Magnetic Effects Of Electric Current

Multiple Choice Questions

Question 1.
Choose the incorrect statement from the following regarding magnetic lines of field
A. The direction of magnetic field at a point is taken to be the direction in which the north pole of a magnetic compass needle points

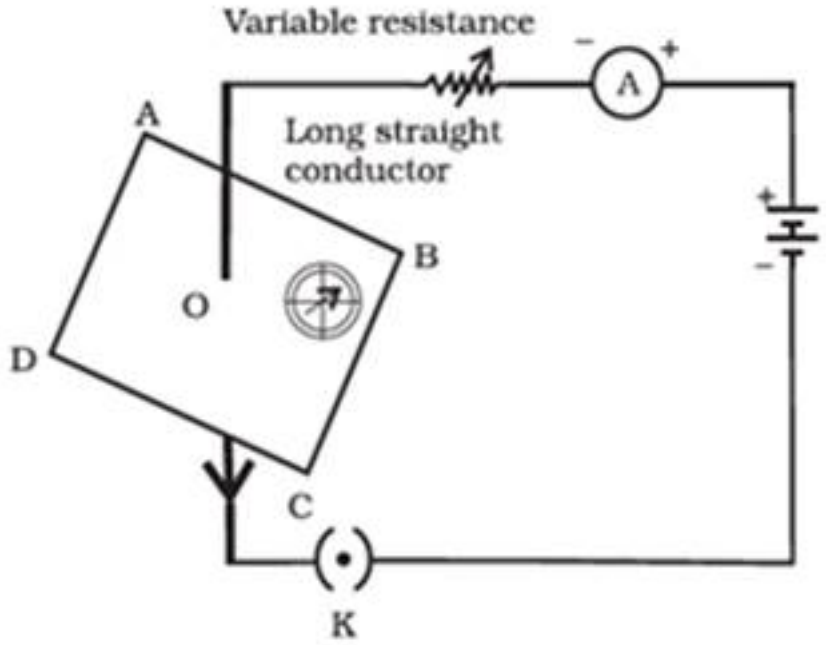
B. Magnetic field lines are closed curves

C. If magnetic field lines are parallel and equidistant, they represent zero field strength

D. Relative strength of magnetic field is shown by the degree of closeness of the field lines

Answer:
This statement is false about the magnetic field lines that if magnetic field lines are parallel and equidistant then they represent zero field strength because if they are parallel and are at equal distance then they have uniform magnetic field and doesn't have zero magnetic field strength.

Question 2.
If the key in the arrangement (Figure 13.1) is taken out (the circuit is made open) and magnetic field lines are drawn over the horizontal plane ABCD, the lines are



A. Concentric circles

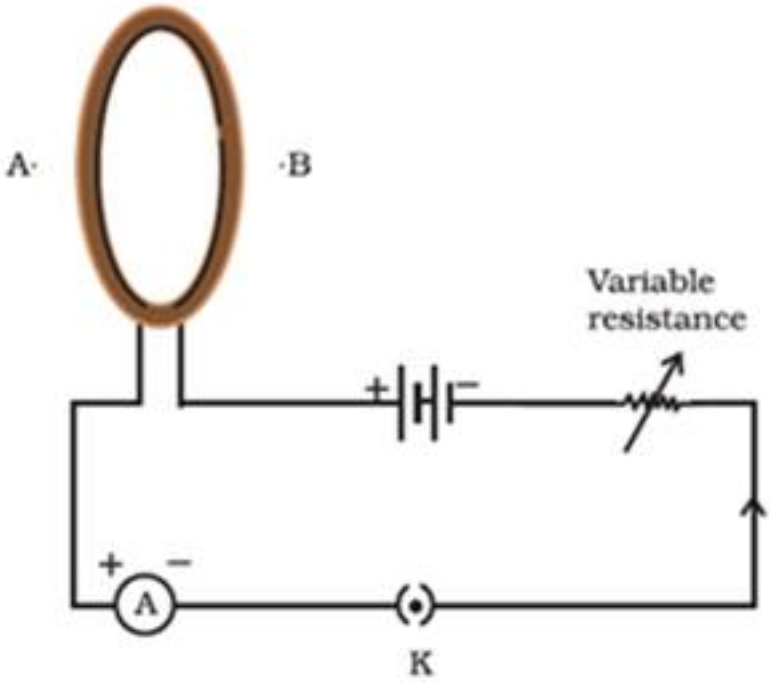
B. Elliptical in shape

C. Straight lines parallel to each other

D. Concentric circles near the point O but of elliptical shapes as we go away from it

Answer:
When the above circuit is open and the magnetic field lines are drawn over the horizontal plane ABCD, then the magnetic field lines will be in the form of concentric circles with centre at the axis of the conductor because since the circuit is open, there will be no flow of current and therefore there will be no magnetic field due to the conductor. So, at point O. only Earth's magnetic field will be present so the magnetic field lines will be in the form of concentric circles

Question 3.
A circular loop placed in a plane perpendicular to the plane of paper carries a current when the key is ON. The current as seen from points A and B (in the plane of paper and on the axis of the coil) is anti clockwise and clockwise respectively. The magnetic field lines point from B to A. The N-pole of the resultant magnet is on the face close to



A. A

B. B

C. A if the current is small, and B if the current is large

D. B if the current is small and A if the current is large

Answer:
On applying Right hand thumb rule, the magnetic field lines will be from point B to point A. As we know that magnetic field lines moves from North pole to South pole outside the magnet. So, A will represent North and B will represent south pole. So, The N-pole of the resultant magnet is on the face close to point A.

