Chapter-12

Magnetic Effects of Electric Current

2 MARKS QUESTIONS

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

2. What is the principle of an electric motor?
Answer:
An electric motor's working principle is known to be based on the magnetic effect of current. A current-carrying loop would experience a force and would rotate when placed in a magnetic field. The direction of rotation of the loop could be provided by Fleming's left-hand rule.

3. What is the role of the split ring in an electric motor?
Answer:
The split ring keeps the motor rotating in the same direction. The split ring in the electric motor also acts as a commutator. The commutator reverses the direction of current flowing through the coil after each half rotation of the coil. Due to this reversal of the current, the coil would continue to rotate in the same direction.

4.Explain different ways to induce a current in a coil.
Answer:
The different ways to induce a current in a coil are as follows:
(a) An electric current is induced in the coil, if a coil is moved rapidly between the two poles of a horse-shoe magnet.

(b) And if a magnet is moved relative to a coil,

5.What precautions should be taken to avoid the overloading of domestic electric circuits?
Answer:
Following precautions should be taken in order to avoid the overloading of domestic circuits:
i. Too many appliances shouldn't be connected to a single socket.

ii. Too many appliances shouldn't be used simultaneously.

iii. Fuse must be connected to the circuit.

iv. Faulty appliances shouldn't be connected into the circuit.

6.List three sources of magnetic fields.
Answer:
Three sources of magnetic fields are the following:
i. Current-carrying conductors

ii. Permanent magnets

iii. Electromagnets

7. When is the force experienced by a current-carrying conductor placed in a magnetic field largest?
Answer:
The force experienced is found to be maximum when the direction of the current is perpendicular to the direction of the magnetic field.

8. Name some devices in which electric motors are used.
Answer:
Water pumps, electric fans, electric mixers and washing machines are some of the devices in which electric motors are used.

9.What is the function of an earth wire? Why is it necessary to earth metallic appliances?
Answer:
Using an earth wire, the metallic body of electric appliances could be connected to the earth so that any electric current leakage is transferred to the ground. This would prevent any electric shock to the user. Therefore, earthing of electrical appliances is very necessary.

10. Name some sources of direct current.

Solution:

DC generators and cells are some sources of direct current.

11. Which sources produce alternating current?

Solution:

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

12. 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.

13.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

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:

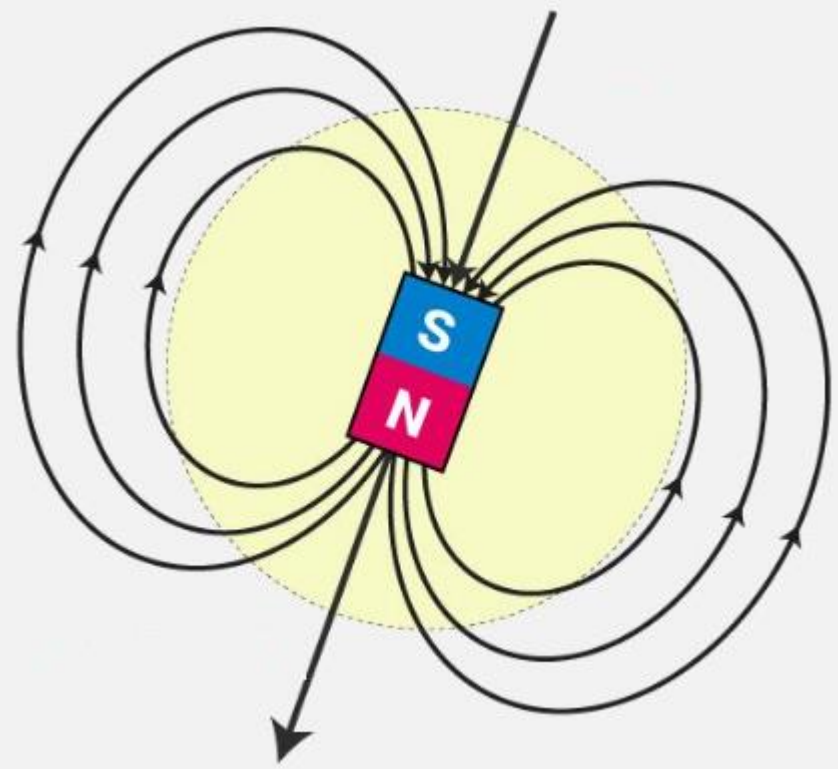
When the current in coil A changes, the magnetic field associated with it also changes. As a result, the magnetic field around coil B undergoes change. The change in the magnetic field of coil B induces a current in it.

