AcadPrime
ACADEMY OF EXCELLENCE

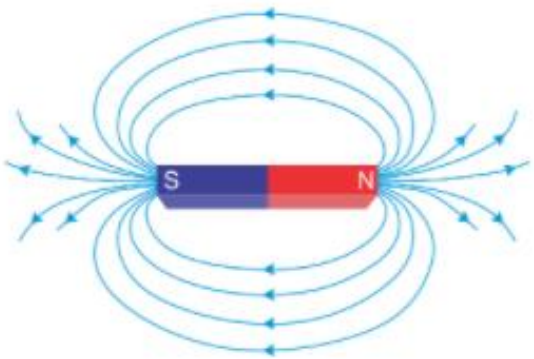
CLASS -10

Chapter – 13 Magnetic Effects of Electric Current

Q1. 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**

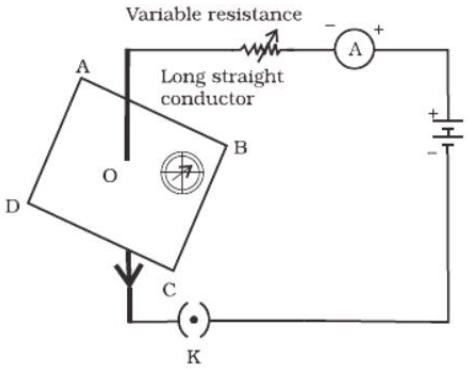
Answer: Option c)



Magnetic field lines around a magnet bar

above diagram shows that option a), b) and c) are correct but option c) is incorrect because the parallel lines of magnetic field represent the uniform magnetic field.

Q2. If the key in the arrangement Figure is taken out (the circuit is made open) and magnetic field lines are drawn over the horizontal plane ABCD, the lines are



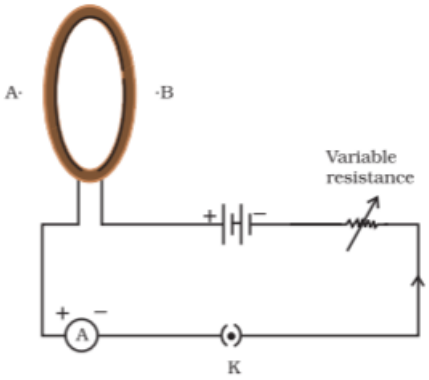
a) **concentric circles**
b) **elliptical in shape**
c) **straight lines parallel to each other**
d) **concentric circles near the point O but of elliptical shapes as we go away from it**

Answer: Option c)

On taking the key out, the circuit is open, no current flows through wire and no magnetic field exists due to the conductor.

It is due to Earth's magnetic field and straight lines are parallel to each other and its horizontal component is from geographical south to geographical north on the horizontal plane ABCD.

Q3. 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: Option a)

The N-pole of resultant magnet is close to A because, the magnetic field lines enter in loop from B and come out from A, as magnetic line come out of the N-pole of magnet. So, face close to A represents N-pole. The currents in A and B are same.

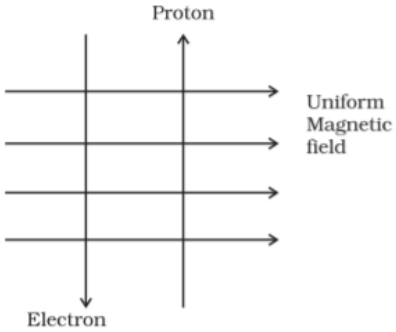
Q4. For a current in a long straight solenoid N- and S-poles are created at the two ends. Among the following statements, the incorrect statement is

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 magnetise 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: Option c)

Option c) is incorrect as the pattern of magnetic field inside a solenoid is uniform and same as bar magnet. One end of the solenoid behaves as magnetic north pole and other is the south pole.