Question 4.
For a current in a long straight solenoid N- and S-poles are created at the two ends. Among the following statements, the incorrect statement is
A. The field lines inside the solenoid are in the form of straight lines which indicates that the magnetic field is the same at all points inside the solenoid

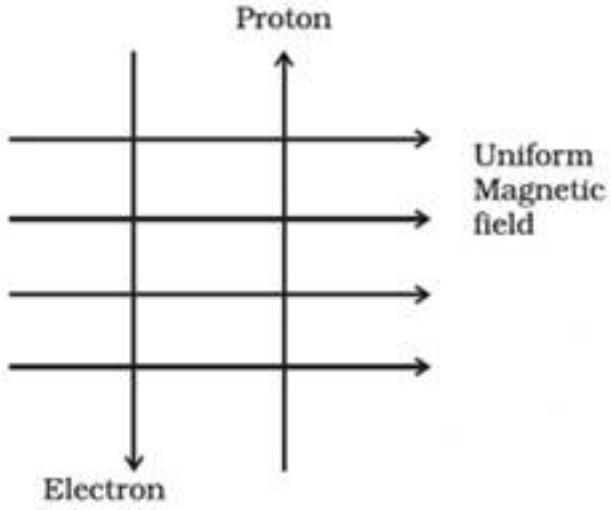
B. The strong magnetic field produced inside the solenoid can be used to magnetize a piece of magnetic material like soft iron, when placed inside the coil

C. The pattern of the magnetic field associated with the solenoid is different from the pattern of the magnetic field around a bar magnet

D. The N- and S-poles exchange position when the direction of current through the solenoid is reversed

Answer:
Statement given in option 'c' is not correct because the pattern of magnetic field lines associated with the solenoid is same as the pattern of magnetic field lines around a bar magnet.

Question 5.
A uniform magnetic field exists in the plane of paper pointing from left to right as shown in Figure 13.3. In the field, an electron and a proton move as shown. The electron and the proton experience



A. Forces both pointing into the plane of paper

B. Forces both pointing out of the plane of paper

C. Forces pointing into the plane of paper and out of the plane of paper, respectively

D. Force pointing opposite and along the direction of the uniform magnetic field respectively

Answer:
The electron and proton experiences forces pointing into the plane of the paper and out of the plane of the paper because the direction of current will be opposite to the direction of electrons and in the direction of protons. As shown in the figure, the direction of electrons and protons is in opposite directions and perpendicular to the direction of the magnetic field. Therefore, the forces acting on electron and proton

will be in same direction. Fleming's left-hand rule can be applied and the direction will be into the plane of paper.

Question 6.
Commercial electric motors do not use
A. An electromagnet to rotate the armature

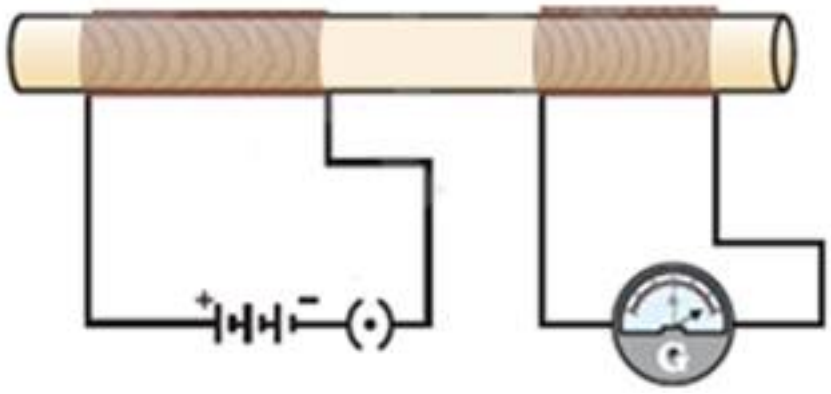
B. Effectively large number of turns of conducting wire in the current carrying coil

C. A permanent magnet to rotate the armature

D. A soft iron core on which the coil is wound

Answer:
Commercial electric motors don't use a permanent magnet to rotate the armature instead commercial electric motors uses an electromagnet for rotating the armature.