4 MARKS QUESTIONS

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.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

4.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.

5. 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

6.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.

7. 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.

8.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.

9.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.

10.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.

11.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.

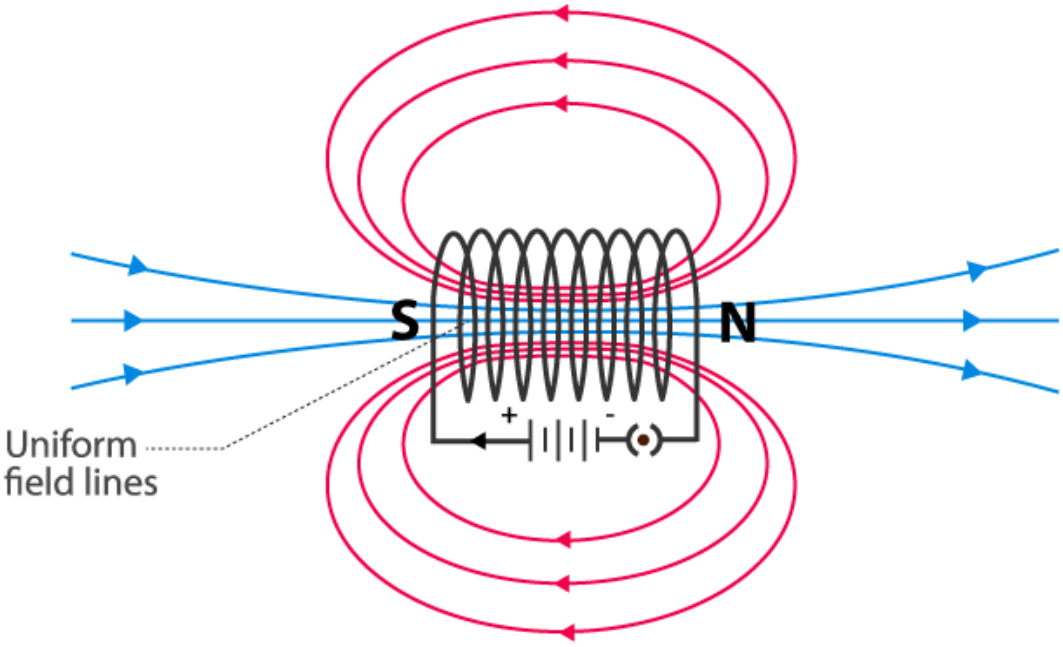
12.What is the function of an earth wire? Why is it necessary to earth metallic appliances?

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.

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

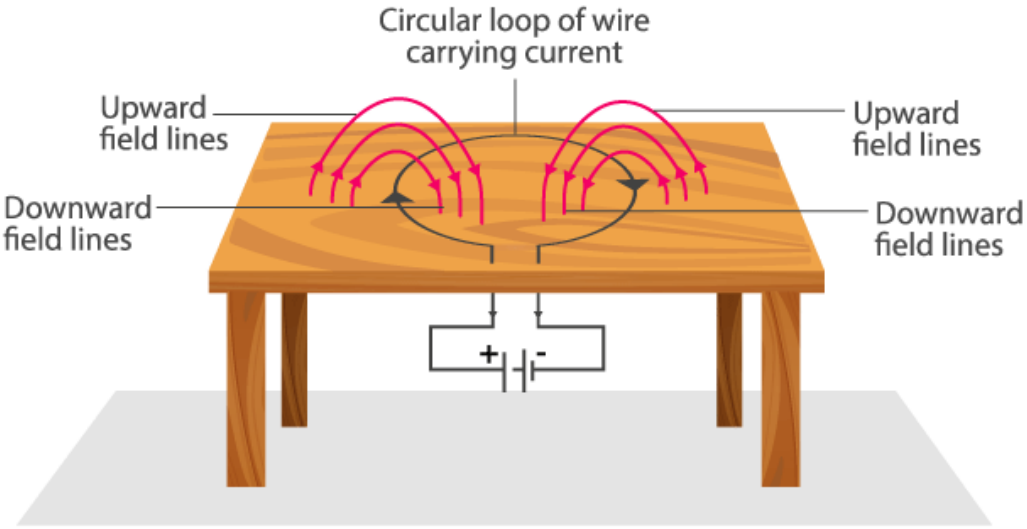
Solution:



7 MARKS QUESTIONS

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.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.