Q5. A uniform magnetic field exists in the plane of paper pointing from left to right as shown in Figure. 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: Option a)

In this the electrons and protons are moving in opposite direction and perpendicular to the direction of magnetic field as the direction of current is opposite to the direction of motion of electron.

Hence, both electron and proton have current in same direction. So, the forces acting on it is given by Fleming's left-hand rule and they are pointing inti the plane of the paper.

Q6. Commercial electric motors do not use

a) An electromagnetic 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

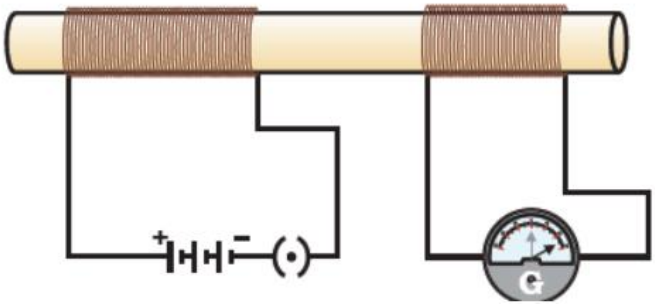
Answer: Option c)

A commercial electric motor uses the following:

i) An electromagnetic is replaced from permanent magnet.
ii) Large number of turns of the conducting wire.
iii) A soft iron core on the coil which is combination of soft core and coil is called an armature. It enhances the power of motor.

So, commercial motor does not use permanent magnet to rotate the armature because they are weak and do not produce strong magnetic fields in the region.

Q7. In the arrangement shown in Figure 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: Option d)

Whenever an electric current through first coil is changed an emf is induced in the coil due to change in magnetic field lines which pass via the second coil.

When key is inserted and removed, the magnetic lines pass through second coil increases and decreases respectively and direction of current is in opposite directions. Galvanometer shows momentary deflections in opposite directions.

Q8. Choose the incorrect statement

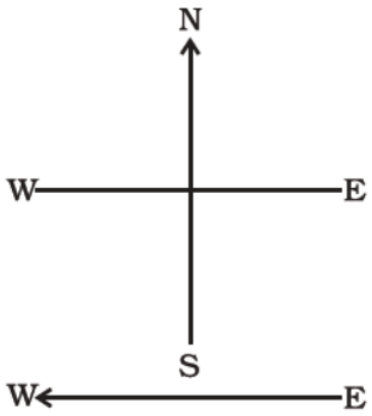
a) **Fleming's right-hand rule is a simple rule to know the direction of induced current**
b) **The right-hand thumb rule is used to find the direction of magnetic fields due to current carrying conductors**
c) **The difference between the direct and alternating currents is that the direct current always 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: Option d)

The frequency of AC in India is 50 cycle/s. So, the time period of AC is 1/50 s. But AC changes its direction after half time period, that is, $1/(2\times 50)$, that is, 1/100 s.

Thus, in India, the AC changes direction after every 1/100 s. So, option d) is incorrect.

Q9. A constant current flow in a horizontal wire in the plane of the paper from east to west as shown in Figure. 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: Option b)

As per the right thumb rule, when conductor is held in right hand, keeping thumb from east to west, the curve of the finger will be from north to south at a point lying directly below the wire.

Q10. The strength of magnetic field inside a long current carrying straight solenoid is

a) **more at the ends than at the centre**
b) **minimum in the middle**
c) **same at all points**
d) **found to increase from one end to the other**

Answer: Option c)

The strength of magnetic field lines inside a long current carrying straight solenoid same at all points because the magnetic field lines are straight, equi-spaced and parallel to the axis of solenoid and hence uniform magnetic field exist inside the solenoid.

Q11. 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: Option a)

To convert an AC into DC generator the split ring commutator are used which converts the direction of induced current, in the same direction throughout the complete rotation of the armature.