Question 7.
In the arrangement shown in Figure 13.4 there are two coils wound on a non-conducting cylindrical rod. Initially the key is not inserted. Then the key is inserted and later removed. Then



A. The deflection in the galvanometer remains zero throughout

B. There is a momentary deflection in the galvanometer but it dies out shortly and there is no effect when the key is removed

C. There are momentary galvanometer deflections that die out shortly; the deflections are in the same direction

D. There are momentary galvanometer deflections that die out shortly; the

deflections are in opposite directions

Answer:
In the given figure, when electric current through first coil changes then due to change in magnetic field lines, there will be an EMF (electromotive force) induced in the another coil. When the key is inserted in the circuit and when it is removed, the magnetic field lines will be first increase and then decreases. So, the current will be in opposite directions in the two cases, therefore, there are momentary galvanometer deflections in opposite directions.

Question 8.
Choose the incorrect statement
A. Fleming's right-hand rule is a simple rule to know the direction of induced current

B. The right-hand thumb rule is used to find the direction of magnetic fields due to current carrying conductors

C. The difference between the direct and alternating currents is that the direct current always flows in one direction, whereas the alternating current reverses its direction periodically

D. In India, the AC changes direction after every 1/50 second

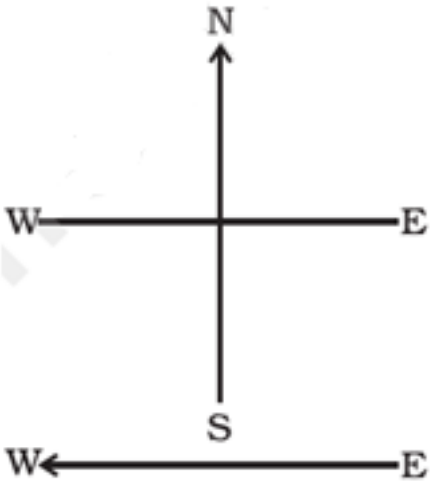
Answer:
The frequency of Alternating current in India = 50 cycles/ second

Therefore, time period of alternating current =1/50s

Since, AC changes the direction of current after every half time period. Therefore Ac will change current in 1/100 seconds.

So, statement given in option d is not correct.

Question 9.
A constant current flows in a horizontal wire in the plane of the paper from east to west as shown in Figure 13.5. The direction of magnetic field at a point will be North to South



A. Directly above the wire

B. Directly below the wire

C. At a point located in the plane of the paper, on the north side of the wire

D. At a point located in the plane of the paper, on the south side of the wire

Answer:
The direction of magnetic field at a point will be from North to South will be directly below the wire. On applying Fleming's Right hand rule, the direction of magnetic field will be from North to South below the wire.

Question 10.
The strength of magnetic field inside a long current carrying straight solenoid is
A. More at the ends than at the center

B. Minimum in the middle

C. Same at all points

D. Found to increase from one end to the other

Answer:
Since magnetic field lines are parallel to each other inside a long current carrying straight solenoid which means that magnetic field is same at all points.

Question 11.

To convert an AC generator into DC generator
A. Split-ring type commutator must be used

B. Slip rings and brushes must be used

C. A stronger magnetic field has to be used

D. A rectangular wire loop has to be used

Answer:
An AC generator consists of slip rings whereas a DC generator consists of split ring. So, to convert an AC generator into DC generator, split ring type commutator should be used.

Question 12.
The most important safety method used for protecting home appliances from short circuiting or overloading is
A. Earthing

B. Use of fuse

C. Use of stabilizers

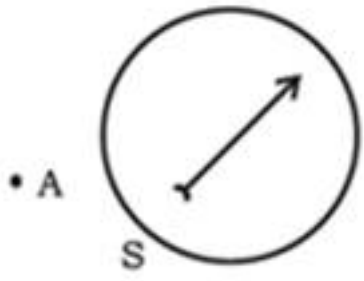
D. Use of electric meter

Answer:
An electric fuse is wire which is made of a material of high resistance and low melting point. Using an electric fuse prevents the flow of unduly high electric current and protects the appliances from the damage. Due to Joule heating, the fuse melts to break the electric circuit. So, use of fuse is the most important method used for protecting home appliances from short circuiting or overloading.

Short Answer Questions

Question 1.
A magnetic compass needle is placed in the plane of paper near point A as shown in Figure 13.6. In which plane should a straight current carrying conductor be placed so that it passes through A and there is no change in the deflection of the

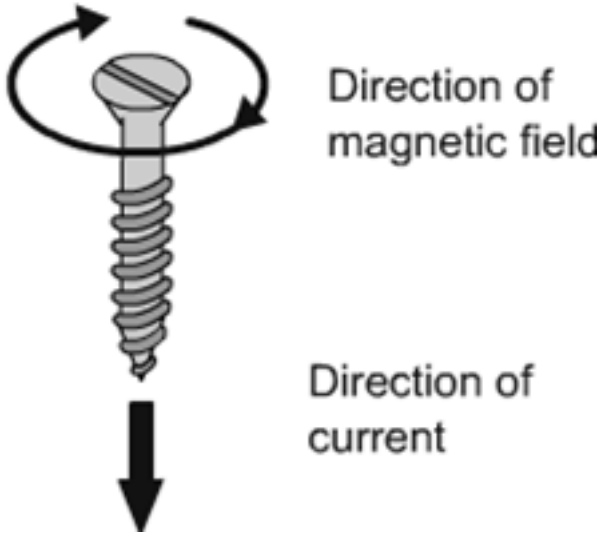
compass? Under what condition is the deflection maximum and why?



