 16. What is short circuiting? State one factor/condition that can lead to it. Name a device in the household that acts as a safety measure for it. State the principle of its working.

Answer: Short circuiting:- When the live wire and neutral directly touches each other due to bad insulation of those wire or any other reason, the current in the circuit increases suddenly. This sudden increment can cause serious damages to the

appliances as well as it can cause electrical fires. To prevent this situation a very intelligent solution is used. Basically, a fuse wire is inserted into the circuit. Fuse wire is a conductor wire with a very low melting point. Low melting point is the main characteristic here. Working/Principle of fuse wire:

•Some devices require very high amount of current, the flow of so much current can sometimes cause the melting of the insulating wire due to heating effect of the electric current or by any other reason if the insulation of the wire damages and current increases suddenly.

•This can result into severe electric fires. To prevent this situation a fuse is introduced into the circuit, which is made up of a low melting point conductor wire.



The wire inside the conductor melts and breaks the circuit as soon as the heating due to current increases.

This prevents further fire or electric short circuit. A fuse wire is a safety measure to prevent electric fires and short circuits. Some usefulness of Fuse:

•Without using Fuse we will be facing daily short circuited electric circuits.

•Device which requires high current can damage permanently causing loss of money and resources.

•Also, fuse prevents electric fires.

Q. 17. State the safety measures in using electricity.

Answer: Electricity is as dangerous as it is useful, in dealing with electricity or electric device one must be very careful. We use electricity in our household and daily life, here are some precautions we should do to prevent any kind of loss:

1. Avoid water at all times when working with electricity. Never touch or try repairing any electrical equipment or circuits with wet hands.

2. Always use appropriate insulated rubber gloves and goggles while working on any branch circuit or any other electrical circuit.

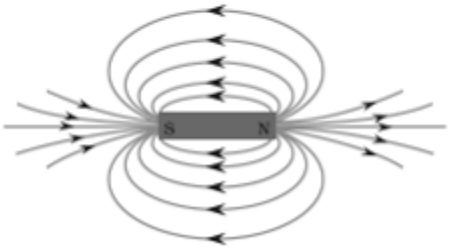
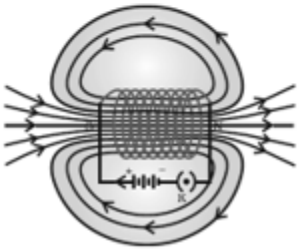
3. Always wear rubber slippers/shoes while handling electricity.

4. Do not touch anything without complete knowledge. This may cause severe damage.

5. Never use any electrical device with broken cords, damaged insulation or broken plugs.

Q. 18. Distinguish between a bar magnet and a solenoid.

Answer:

Bar magnet	**Solenoid**
• It has its natural magnetism.	• Its magnetism is created like it a type of artificial magnetism.
• Its magnetism cannot be destroyed it is always present.	• Its magnetism can be destroyed or it can be stopped anytime.
• Its magnetism cannot be increased or decreased by any other external way.	• Its magnetism can be increased or decreased depending on our needs.
• Its magnetism does not depend on any external applied factors.	• Its magnetism does depend on various external factors applied like current, no of turns.
Diagram of a bar magnet: - 	Diagram of a solenoid: - 

Q. 19.A. How can a magnetic field be produced without using a magnet?

Answer: A magnetic field is a field which is present around magnet and has magnetic properties. So, to produce magnetic field a magnet is surely needed. But we have learnt from the Oersted's experiment that whenever a current is passed through a conductor, a magnetic field is produced around it.

