In text 13.1 Page: 224

1. Why does a compass needle get deflected when brought near a bar magnet?

Solution:

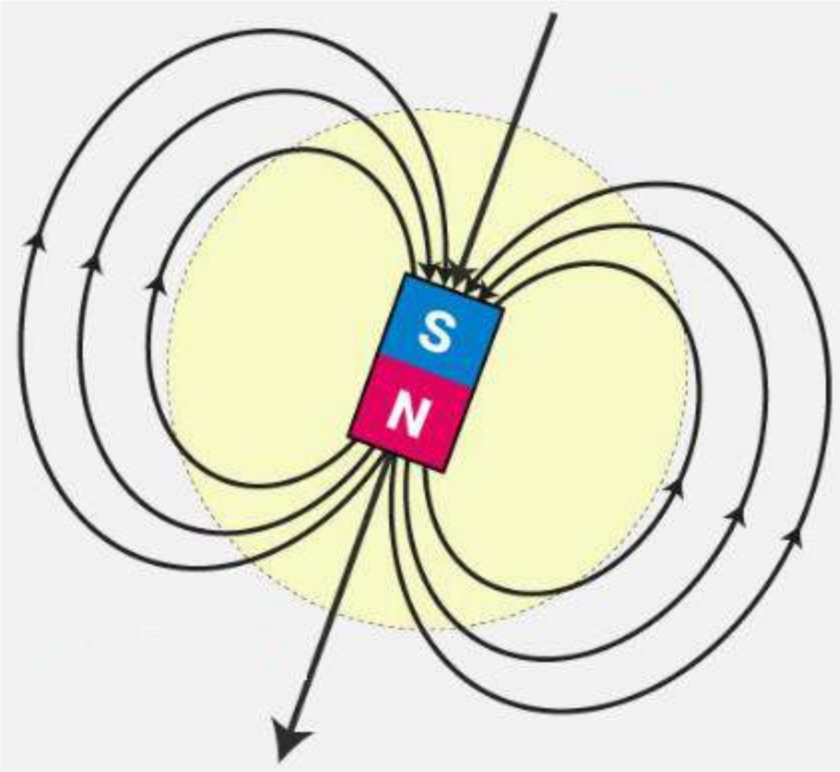
The compass needle is a small magnet. When the compass needle is brought close to a bar magnet, the magnetic field lines of the compass needle interact with the magnetic field lines of the bar magnet, which causes the compass needle to deflect.

In text 13.2.2 Page: 228

1. Draw magnetic field lines around a bar magnet.

Solution:

Magnetic field lines of a bar magnet emerge from the North Pole and terminate at the South Pole, as shown in the figure below.



2. List the properties of magnetic field lines.

Solution:

The properties of magnetic field lines are as follows:

-
- Magnetic field lines do not intersect with each other.
- They emerge from the North Pole and terminate at the South Pole.
- Inside the magnet, the direction of the field lines is from the South Pole to the North Pole.

3. Why don’t two magnetic field lines intersect each other?

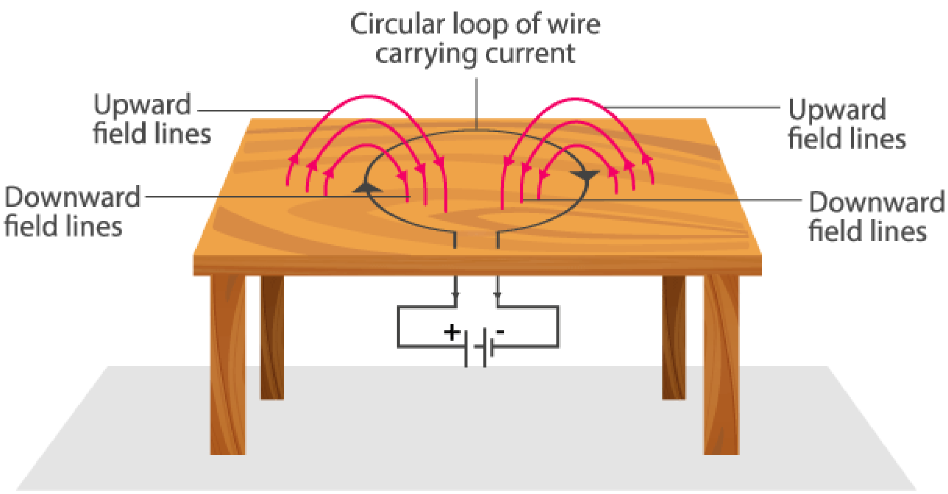
Solution:

If two magnetic field lines intersect, then at the point of intersection, the compass needle shows two different directions, which is not possible. Hence they do not intersect with each other.

In text 13.2.4 Page: 229

1. 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.

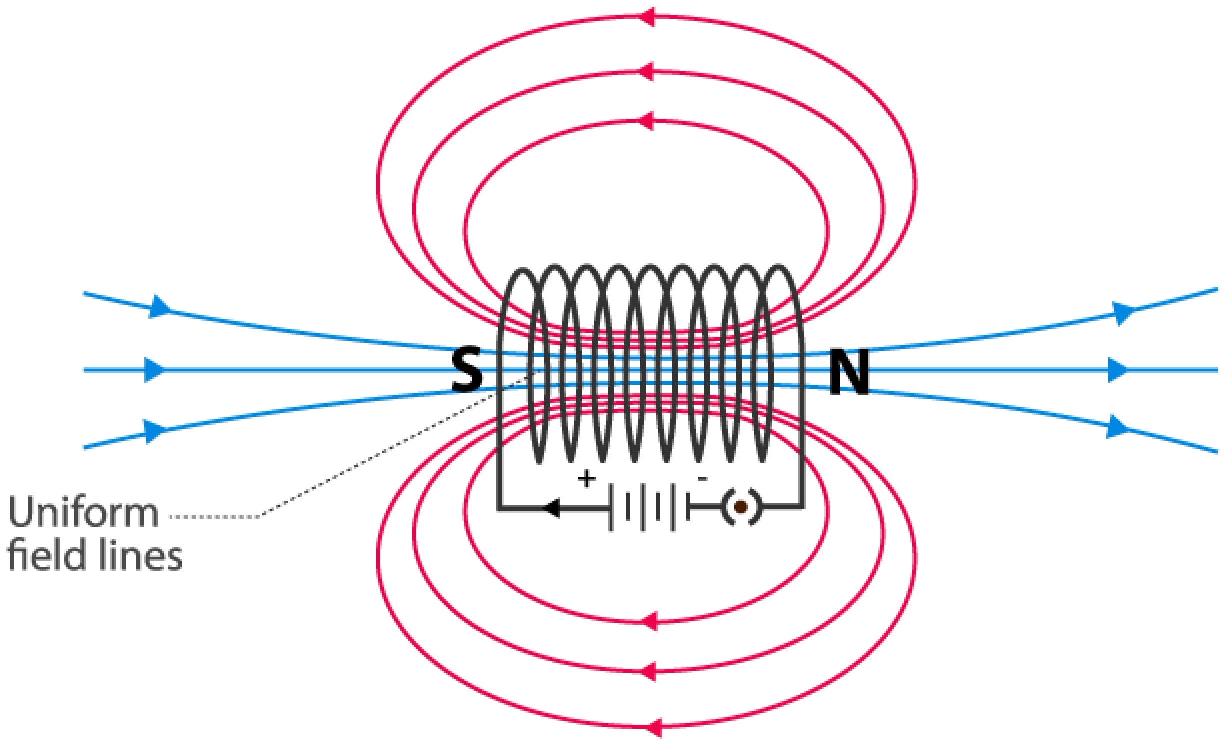
Solution:



For the downward direction of the current, the direction of the magnetic field will be as if emerging from the table outside the loop and merging with the table inside the loop. Similarly, for current flowing in an upward direction, the direction of the magnetic field will be as if they are emerging from the table outside the loop and merging with the table inside the loop, as shown in the figure.