Answer:
Since the deflection in the compass will be maximum when magnetic field and electric current are perpendicular to each other. So, to obtain no deflection in the magnetic compass, the current carrying conductor should be placed in the same plane.

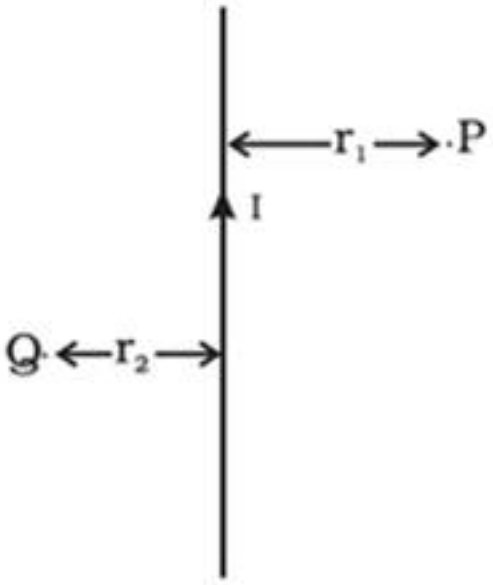
Question 2.
Under what conditions permanent electromagnet is obtained if a current carrying solenoid is used? Support your answer with the help of a labelled circuit diagram.

Answer:



To make a permanent electromagnet, a soft iron core is placed inside the solenoid and the soft-iron should be made up of ferromagnetic material which increases the magnetic properties of solenoid.

Question 3.
AB is a current carrying conductor in the plane of the paper as shown in Figure 13.7. What are the directions of magnetic fields produced by it at points P and Q? Given r1 > r2, where will the strength of the magnetic field be larger?



Answer:
At point P: By applying Fleming's right hand rule, magnetic field will be in anticlockwise direction around the current direction. The magnetic field will be to point P and towards the plane of paper.

At point Q: At this point, the direction of the current is away from the conductor and away from the plane of paper.

Magnetic field will be stronger at point Q than at point P because the strength of magnetic field is stronger when it is near to the conductor and weak when away from the conductor.

Question 4.
A magnetic compass shows a deflection when placed near a current carrying wire. How will the deflection of the compass get affected if the current in the wire is increased? Support your answer with a reason.

Answer:
If the current in the wire is increased, then the magnetic field will also increase because the magnetic field is directly proportional to the applied current.

Question 5.
It is established that an electric current through a metallic conductor produces a magnetic field around it. Is there a similar magnetic field produced around a thin beam of moving (i) alpha particles, (ii) neutrons? Justify your answer.

Answer:
When an electric current through a metallic conductor is established and produces a magnetic field around it. Alpha particles are positively charged particles, so magnetic field will be created along the path of the alpha particles but neutrons are the particles which have no charge on them. So, there will be no magnetic field along the path of neutrons.

Question 6.
What does the direction of thumb indicate in the right-hand thumb rule. In what way this rule is different from Fleming's left-hand rule?

Answer:
In right hand thumb rule, the direction of thumb indicates the direction of electric current and the direction of fingers wrapping shows the direction of magnetic field.

This rule is different from Fleming's left-hand rule because Fleming left hand rule explains the effects of magnetic field on a current carrying conductor whereas Right hand thumb rule explains the magnetic field produced due to a current carrying conductor.

Question 7.
Meena draws magnetic field lines of field close to the axis of a current carrying circular loop. As she moves away from the center of the circular loop she observes that the lines keep on diverging. How will you explain her observation?

Answer:
Since magnetic field is stronger near the current carrying conductor and weak when away from the conductor. In current carrying circular loop, the magnetic field lines are stronger at the periphery of the loop but as we move away i.e. towards the center of the loop, the magnetic field becomes weak there. As a result, the magnetic field lines looks like straight lines at the center and as we move near to

the conductor i.e. towards periphery, the magnetic field lines seems like diverging so as to maintain the circular shape around the wire of the circular loop.

Question 8.
What does the divergence of magnetic field lines near the ends of a current carrying straight solenoid indicate?

Answer:
The divergence of the magnetic field lines near the ends of a current carrying straight solenoid indicates that that the solenoid behaves like a magnet. As like magnetic field lines makes loop around a magnet similarly the divergence of magnetic field lines near the ends of current carrying straight solenoid indicates that solenoid behaves like magnet. The divergence of magnetic field lines shows that the magnetic field is strongest at the poles/ends of the solenoid.

Question 9.
Name four appliances wherein an electric motor, a rotating device that converts electrical energy to mechanical energy, is used as an important component. In what respect motors are different from generators?