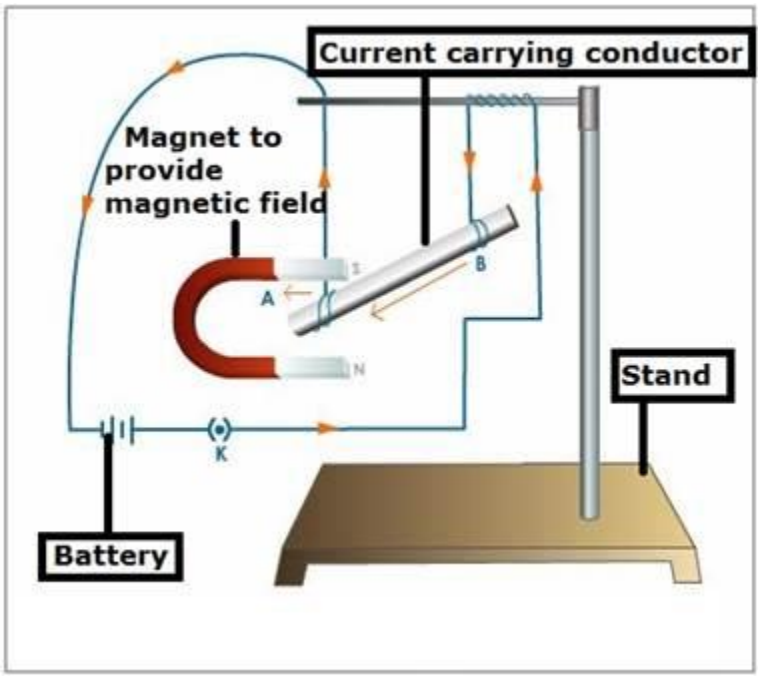
The current carrying conductor behaves like a magnet. And a magnetic field is produced around it. The magnetic field produced depends on the magnitude of the current and the length or number of loop of current. The direction of the produced magnetic field from a current carrying conductor is given by Right-Hand Thumb Rule.

Q. 19.B. Describe an activity with labelled diagram to show that a current carrying conductor experiences a force in a magnetic field.

Answer: In the following experiment:

Whenever a current carrying conductor is placed in a magnetic field then the conductor will experience a magnetic force. This happens because the current in the conductor has its own magnetic field and there is also a magnetic field present. So both the field

will interact and will result in repulsion or attraction of the conductor wire toward the fixed magnets.



The magnetic force depends on four things:

•Amount of current

•Strength of Magnetic field

•Length of the wire which remain in magnetic field

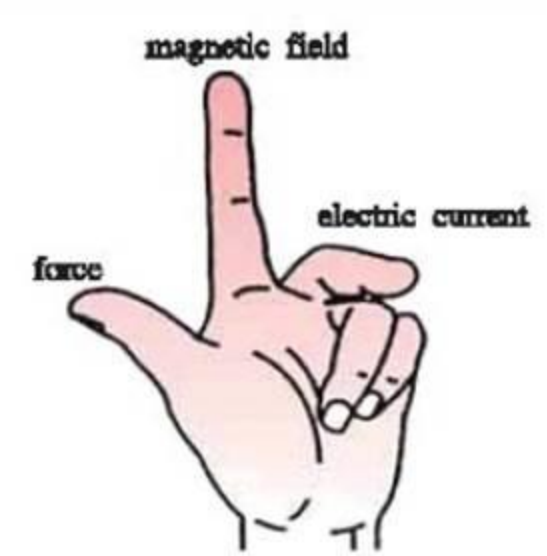
•And the angle between the current carrying conductor and magnetic field.

The direction of magnetic force acting on a current wire placed in a magnetic field is given by Flemings left hands rule.

Q. 19.C. State the rule to determine the direction of force.

Answer: The direction of magnetic force acting on a current wire placed in a magnetic field is given by Flemings left hands rule.

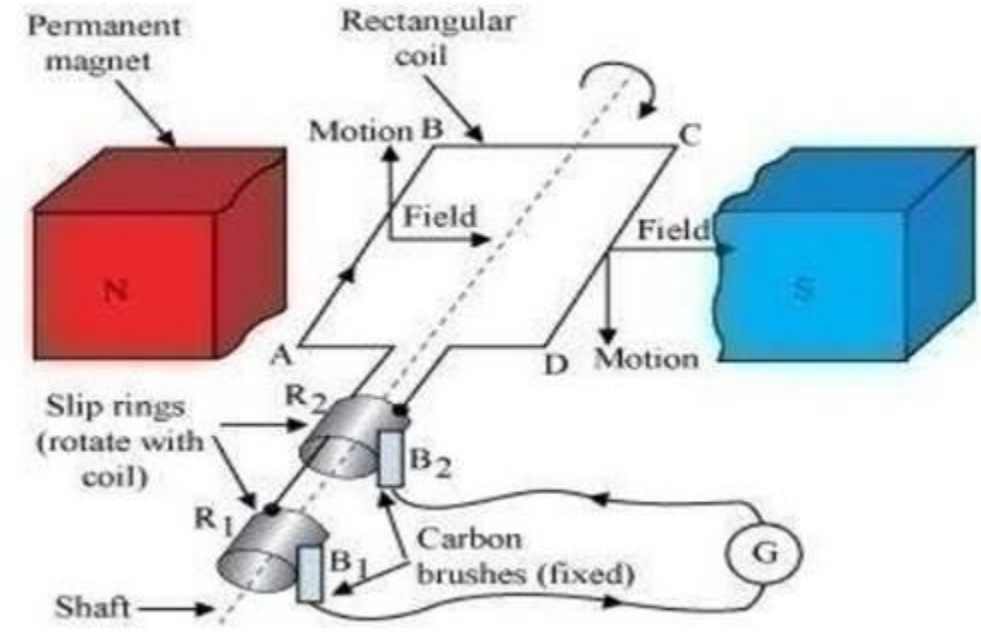
According to Flemings Left-hand rule:- If we arrange our left hand's thumb, index finger and middle finger mutually perpendicular to each other. And if we put our index finger in the direction of magnetic field applied and centre finger in direction of electric current then the thumb will point in the direction of the magnetic force.