2. The magnetic field in a given region is uniform. Draw a diagram to represent it.

Solution:



3. Choose the correct option.

The magnetic field inside a long straight solenoid-carrying current

1. **is zero.**
2. **decreases as we move towards its end.**
3. **increases as we move towards its end.**
4. **is the same at all points.**

Solution:

d. is the same at all points

The magnetic field inside a long straight current-carrying solenoid is uniform. Therefore, it is the same at all points.

In text 13.3 Page: 231

1. Which of the following property of a proton can change while it moves freely in a magnetic field? (There may be more than one correct answer.)

1. **Mass**
2. **Speed**
3. **Velocity**
4. **Momentum**

Solution:

(c) and (d)

When a proton enters the region of a magnetic field, it experiences a magnetic force. Due to this, the path of the proton becomes circular. As a result, the velocity and the momentum change.

2. In Activity 13.7, how do we think the displacement of rod AB will be affected if (i) current in rod AB is increased; (ii) a stronger horse-shoe magnet is used; and (iii) length of the rod AB is increased?

Solution:

A current-carrying conductor, when placed in a magnetic field, experiences force. The magnitude of this force will increase with the increase in the amount of current, the length of the conductor and the strength of the magnetic field. Hence, the strength of the magnetic force exerted on the rod AB and its displacement will increase if

1. The current in rod AB is increased
2. A stronger horseshoe magnet is used
3. When the length of the rod AB increases

3. A positively-charged particle (alpha-particle) projected towards the west is deflected towards north by a magnetic field. The direction of magnetic field is

1. **towards south**
2. **towards east**
3. **downward**
4. **upward**

Solution:

The direction of the magnetic field can be determined using Fleming's Left-hand rule. According to the rule, if we arrange our thumb, forefinger and the middle finger of the left hand right perpendicular to each other, then the thumb points towards the direction of the magnetic force, the middle finger the direction of current and the forefinger the direction of magnetic field. Since the direction of the positively charged particle is towards the west, the direction of the current will also be towards the west. The direction of the magnetic force is towards the north. Hence the direction of the magnetic field will be upward according to Fleming's Left-hand rule.

In text 13.4 Page: 233

1. State Fleming's left-hand rule.

Solution:

Fleming's Left-hand rule states that if we arrange our thumb, forefinger and middle finger of the left hand at right angles to each other, then the thumb points towards the direction of the magnetic force, the forefinger points towards the direction of the magnetic field and the middle finger points towards the direction of the current.

2. What is the principle of an electric motor?

Solution:

The working principle of an electric motor is based on the magnetic effect of current. A current-carrying conductor, when placed in a magnetic field, experiences force and rotates. The direction of the rotation of the conductor can be determined by Fleming's Left-hand rule.

3. What is the role of split ring in an electric motor?

Solution:

The split ring plays the role of a commutator in an electric motor. The commutator reverses the direction of the current flowing through the coil after each half-rotation of the coil. Due to this reversal of current, the coil continues to rotate in the same direction.

In text 13.5 Page: 236

1. Explain different ways to induce current in a coil.

Solution:

Following are the different ways to induce a current in a coil:

- If the coil is moved rapidly between the two poles of a horseshoe magnet, an electric current is induced in the coil.
- When a magnet is moved relative to the coil, an electric current is induced in the coil.

In text 13.6 Page: 237

1. State the principle of an electric generator.

Solution:

An electric generator works on the principle of electromagnetic induction. In a generator, electricity is generated by rotating a coil in the magnetic field.

2. Name some sources of direct current.

Solution:

DC generators and cells are some sources of direct current.

3. Which sources produce alternating current?

Solution:

Power plants and AC generators are some of the sources that produce alternating current.