Answer:
The four appliances where an electric motor, a rotating device that converts electrical energy to mechanical energy are as follows:

1. CD/DVD Player

2. Table Fan

3. Vacuum cleaner

4. Hand Blender

Electric motors are different from electric generators because electric motors works on the principle of Fleming's left hand rule whereas Electric generators works on the principle of Fleming's right hand rule.

Question 10.
What is the role of the two conducting stationary brushes in a simple electric motor?

Answer:
The two conducting stationary brushes are used in a simple electric motor in order to keep the two poles of the armature in contact with the power supply.

Question 11.
What is the difference between a direct current and an alternating current? How many times does AC used in India change direction in one second?

Answer:
The difference between Alternating current and Direct current are:

Alternating current reverses the direction of the current periodically as reflected in the name 'Alternating' which means changing current whereas the direct current flows only in one direction and don't reverses the direction of current. D.C can be transmitted over long distances without loss of energy but Alternating current can' t be transmitted to long distances.

AC used in India changes its direction at rate of 100 times in a second.

Question 12.
What is the role of fuse, used in series with any electrical appliance? Why should a fuse with defined rating not be replaced by one with a larger rating?

Answer:
An electric fuse is wire which is made of a material of high resistance and low melting point. Using an electric fuse prevents the flow of unduly high electric current and protects the appliances from the damage. Due to Joule heating, the fuse melts to break the electric circuit.

A fuse with defined rating should not be replaced by the one with a higher rating because a fuse wire works due to its low melting point which is due to its rating and if a fuse with higher rating is used than it might not melt and thus failing in its purpose of using it.

Long Answer Questions

Question 1.
Why does a magnetic compass needle pointing North and South in the absence of a nearby magnet get deflected when a bar magnet or a current carrying loop is brought near it. Describe some salient features of magnetic lines of field concept.

Answer:
Due to interaction between the magnetic fields of the compass needle and the magnetic field of bar magnet, a magnetic compass needle shows deflection when a bar magnet is brought close to it.

The various features of magnetic field lines are:

1. The direction of magnetic field lines is from North to South pole.

2. Magnetic field lines are closed curves.

3. The more the lines are closer, the more will be the magnetic field.

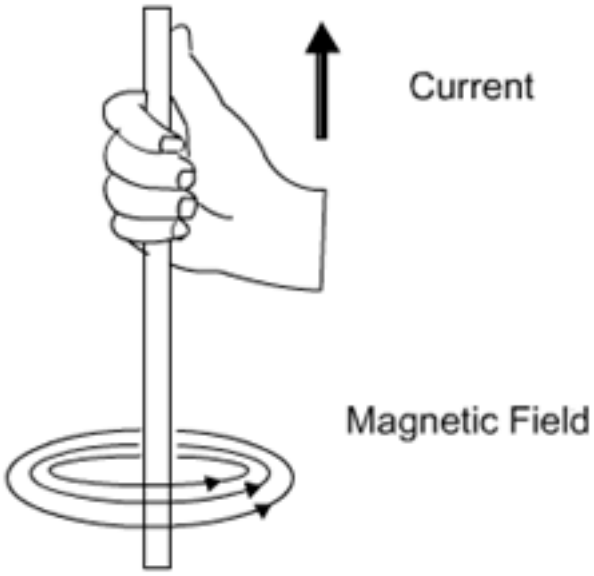
4. No two field lines can cross each other.

5. Strength of magnetic field near the poles.

Question 2.
With the help of a labelled circuit diagram illustrate the pattern of field lines of the magnetic field around a current carrying straight long conducting wire. How is the right hand thumb rule useful to find direction of magnetic field associated with a current carrying conductor?

Answer:

The pattern of the magnetic field lines of the magnetic field around a current carrying straight long conducting wire are in circular pattern in form of concentric circles as shown in the below diagram:



As depicted in the diagram , the direction of magnetic field can be find out by using the right hand thumb rule which says that if we are holding a current carrying conductor in the right hand such that the thumb will point towards the direction of the current. The fingers will wrap around the conductor in the direction of the field lines of the magnetic field.

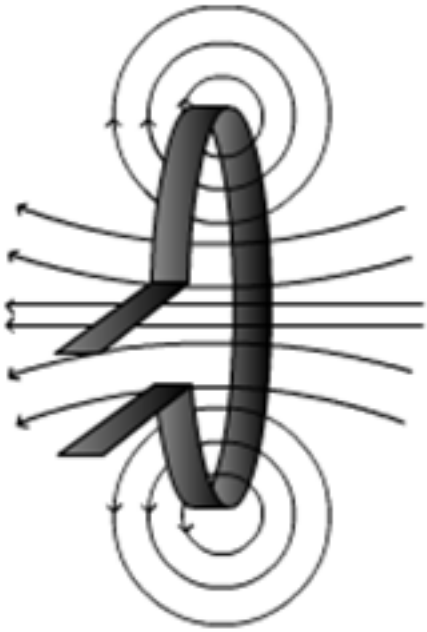
Question 3.
Explain with the help of a labelled diagram the distribution of magnetic field due to a current through a circular loop. Why is it that if a current carrying coil has n turns the field produced at any point is n times as large as that produced by a single turn?