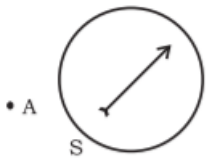
Q12. The most important safety method used for protecting home appliances from short circuiting or overloading is

a) **earthing**
b) **use of fuse**
c) **use of stabilizers**
d) **use of electric meter**

Answer: Option b)

Short Answer Type Questions

Q13. A magnetic compass needle is placed in the plane of paper near point A as shown in Figure. 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:

The s current carrying conductor is placed in the plane of paper so it passes through A which produces magnetic field perpendicular to plane of paper. The compass needle remains undeflected due to vertical magnetic field.

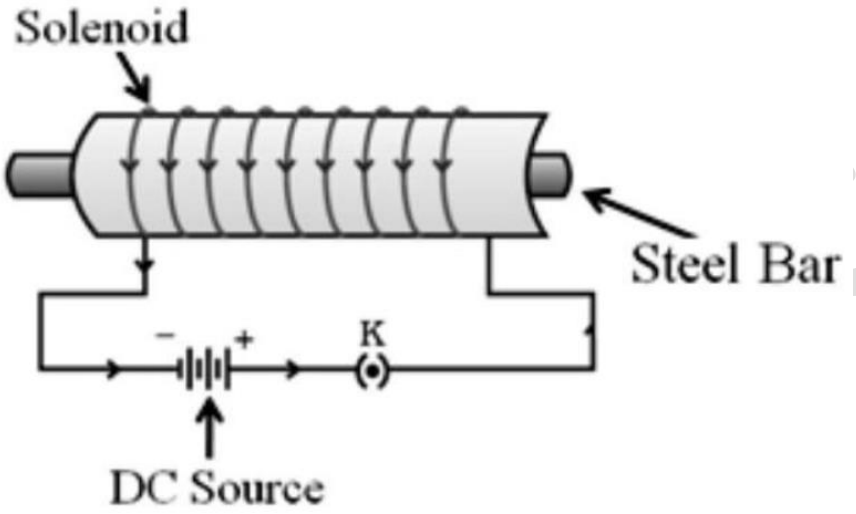
The deflection in compass needle is maximum when the conductor is perpendicular to the plane of paper and the magnetic field lies in the plane of paper.

Q14. Under what conditions permanent electromagnet is obtained if a current carrying solenoid is used? Support your answer with the help of labelled circuit diagram?

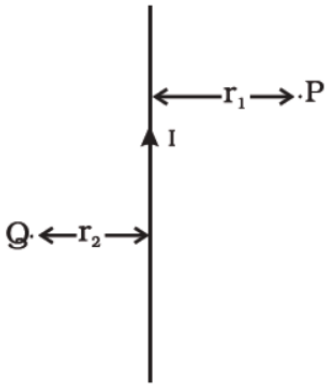
Answer:

The conditions to obtain permanent electromagnet as following if a current carrying solenoid is used are

i) the current through the solenoid is direct current.
ii) The rod inside is made of steel.
iii) The magnetic material is of high retentivity.



Q15. AB is a current carrying conductor in the plane of the paper as shown in figure. What are directions of magnetic fields produced by it at points P and Q? Give r1 > r2, where will the strength of the magnetic field be larger?



Answer:

the current conductor AB is in the plane of the paper so the direction of magnetic field is at P and out of it at the point Q. The magnitude of magnetic field B is inversely proportional to distance r,

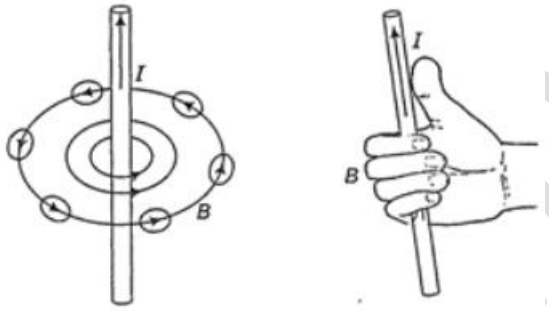
$$B \propto \frac{1}{r}$$

Magnetic field B is stronger near the conductor at Q than at P as r1 > r2.