4. Choose the correct option.

A rectangular coil of copper wires is rotated in a magnetic field. The direction of the induced current changes once in each

1. **two revolutions**
2. **one revolution**
3. **half revolution**
4. **one-fourth revolution**

Solution:

c. half revolution

When a rectangular coil is rotated in a magnetic field, the direction of the induced current changes once in a half revolution; as a result, the direction of the current in the coil remains the same.

In text 13.7 Page: 238

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

Solution:

The safety measures commonly used in electric circuits are as follows:

1. **Fuse**

Each circuit should be connected to a fuse because a fuse prevents the flow of excessive current through the circuit. When the current in the circuit exceeds the maximum limit of the fuse element, the fuse melts to stop the flow of current protecting the appliance connected to the circuit.

1. **Earthing**

Earthing protects the user from electric shocks. Any leakage of current in an appliance is transferred to the ground by earthing, and the people using the appliance are prevented from getting electrocuted.

2. 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.

Solution:

The current drawn by the electric oven can be calculated using the formula

$P = V \times I$

$I = P/V$

Substituting the values, we get

I = 2000 W/220 V = 9.09 A

The current drawn by the electric oven is 9.09 A which exceeds the safe limit of the circuit. This causes the fuse to melt and break the circuit.

3. What precaution should be taken to avoid the overloading of domestic electric circuits?

Solution:

A few of the precautions to be taken to avoid the overloading of domestic electric circuits are as follows:

- Connecting too many devices to a single socket should be avoided
- Using too many appliances at the same time should be avoided
- Faulty appliances should not be connected to the circuit

Exercises

Page: 240

1. Which of the following correctly describes the magnetic field near a long straight wire?

1. **The field consists of straight lines perpendicular to the wire.**
2. **The field consists of straight lines parallel to the wire.**
3. **The field consists of radial lines originating from the wire.**
4. **The field consists of concentric circles centered on the wire.**

Solution:

4. The field consists of concentric circles centred on the wire.

The magnetic field near a long straight wire is concentric circles. Their centres lie on the wire.

2. The phenomenon of electromagnetic induction is

1. **the process of charging a body.**
2. **the process of generating a magnetic field due to a current passing through a coil.**
3. **producing induced current in a coil due to relative motion between a magnet and the coil.**
4. **the process of rotating a coil of an electric motor.**

Solution:

3. producing induced current in a coil due to relative motion between a magnet and the coil.

The phenomenon of inducing current in a coil due to the relative motion between the coil and the magnet is known as electromagnetic induction.

3. The device used for producing electric current is called a

1. **generator**
2. **galvanometer**
3. **ammeter**
4. **motor**

Solution:

a. generator

The device used for producing electric current is known as a generator. The generator converts mechanical energy to electric energy.

4. The essential difference between an AC generator and a DC generator is that

1. **AC generator has an electromagnet while a DC generator has permanent magnet.**
2. **DC generator will generate a higher voltage.**
3. **AC generator will generate a higher voltage.**

4. **AC generator has slip rings while the DC generator has a commutator.**

Solution:

4. AC generator has slip rings, while the DC generator has a commutator.

AC generators have two rings known as the slip rings, while DC generators have two half rings known as the commutator. This is the main difference between AC generator and DC generator.

5. At the time of short circuit, the current in the circuit

1. **reduces substantially.**
2. **does not change.**
3. **increases heavily.**
4. **vary continuously.**

Solution:

3. increases heavily

When two naked wires in the circuit come in contact with each other, the amount of current flowing in the circuit increase abruptly resulting in short circuit.

6. State whether the following statements are true or false.

1. **An electric motor converts mechanical energy into electrical energy.**
2. **An electric generator works on the principle of electromagnetic induction.**
3. **The field at the center of a long circular coil carrying current will be parallel straight lines.**
4. **A wire with a green insulation is usually the live wire of an electric supply.**

Solution:

1. False

An electric motor converts electrical energy into mechanical energy.

2. True

An electric generator is a device that generates electricity by rotating a coil in a magnetic field.

3. True

A long circular coil is a solenoid. The magnetic field lines inside a solenoid are parallel straight lines.