Answer:
The magnetic field lines due to a current carrying circular loop can be shown with the help of following diagram:

Magnetic field lines are in the form of concentric circles in a circular current carrying conductor. Magnetic field lines are strong near the periphery because magnetic field lines remain close when they are near to the conductor

When we move towards the centre of the conductor, the magnetic field lines distant each other and at the centre, the arc appear of big circles.

On increasing the number of coils in the circular loop, the magnitude of the magnetic field increases and is equal to n times with n number of coils in the loop.



Question 4.
Describe the activity that shows that a current-carrying conductor experiences a force perpendicular to its length and the external magnetic field. How does Fleming's left-hand rule help us to find the direction of the force acting on the current carrying conductor?

Answer:
The activity to demonstrate that a current carrying conductor experiences a force perpendicular to its length and the external magnetic field can be explained as follows:

Activity: To show the effect of magnetic field on current-carrying conductor

Materials Required: For this, we need to take a small aluminum rod, a horse-shoe magnet, battery, plug key, wires and a stand.

1. Suspend an aluminum rod horizontally from the stand and two wires at the ends of it are tied. The wires are connected to a Rheostat, battery and a key so that a circuit is completed,

2. Place a horse shoe magnet in such a manner that the aluminum rod is between the poles of magnet.

Assume that the above the aluminum rod is South pole of the magnet and below, north pole of the magnet. Insert the plug key and current is supplied to the rod.

Observation: the aluminum rod is deflected towards the left direction

On changing the direction of current, the rod is deflection towards the right direction.

Hence, it demonstrates that a currentcarrying conductor experiences a force perpendicular to its length and the external magnetic field

The direction of the magnetic field can be find out with the help of Fleming's left-hand rule. Let current is moving in anticlockwise direction, then the direction of magnetic field will be in clockwise direction i.e. at the top of the loop whereas vice-versa in case of clockwise direction of current.

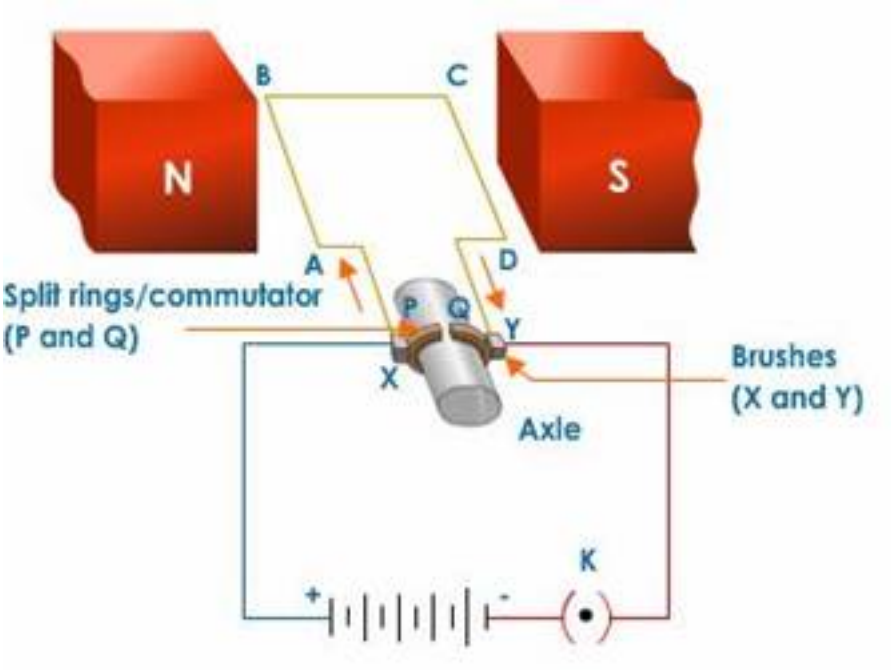
Question 5.
Draw a labelled circuit diagram of a simple electric motor and explain its working. In what way these simple electric motors are different from commercial motors?

Answer:
Working of Electric Motor:-

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

Construction of an electric motor:

An electric motor consists of a rectangular coil of insulated wire. The rectangular coil is placed between the two poles of magnetic field such that the arm AB and CD are perpendicular to the direction of the magnetic field. The ends of the coil are connected through two halves of a split ring. The inner sides of the halves are insulated and attached to an axle. The external edges of the conducting halves touch two conducting stationary brushes X and Y.