Q16. 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:

A magnetic compass shows a deflection when placed near a current carrying wire as,



The deflection of the compass increases because the magnetic field B due to current carrying straight conductor is directly proportional to the strength of the current I passing through it.

$$B \propto I$$

when current is increased, magnetic field produced is stronger and vice-versa.

Q17. 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:

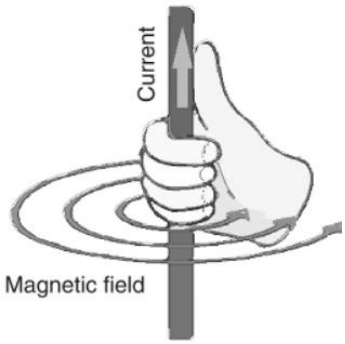
In case of a movement of a charged particle the magnetic field is created around the path on which the charged particle moves.

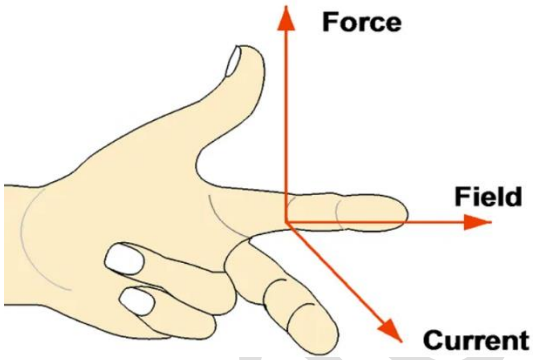
i) Yes, a thin beam of alpha (which are positively charged) is like straight conductor carrying current in the direction of motion.
ii) No, as neutrons carry no change so no magnetic field would be created around its path.

Q18. What does the direction of thumb indicate on the right-hand thumb rule? In what way this rule is different from Fleming's left-hand rule.

Answer:

Maxwell's right-hand thumb rule states that the thumb shows the direction of electric current. The curled finger holding the conductor give the direction of magnetic lines.





Fleming's left-hand rule gives the direction of force experience by a current carrying straight conductor placed in an external magnetic field.

Q19. Meena draws magnetic field lines of field close to the axis of a current carrying circular loop. As she moves away from the centre of the circular loop, she observes that the lines keep on diverging. How will you explain her observation?

Answer:

The magnetic field is stronger near the conductor and decreases on moving away from the conductor. A current carrying circular loop, the magnetic field is stronger near the periphery and weaker near the centre of the loop. So, the magnetic field lines appear as straight lines near the centre.

On moving towards the periphery of the circular loop, the magnetic lines appear to be diverging so that they can be circular around the wire of the loop.

Q20. What does the divergence of magnetic field lines near the ends of a current carrying straight solenoid indicate?

Answer:

The divergence of magnetic field lines the ends of a current carrying straight solenoid indicates a decrease in the strength of the magnetic field near the ends of the solenoid.

Q21. 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 are electric fans, washing machines, mixers grinders, electric drills, tape recorders, etc uses an electric motor as a rotating device to converts electrical energy to mechanical energy. The motor converts the electric energy into mechanical energy.

The generator converts mechanical energy into electrical energy and also mechanical power to electric power and varies in the magnitude with a frequency.

Q22. What is the role of the two conducting stationary brushes in a simple electric motor?

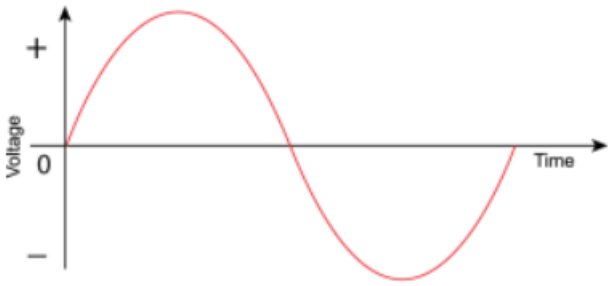
Answer:

The two conducting stationary brushes draw current from the battery and supply to the armature of the motor because they touch the outer sides of the two halves of the split rings whereas inner sides of split rings are insulated and attached to the axle of the motor.