4. False

Live wires have red insulation cover, while the earth wire has green insulation.

7. List two methods of producing magnetic fields.

Solution:

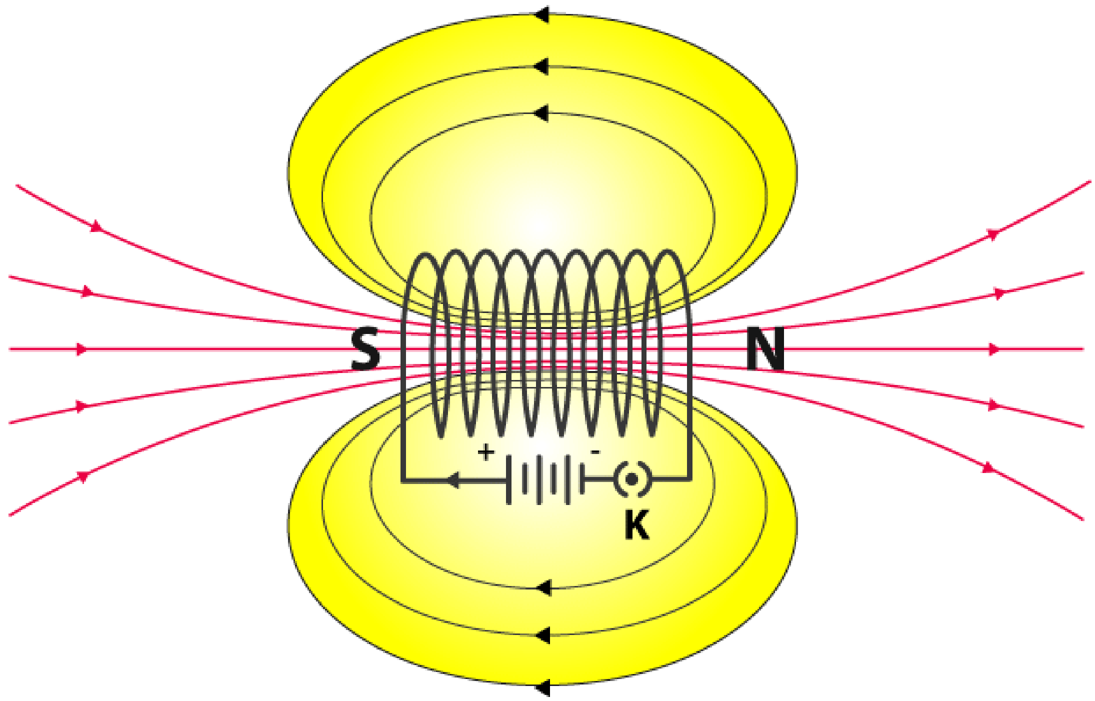
Following are the methods of producing magnetic fields:

- By using a permanent magnet, we can produce a magnetic field, and it can be visualized by spreading iron fillings on white paper and keeping a magnet beneath the paper.
- A current-carrying straight conductor produces magnetic field.
- Different types of conductors, such as solenoid and circular loops, can be used to see the presence of a magnetic field.

8. 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.

Solution:

A solenoid is a long coil of circular loops of insulated copper wire. The magnetic field produced around the solenoid when the current is passed through it is similar to the magnetic field produced around the bar magnet when a current is passed through it. The figure shown below shows the arrangement of magnetic fields produced around the solenoid when current is passed through it.



When the north pole of the bar magnet is brought close to the end connected to the negative terminal of the battery, the solenoid repels the battery. As like poles repel each other, we can infer that the end connected to the negative terminal behaves as a north pole while the end connected to the positive terminal behaves as a south pole.

9. When is the force experienced by a current–carrying conductor placed in a magnetic field largest?

Solution:

When the direction of the current is perpendicular to the direction of the magnetic field, the force experienced is the largest.

10. Imagine that you are sitting in a chamber with your back to one wall. An electron beam, moving horizontally from back wall towards the front wall, is deflected by a strong magnetic field to your right side. What is the direction of magnetic field?