3.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.

4.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.

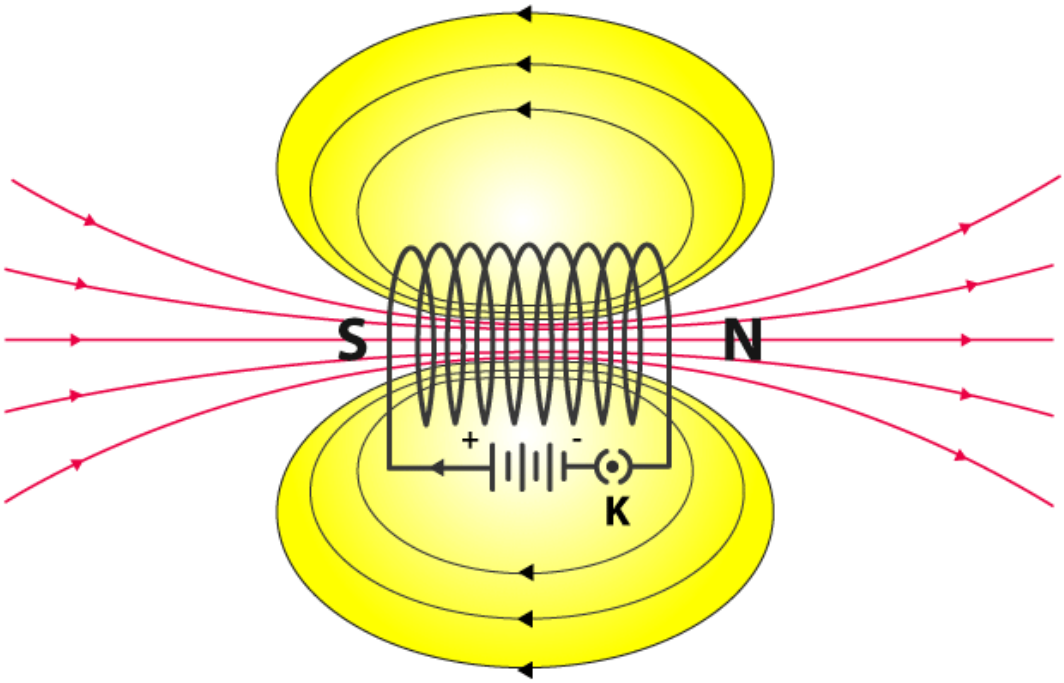
4. False

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

5.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.