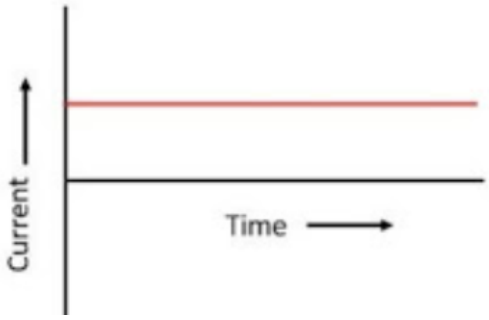
Q23. What is the difference between a direct current and an alternating current? How many times does AC used in India change direction in one second?

Answer:

Alternating current is an electric current which changes its direction, that is, polarity after a certain fixed interval of time.



Direct current is an electric current whose magnitude is constant or variable and the direction of flow in a conductor is same. Sources of DC are voltaic cell, a dry cell, battery, DC generator etc.



The frequency of AC in India is $f = 50\ cycle/s$

Therefore, time period of AC is,

$$T = \frac{1}{f} = \frac{1}{50}\ s$$

But AC changes its direction after every half time period,

$$T = \frac{1}{50 \times 2} = \frac{1}{100} s$$

Thus, in India AC change its direction after every 1/100 s.

So, in one second AC changes direction 100 times.

Q24. 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:

The fuse used in series with any electrical appliance control current through the appliance. It protects the appliance from short-circuiting or over/loading, when current exceeds the limit of the fuse rated, so it blows off and the appliance is disconnected from the electric supply.

When a fuse for an appliance is replaced by one with larger rating, it does not blow off and the appliance is damaged due to larger current passing through it.

Long Answer Type Questions

Q25. 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:

When a magnetic compass needle pointing north and south is acting upon by the earth's magnetic field. But in the presence of a magnet or a current loop the earth's magnetic field near the compass is modified and the needle is deflected.

The salient features of magnetic field lines are:

i) A magnetic line is directed from north-pole to south pole outside the magnet.
ii) A magnetic line is a closed and continuous curve.
iii) The magnetic lines never intersect each other, it means the force is acting in two directions, which is not possible.
iv) Closer the field lines, stronger is the magnetic field.
v) Magnetic field lines are parallel and equidistant and represent a uniform magnetic field.

Q26. 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:

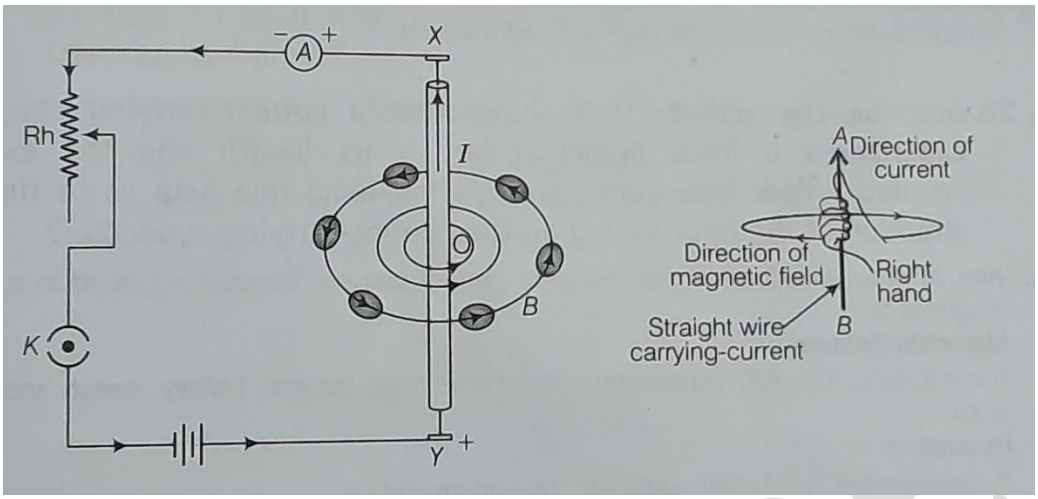
Let's take a thick straight conductor XY and pass it through the centre of a thick cardboard.