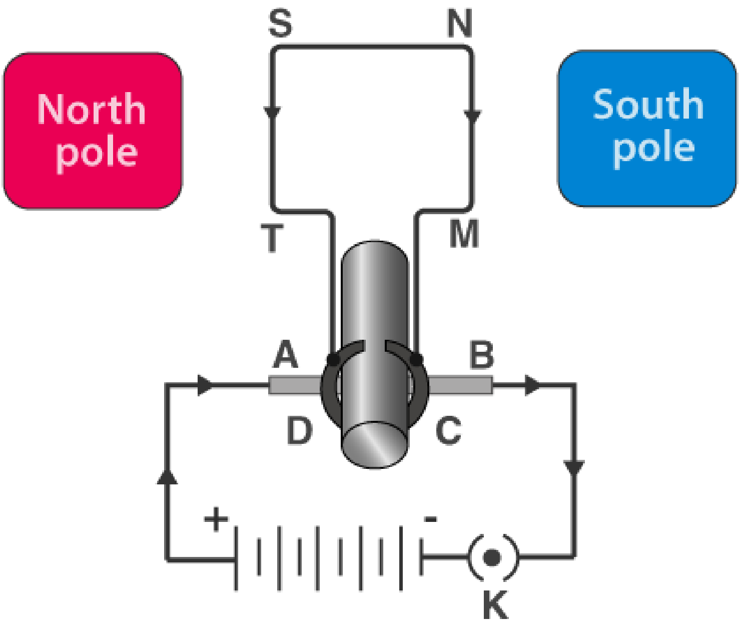
Solution:

The direction of the magnetic field can be determined using Fleming's Left-hand rule. The direction of the magnetic field will be perpendicular to the direction of the current and the direction of deflection, i.e., either upward or downward. The direction of the current is from the front wall to the back wall because negatively charged electrons move from the back wall to the front wall. The direction of the magnetic force is rightward. Hence, using Fleming's left-hand rule, it can be concluded that the direction of the magnetic field inside the chamber is downward.

11. Draw a labelled diagram of an electric motor. Explain its principle and working. What is the function of a split ring in an electric motor?

Solution:

An electric motor is a device that converts electrical energy to mechanical energy. It works on the principle of the magnetic effect of current. The figure listed below shows a simple electric motor.



When current is made to flow through the coil MNST by closing the switch, the coil starts to rotate in the anticlockwise direction. This is due to the downward force acting on the length MN and simultaneously an upward force acting along the length ST. As a result of which, the coil rotates in the anticlockwise direction. Current in the length MN flows from

M to N, and the magnetic fields act from left to right normal to the length MN. According to Fleming's Left-Hand rule, a downward force acts along the length MN. Similarly, the current along the length ST flows from S to T and the magnetic field acts from left to right. Therefore, an upward force acts along the length ST. These two forces together cause the coil to rotate anti-clockwise. After half a rotation, the position of MN and ST interchange. The half-ring C comes in contact with brush B and the half-ring D comes in contact with rush C. Hence the direction of current in the coil MNST gets reversed.

12. Name some devices in which electric motors are used.

Solution:

A few devices in which electric motors are used are:

- Electric fans
- Water pumps
- Mixers
- Washing machines

13. A coil of insulated copper wire is connected to a galvanometer. What will happen if a bar magnet is (i) pushed into the coil, (ii) withdrawn from inside the coil, (iii) held stationary inside the coil?

Solution:

(i) When a bar magnet is pushed into the coil, a current is induced in the coil momentarily. As a result, the galvanometer deflects in a particular direction momentarily.

(ii) When the bar magnet is withdrawn from inside the coil, a current is induced momentarily but in the opposite direction, and the galvanometer deflects in the opposite direction momentarily.

(iii) When the bar magnet is held stationary inside the coil, no current will be induced. As a result, there will be no deflection in the galvanometer.

14. 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.