So, as mentioned magnetic force, magnetic field and electric current all are perpendicular to each other.

Q. 20.A. Explain the various part of AC generator.

Answer: An AC generator is a device which produces an alternating current when a changing magnetic field is applied on a conductor coil. The frequency of the current is same as of the frequency of rotation of the conductor coil. There are various parts of an AC generator which are shown in the image:-



The parts of AC generator are:

Rectangular Coil: Rectangular Coil is the conductor coil in which current is produced. When the coil rotates in an applied magnetic field due to electromagnetic induction a current is produced.

Permanent magnet: Permanent magnet are another most important part. They provide a steady magnetic field in which the coil rotates. Without them there is no magnetic field and there will be no electromagnetic induction.

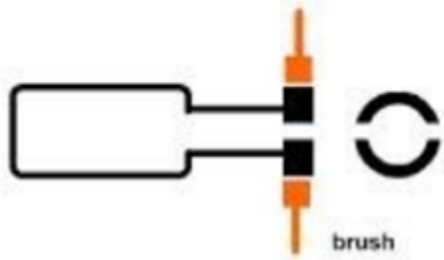
Slip Rings: When the coil rotates, the wire attached to them through which we will get electricity will also rotate and will create a problem by as the wire will all get curl up. So the solution to this problem is slip rings. The current which is produced through coil is transported to the rings. Inner part of the ring is allowed to have rotation but the exterior part is not allowed and inner and exterior part are both connected. So the current passes to exterior part from inner part and then to the wire.

Carbon brushes: Carbon Brushes are the fixed part which is connected to slip rings. They are fixed and current from slip rings passes to carbon brush and then to the wire.

Shaft: Shaft is like a handle attached to the coil, which is used for moving the coil. It basically makes rotation easier and faster.

Q. 20.B. What is the difference between direct current generator and alternating current generator?

Answer:

Direct Current Generator	**Alternating Current Generator**
The current generated is DC (Direct Current).	The current generated is AC (Alternating Current).
DC generator is used to power very large electric motors.	AC generator is used to power small electrical appliances.
DC generator has commutator additional with brushes and slip rings.	AC generator has brushes and slips rings.
	

Q. 21. Mr. Sharma used to park his car in the basement of his house. One day in the morning he noticed that his basement is full of knee-deep water and its walls were wet because of the hours-long rain at night. When he entered the basement, he experienced a major shock. His father seeing him from outside, rushed to the main switch and switched it off and thus saved his life.

(a) Why Mr. Sharma experienced the shock?

(b) What precautions should Mr. Sharma take to avoid such incidences in future?

(c) Which qualities were shown by Mr. Sharma's father?

Answer: (a) Mr. Sharma experienced the shock because due to the electricity leakage. Which occurred due to bad wirings or there might be a bad insulation of those electric wire. When last night rain occurred, the basement got flooded with water. And that water got in contact with those badly insulated wire or open wire. And due to the fact that water is a good conductor of electricity, Ms. Sharma experienced the shock.

(b) There are no of precaution which Mr. Sharma should take. Some of them are:

•Monthly checking of all the wirings of the house. So that he can find out about open wires.

•At the times of rain/monsoon, we must check the water before going into it.

•Always use appropriate insulated rubber gloves and goggles while working on any branch circuit or any other electrical circuit.

•Always wear rubber slippers/shoes while handling electricity.

(c) Mr. Sharma's father is a very intelligent man. He quickly off the main switch which shows that he is very responsible man. Moreover we can also say that he has very caring attitude towards his son.