Connect the ends of the conductor to the terminals of a battery through a variable resistor, a key K and an ammeter (A) so that the current flows from Y to X. when we sprinkle some iron fillings on the cardboard, this average themselves in concentric circles around O when cardboard is gently tapped.

The concentric circles indicate the lines of a magnetic field. These concentric circles represent the magnetic field around a current carrying straight wire become larger and larger as we move away from it.

We use right-hand thumb rule to find the direction of magnetic field. It follows as imagine the straight conductor in your right hand such that the thumb points in the direction of current.

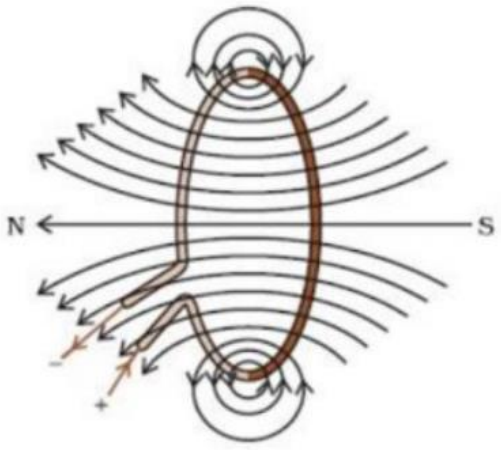
Then, the direction of asking of fingers of the right hand gives the direction of magnetic field lines.



Q27. 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:

In current carrying circular loop the concentric circles represent the magnetic field around and becomes larger as we move away from the wire. At the centre of the loop the field appears as straight line.



The magnetic field produced by current carrying circular wire at a given point, depend on

i) Amount of current flowing through the wire: The strength of magnetic field (B) of current carrying circular wire is directly proportional to the amount of current (I) flowing through it,

$$B \propto I$$

ii) Number of turns of the circular wire: the strength of the magnetic field is directly proportional to the number of turns (N) of the wire,

$$B \propto N$$

If there is a circular coil have n turns, the field produced is n times as large as that produced by a single turn because the current in each circular turn has same direction and the field adds up.

Q28. 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?

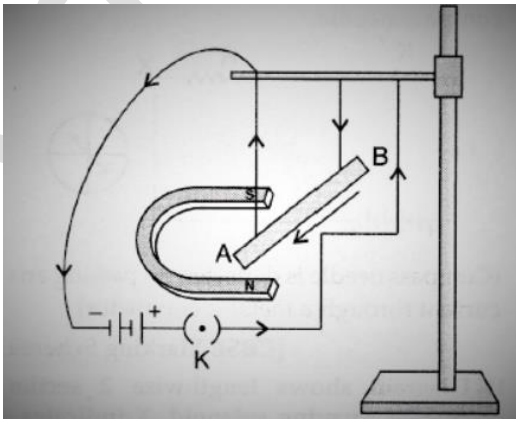
Answer:

Aim: To show force exerted on a current carrying conductor in a strong magnetic field.

Materials Required: A conducting rod (AB) connecting wires, horse shoe magnet, battery, switch and clamp stand.

Procedure:

i) Connect rod AB to the battery and key.
ii) Place horse shoe magnet in such a way that the rod AB lines between the poles with magnetic field directed upwards, N-pole is vertically above the rod.
iii) Plug in the key.