Solution:

When the current in coil A changes, the magnetic field associated with it also changes. As a result, the magnetic field around coil B undergoes change. The change in the magnetic field of coil B induces a current in it.

15. State the rule to determine the direction of a (i) magnetic field produced around a straight conductor-carrying current, (ii) force experienced by a current-carrying straight conductor placed in a magnetic field which is perpendicular to it, and (iii) current induced in a coil due to its rotation in a magnetic field.

Solution:

(i) The rule used to determine the direction of the magnetic field produced around a straight conductor-carrying current is Maxwell's right-hand thumb rule.

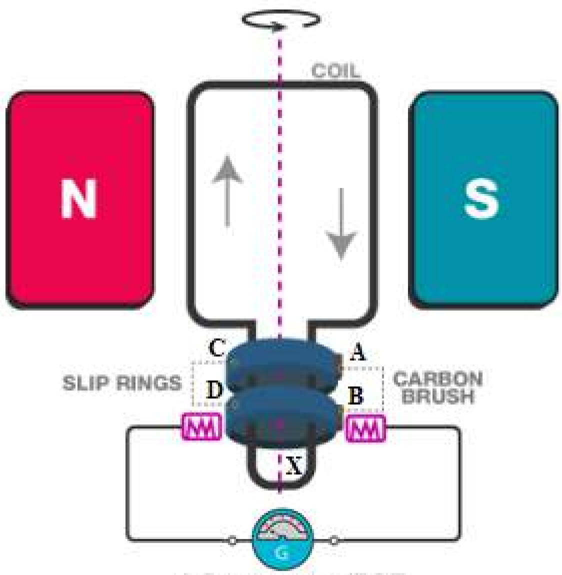
(ii) The rule used to determine the force experienced by a current-carrying straight conductor placed in a magnetic field which is perpendicular to it is the Fleming's left hand rule.

(iii) The rule used to determine the current induced in a coil due to its rotation in a magnetic field is Fleming's right-hand rule.

16. Explain the underlying principle and working of an electric generator by drawing a labelled diagram. What is the function of brushes?

Solution:

The electric generator converts mechanical energy into electrical energy. The working principle of the electric generator is electromagnetic induction. It generates electricity by rotating a coil in the magnetic field. The figure below shows the construction of a simple AC generator.



In the diagram,

A and B are brushes.

C and D are slip rings.

X is the axle.

G is the galvanometer.

When the axle X is rotated clockwise, MN moves upwards while ST moves downward. The movement of MN and ST in the magnetic field results in the production of electric current due to electromagnetic induction. MN moves upwards, and the magnetic fields act from left to right. Therefore, according to Fleming's right hand rule, the direction of the induced current will be from M to N along the length MN. Similarly, the direction of the induced current will be from S to T along the length ST. The direction of the current in the coil is MNST. Hence, the galvanometer shows a deflection in a particular direction.

After half a rotation, length MN starts moving downwards while the length ST starts moving upwards. Now, the direction of the induced current reverses to TSNM. Since the direction of the induced current reverses every half rotation, the current induced is known as alternating current.

Function of Brushes

Brushes are kept pressed onto two slip rings separately. The outer ends of the brushes are connected to the galvanometer. Thus, brushes help in transferring current from the coil to the external circuit.

17. When does an electric short circuit occur?

Solution:

Listed below are two instances of when a short-circuit can occur:

1) When too many appliances are connected to a single socket or when high power rating appliances are connected to a light circuit, the resistance of the circuit becomes low. As a result, the current flowing through the circuit becomes very high. This condition results in a short circuit.

2) When live wires whose insulation has worn off come in contact with each other, the current flowing in the circuit increases abruptly, which results in a short circuit.

18. What is the function of an earth wire? Why is it necessary to earth metallic appliances?

Solution:

The metallic body of electric appliances is earthed by means of an earth wire. Any leakage of electric wire is transferred to the ground by means of the earth wire. This prevents the user of the electric appliance from getting electric shocks. This is the reason why it is important for metallic appliances to be earthed.