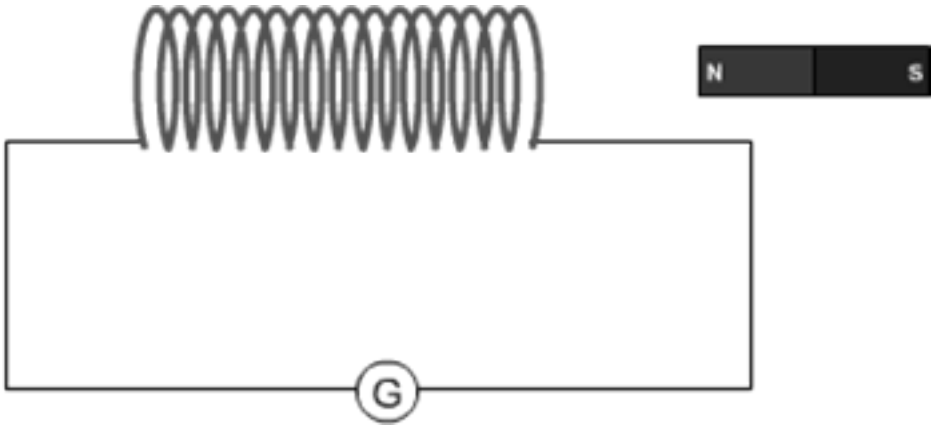
Working of an electric motor:

Current flowing in the rectangular coil ABCD from the battery source through conducting brush X and the current flows back to the rectangular coil through brush Y. The current in arm AB of the coil flows from A to B and in arm CD, it flows from C to D i.e. opposite to the direction of the arm AB. The direction of current can be find out using Fleming's left hand rule. The force acting on arm AB pushes it downwards and while force acting on CD pushes it downwards. Therefore, the coil and the axle are free to turn about an axis and can rotate in anticlockwise direction. At half rotation, Q makes contact with brush X and P with brush Y. So, now the current is reversed and flows along the path DCBA. The split ring acts as a commutator in the electric motor. On reversing the current, the direction of force acting on arms AB and CD also gets reversed. Now AB will be pushed in upward direction and CD will be pushed in downward direction. So, now the coil and axle rotate a half turn more in the same direction. The current reverses in every half rotation of the coil to the axle.

Commercial electric motors don't use a permanent magnet to rotate the armature instead commercial electric motors uses an electromagnet for rotating the armature.

Question 6.
Explain the phenomenon of electromagnetic induction. Describe an experiment to show that a current is set up in a closed loop when an external magnetic field passing through the loop increases or decreases.

Answer:
Electromagnetic Induction is defined as the process by which a changing magnetic field in a conductor induces a current in another conductor, is known as electromagnetic Induction.



An experiment to show that a current is set up in a closed loop when an external magnetic field passing through the loop increases or decreases is as follows:

1. Insert a coil over a hollow tube of a cardboard. With the wire connect the ends of the coil with a galvanometer.

2. Move the north pole of the magnet towards the end B of the coil

Observation: The galvanometer shows a deflection in the needle towards right direction

3. When Galvanometer is moved away from the coil

Observation: there is deflection in the galvanometer needle towards left direction.

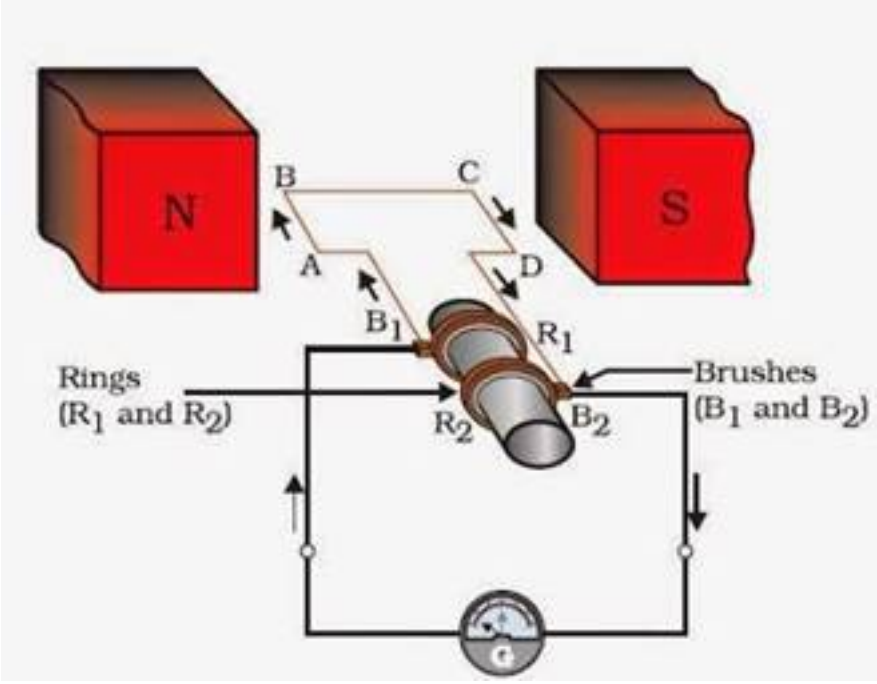
4. When galvanometer is kept static

Observation: there is no deflection in the galvanometer.

This proves that when the coil and the magnet are brought in contact, a current is induced in the coil.

Question 7.
Describe the working of an AC generator with the help of a labeled circuit diagram. What changes must be made in the arrangement to convert it to a DC generator?