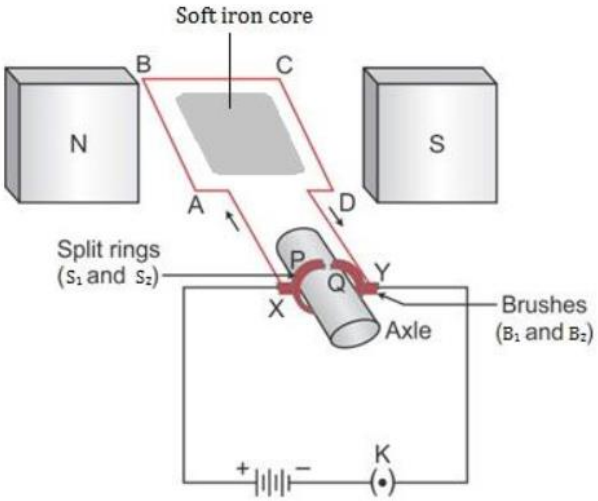
Observations:

- A current carrying rod AB has a force perpendicular to its length and the magnetic field.
- When a current carrying conductor is placed in a magnetic field, the conductor show deflection.

- Fleming's left-hand rule says that the direction of displacement in this case.
- Assuming that the current is moving in anti-clockwise direction in the loops.
- The magnetic field is in clockwise direction at the top of loop.
- It is in anti-clockwise direction at the bottom of the loop.

Q29. 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:

i) Let coil ABCD be in horizontal position. When the key is switched on, the current flows in direction DCBA and then leaves through the brushes B_2, via ring.

ii) Using Fleming's left-hand rule, no force acts on arm BC and AD as they are parallel to magnetic field, arm AB experiences a force in downwards direction and arm CD experiences an equal force in upward direction. A torque is on the coil to rotate it, in anti-clockwise direction.

iii) the coil reaches the vertical position, brushes loose contact with the rings and current stops flowing, coil does not stop due to inertia of motion.

iv) When the coil passes the vertical position, the rings automatically change their positions and come in contact with opposite brushes.

v) direction of current reverses but the direction of current on right-hand side remains same.

vi) So, the force on right hand-side is always upward and a force on left-hand side is always in downwards direction. Thus, the coil continues in anti-clockwise direction.

A commercial electric motor uses the following.

i) An electromagnet in place of permanent magnet.

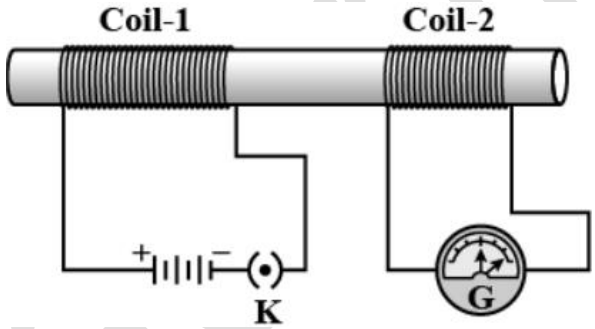
ii) Large number of turns conducting wire in coil.
iii) A soft iron core with the coil. The combination of iron core and coil is an armature, it enhances the power of motor.

commercial motor do not use permanent magnet to rotate the armature because permanent magnet are weak and do not produce strong magnetic field.

Q30. 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 increase or decrease.

Answer:

The phenomenon was discovered by Michael Faraday and Joseph Henry in 1831. The phenomenon of generating of an electric current in a closed circuit from magnetic effect, by changing the magnetic field called electromagnetic induction. Electric current produced is called induced current. The potential difference is due to induced current called induced emf.



Experiment:

Two different coils of copper wire, coil 1 and 2, having large number of turns are arranged as the circuit diagram.

coil 1, have larger number of turns, is connected in series with a battery and a plug key whereas the other coil 2 is connected with a galvanometer.