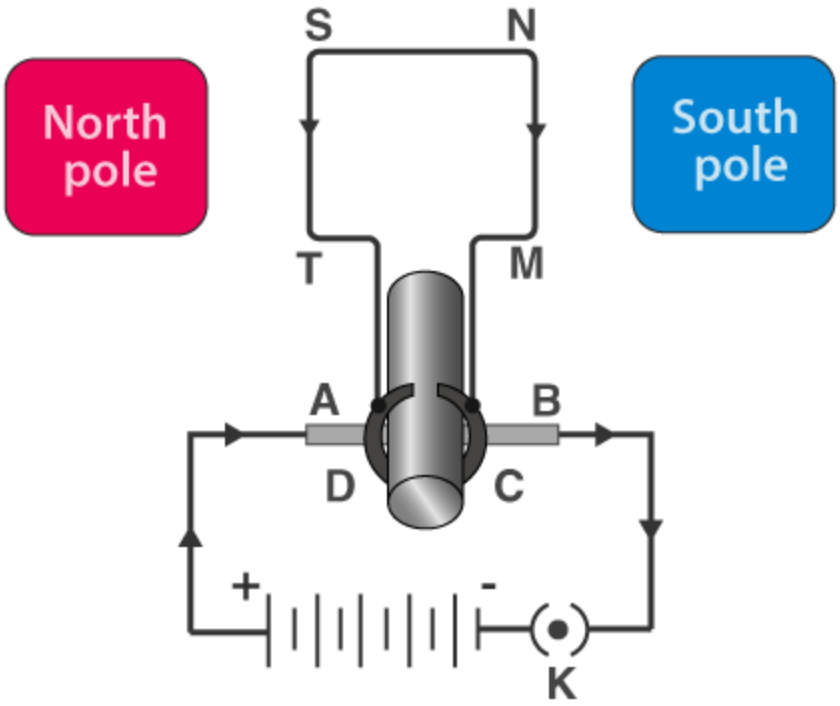


When the north pole of the bar magnet is brought close to the end connected to the negative terminal of the battery, the solenoid repels the battery. As like poles repel each other, we can infer that the end connected to the negative terminal behaves as a north pole while the end connected to the positive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

6.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.



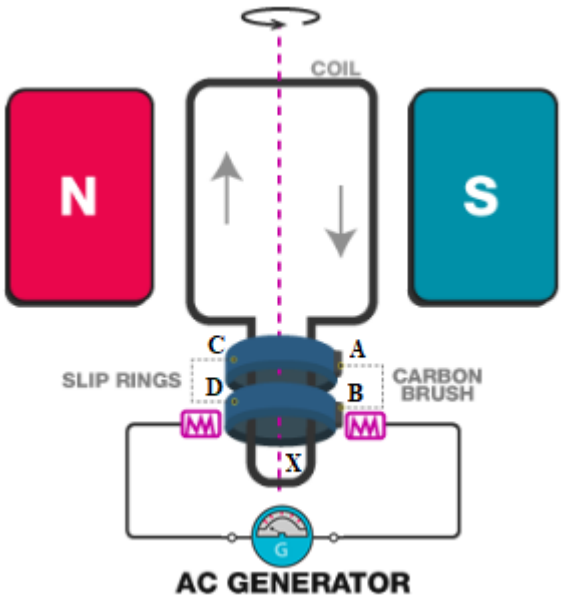
When current is made to flow through the coil MNST by closing the switch, the coil starts to rotate in the anticlockwise direction. This is due to the downward force acting on the length MN and simultaneously an upward force acting along the length ST. As a result of which, the coil rotates in the anticlockwise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

7. 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.

MULTIPLE CHOICE QUESTIONS

1) The most suitable material for making the core of an electromagnet is:

a) Steel

b) Iron

c) Soft iron

d) Aluminium

Correct Answer: Option (c)

2) Which of the following is not attracted by a magnet?

(a) Steel

(b) Cobalt

(c) Brass

(d) Nickel

Correct Answer: Option (c)

3) When a straight conductor is carrying current:

a) There are circular magnetic field lines around it

b) There are magnetic field lines parallel to the conductor

c) There are no magnetic field lines

d) None of the above

Correct Answer: Option (a)

4) A plotting compass is placed near the south pole of a bar magnet. The pointer of the plotting compass will:

(a) Point away from the south pole

(b) Point parallel to the south pole

(c) Point towards the south pole

(d) Point at right angles to the south pole

Correct Answer: Option (c)

5) Two magnetic field lines:

a) Intersect at the neutral point

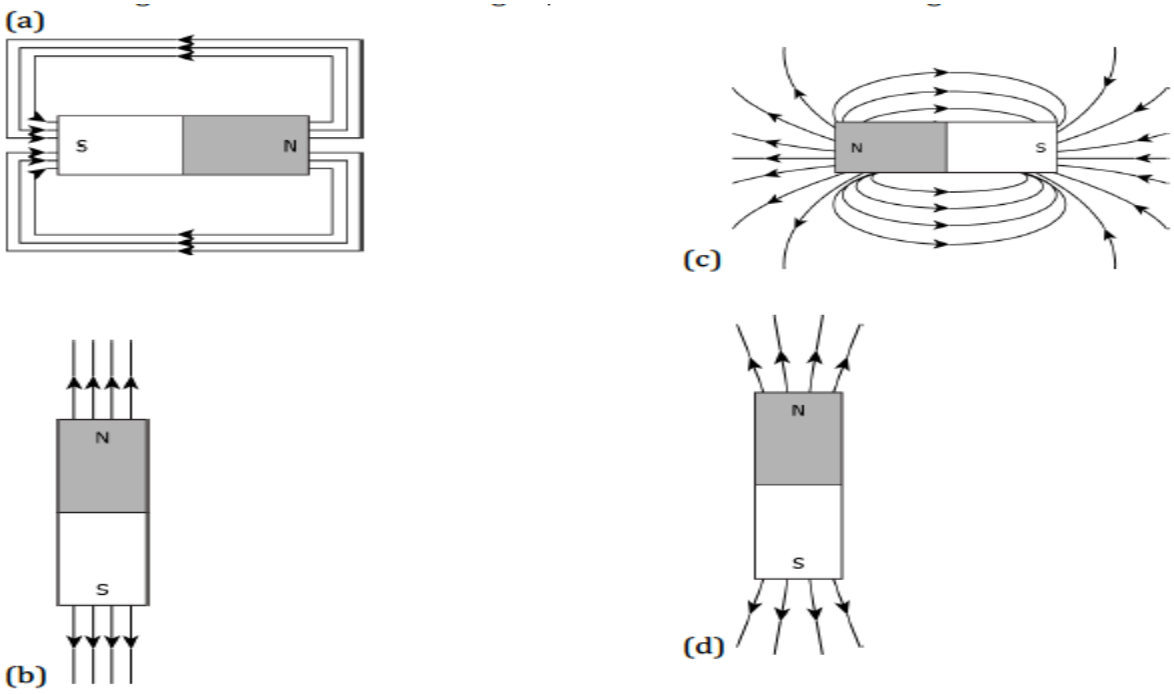
b) Never intersect each other

c) Intersect near north-pole or south pole

d) Intersect at the midpoint of the magnet

Correct Answer: Option (b)

6) A student learns that magnetic field strength around a bar magnet is different at every point. Which diagram shows the correct magnetic field lines around a bar magnet?



Correct Answer: Option (c)

7) The front face of a circular loop of a wire is the North Pole, the direction of current in this face of the loop will be:

a) Clockwise

b) Anticlockwise

c) Towards North

d) Towards South

Correct Answer: Option (b)

8) Which of the following statements is incorrect regarding magnetic field lines?

(a) The direction of the 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 the magnetic field is shown by the degree of closeness of the field lines.

Correct Answer: Option (c)

9) The magnetic field inside a long straight solenoid carrying current:

a) Is zero

b) Decrease as we move towards its end

c) Is the same at all points

d) Increase as we move towards its end

Correct Answer: Option (c)

10) A strong bar magnet is placed vertically above a horizontal wooden board. The magnetic lines of force will be:

(a) Only in the horizontal plane around the magnet

(b) Only in the vertical plane around the magnet

(c) In horizontal as well as vertical planes around the magnet

(d) In all the planes around the magnet

Correct Answer: Option (d)

FILL IN THE BLANKS

1.A coil of wire that produces a magnetic field when an electric current flows through it is called an _____.

Answer: electromagnet

2.The direction of the magnetic field around a current-carrying wire is determined by _____.

Answer: the right-hand rule

3.The strength of an electromagnet can be increased by increasing the number of _____.

Answer: turns in the coil

4.The magnetic field inside a solenoid is _____ when an electric current flows through it.

Answer: intensified

5.The magnetic field around a current-carrying straight conductor forms _____ lines.

Answer: concentric

6.The SI unit of magnetic flux is the _____.

Answer: weber

7.A device that uses the principle of electromagnetic induction to convert mechanical energy into electrical energy is called a _____.

Answer: generator

8.The phenomenon where a changing magnetic field induces an electromotive force (EMF) in a coil is known as _____.

Answer: electromagnetic induction

9.The magnetic field strength of an electromagnet can be increased by placing a _____ core inside the coil.

Answer: ferromagnetic

10.The direction of the induced current in a coil is governed by _____.

Answer: Lenz's Law