Answer:



An electric generator consists of a rotating rectangular coil ABCD placed between two poles of permanent magnet. The coil ends are connected to the two rings R1 and R2 . The inner sides of the ring are insulated. The stationary brushes B1 and B2 are kept pressed separately on rings R1 and R2. The rings are internally attached to the axle. The axle is mechanically rotated from outside to rotate the coil inside the magnetic field. The outer ends of the rings are connected to the galvanometer.

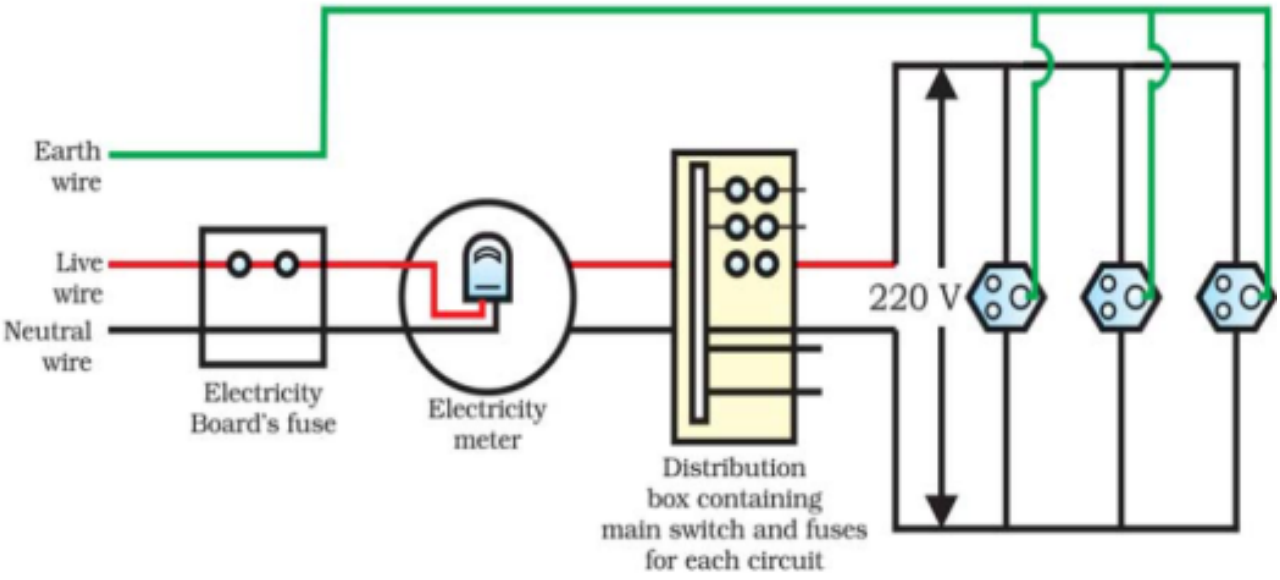
Working of Electric generator:

When the axle connected to the two rings is rotated, then the arm AB moves upward and CD moves downward in the magnetic field produced by the permanent magnet. Let the coil AB is rotated in clockwise direction. Using Fleming's right-hand rule, the induced currents are set up in directions along AB and CD and an induced current flow in ABCD. If there are large number of turns in the coil, then the current adds up in each current to give large current. This means that the current in the external current flows from B2 to B1. After half turn, arm AB moves in downward direction and CD moves in upward direction. Now the direction of induced current is reversed and now current flows in DCBA direction. The current now flows from B1 to B2. Thus, after every half rotation, the direction of the current reverses. This current is known as alternating current which changes the direction of current periodically.

AC generator can be converted into a DC generator with the help of a split ring commutator.

Question 8.
Draw an appropriate schematic diagram showing common domestic circuits and discuss the importance of fuse. Why is it that a burnt out fuse should be replaced by another fuse of identical rating?

Answer:
The diagram of domestic circuit is:



The electric power is supplied through electric poles by underground cables. In this supply, there are three wires: Live wire, insulation wire and the Earth wire. Live wire is of Red color, insulation wire is of black color and the Earth wire is of green color. At the meter board in the house, there electric wires are passed through main fuse into electric meters. Through main switch, they are connected to line wire in the house. There are two kinds of circuits used in the house which are: one is of 15A current for appliances with high power rating, the other is of 5A for low power devices. The earth wire is usually connected to metal plate deep in the Earth near the house to minimize shock due to short circuit effects. In each circuit, the different circuits can be connected across live and neutral wires. Each appliance is connected in parallel to each other so that each appliance has an equal potential difference.

An electric fuse is wire which is made of a material of high resistance and low melting point. Using an electric fuse prevents the flow of unduly high electric current and protects the appliances from the damage. Due to Joule heating, the fuse melts to break the electric circuit

A fuse with defined rating should not be replaced by the one with a higher rating because a fuse wire works due to its low melting point which is due to its rating and if a fuse with higher rating is used than it might not melt and thus failing in its purpose of using it.