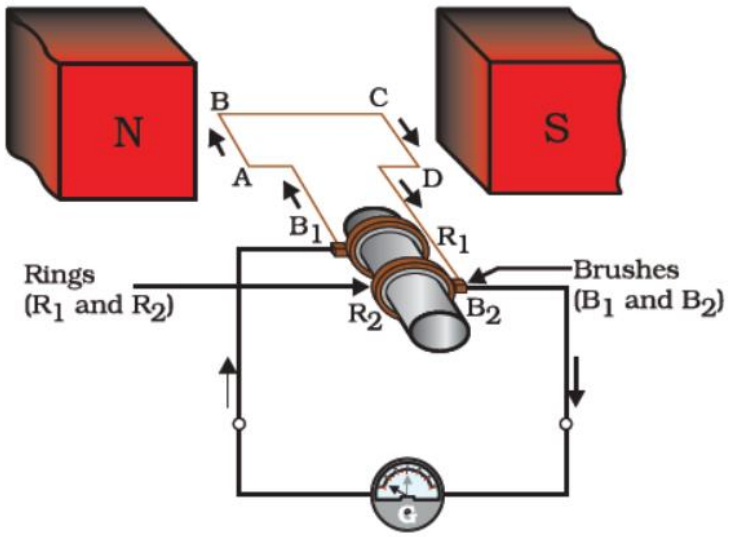
When key K is closed, the galvanometer shows a deflection in its needle and quickly returns to zero, indicating a momentary current in coil 2.

This happens due to an external magnetic field passing through the loop. When key K is open, the coil 1 is disconnected from the battery. The needle moves, but to the opposite side that is the current flows in the opposite direction in coil 2 due to an external magnetic field passing through the loop decreases.

Q31. Describe the working of an AC generator with the help of a labelled circuit diagram. What changes must be made in the arrangement to convert into a DC generator?

Answer:

The working of an AC generator:



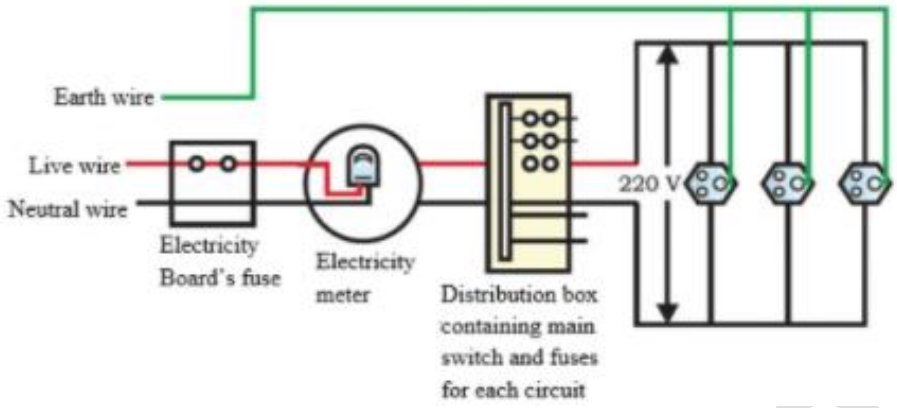
As the coil rotates, the two rings also rotate with the coil. The brushes P and Q keep contact with the rotating ring. When the coil starts rotating with arm AB moving up and CD moving down (clockwise) cutting the magnetic lines. According to Fleming's right-hand rule, the current is induced in these arms in the direction ABCD.

After half rotation, arm CD moves down AB moves up. As a result, the direction of current in each segment changes, giving rise to net induced current in the direction DCBA. So, after every rotation, polarity of current in the respective arm changes, thereby generating an alternating current.

To convert an AC into a DC generator, a split commutator is used, this will produce direct current.

Q32. 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:



- Fuse is a safety device having short length of thin wire made of tin (25%) and lead (75%) alloy with low melting point around 200^oC. In domestic circuits it prevents damage to the appliances due to overloading and short-circuiting.
- The use of an electric fuse prevents the electric circuit and the appliance from damage by stopping the flow of high electric current. The fuse is placed in series with the device.
- A fuse wire works due to lower melting point which. If a fuse with larger rating is used with an appliance, the fuse wire does not melt.
- Due to this, a fuse with defined rating should not be replaced by one with a larger rating.