Magnetic Effects of Electric Current

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

Solution:

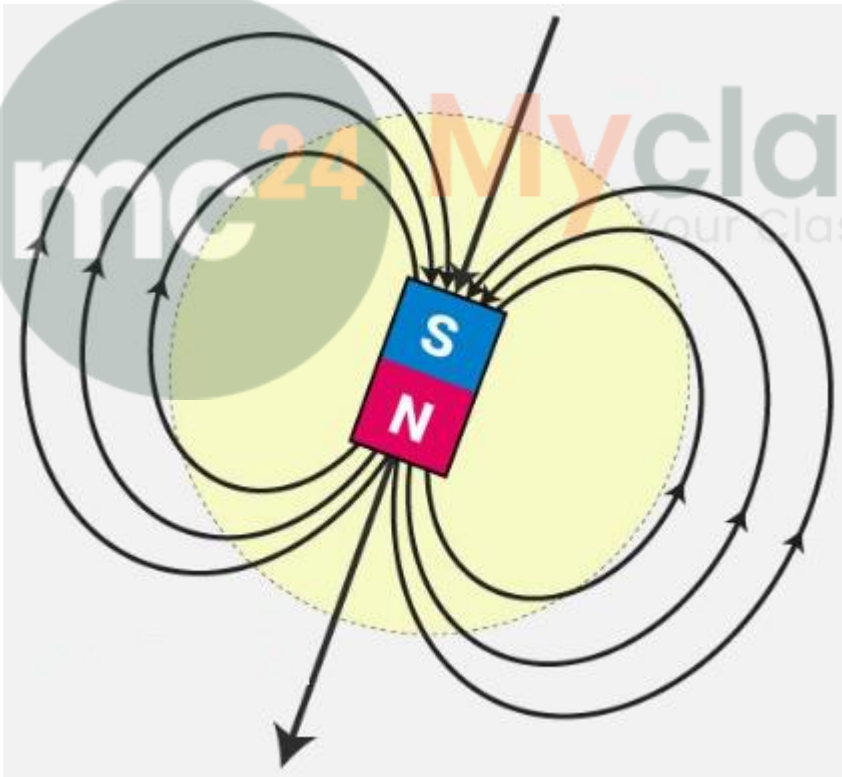
The compass needle is a small magnet. When the compass needle is brought close to a bar magnet, the magnetic field lines of the compass needle interact with the magnetic field lines of bar magnet, which causes the compass needle to deflect.

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?

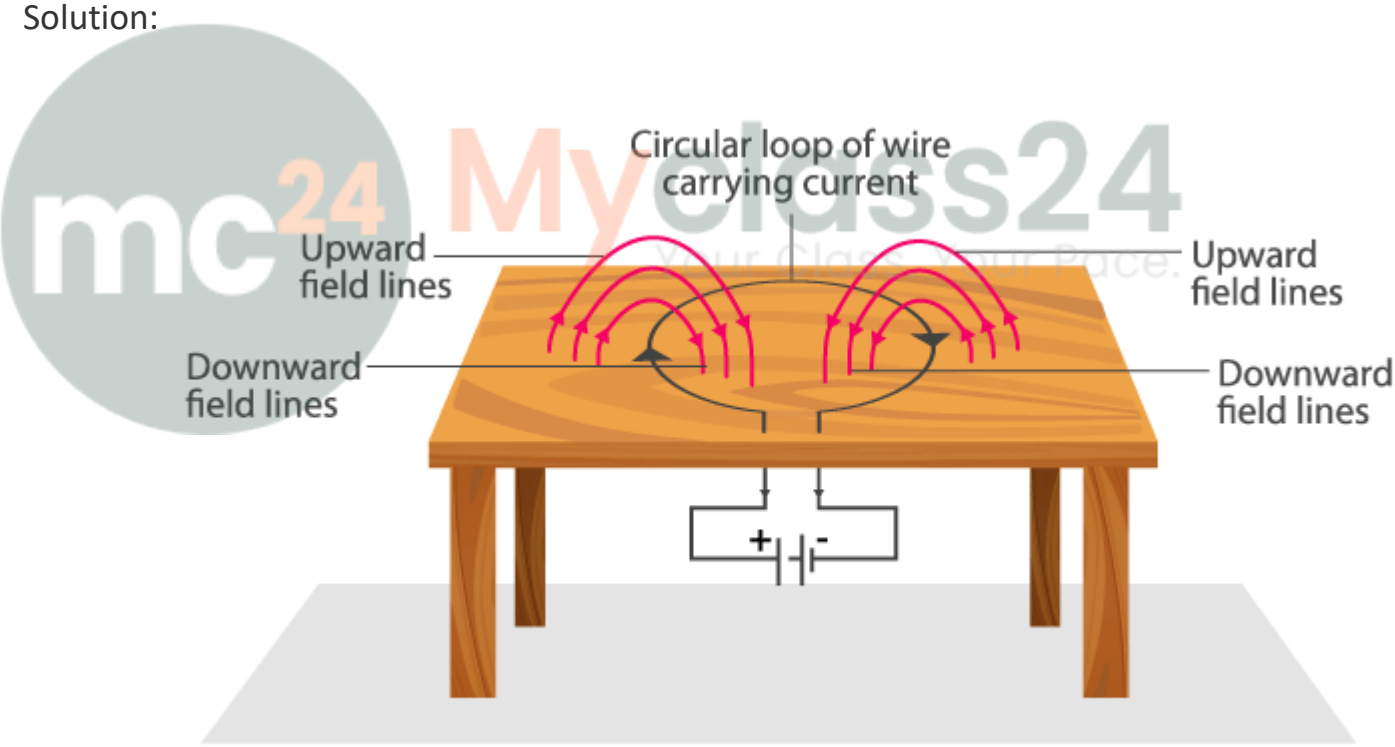
Solution:

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.

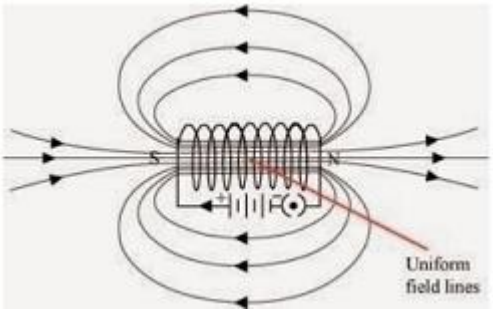
Solution:



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.

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

Solution : The uniform magnetic field is represented by parallel equispaced lines of equal length as follows:



6. Choose the correct option:

The magnetic field inside a long straight solenoid-carrying current

(a) Is zero.

(b) Decrease as we move towards its end.

(c) Increase as we move towards it end.

(d) Is the same all points.

Solution : (d) is the same at all points.

7. Which of the following property of a proton can change while it moves freely in a magnetic field?

(a) mass

(b) speed

(c) velocity

(d) momentum

Solution : (c), (d) Velocity as well as momentum will change.

8. In activity 13.7, how do we think the displacement of rod AB will be affected if (i) current is 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 placed in a magnetic field experiences a force. The magnitude of force increases with the amount of current, strength of the magnetic field, and the length of the conductor. Hence, the magnetic force exerted on rod AB and its deflection will increase if
(i) current in rod AB is increased
(ii) a stronger horseshoe magnet is used
(iii) length of rod AB is increased

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

(a) towards south

(b)towards east

(c) downward

(d) upward

Solution : (d) the direction of magnetic field is vertically upward.

1. State Fleming's left-hand rule.
Ans: 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?

Ans: 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?
Ans: 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.

Intext Exercise 6
1.Explain different ways to induce a current in a coil.
Ans: 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,

Intext Exercise 7
1. State the principle of an electric generator.
Ans: An electric generator works based on the principle of electromagnetic induction. An electric generator is known to generate electricity by rotating a coil in a magnetic field.

2. Name some sources of direct current.
Ans: Cell, DC generator, etc are some sources of direct current.

3. Which sources produce alternating current?
Ans: AC generators, power plants, etc. can produce alternating current.

4. Choose the correct option.
A rectangular coil of copper wire is rotated in a magnetic field. The direction of the induced current changes once in each
a. Two Revolutions
b. One Revolution
c. Half Revolution
d. One-Fourth Revolution
Ans: The correct option is (c). When a rectangular coil of copper is rotated in a magnetic field, the direction of the induced current in the coil would change once in each half revolution.
1. Name two safety measures commonly used in electric circuits and appliances.

Solution:

The safety measured 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 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 is 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:

d. The field consists of concentric circles centered on the wire.

The magnetic field near a long straight wire are concentric circles. Their centers lie on the wire.

2. The phenomenon of electromagnetic induction is

1. **the process of charging a body.**
2. **the process of generating 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:

c. 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 generator. Generator converts mechanical energy to electric energy.

24. The essential difference between A.C. generator and a D.C. generator is that

(a) A.C. generator has an electromagnet while a D.C. generator has permanent magnet.

(b) D.C. generator will generate a higher voltage

(c) A.C. generator will generate a higher voltage

(d) A.C. generator has slip rings while the D.C. generator has commutator.

Solution : (d) A.C. generator has slip rings while the D.C. generator has commutator.

25. At the time of short circuit, the current in the circuit:

(a) reduce substantially

(b) does not change

(c) increase heavily

(d) vary continuously

Solution : (c) increase heavily

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

(a) An electric motor converts mechanical energy into electrical energy.

(b) An electric generator works on the principle of electromagnetic induction.

(c) The field at the centre of a long circular coil carrying current will be parallel straight line

(d) A wire with green insulation is usually the live wire of an electric supply.

Solution :

(a) False

(b) True

(c) True

(d) False

27. List three methods of producing magnetic field.

Solution : Three methods of producing magnetic fields are as follows:

(a) Magnetic field can be produced by placing a permanent magnet or a horse-shoe magnet at the place, where magnetic field is required.

(b) Magnetic field is produced around a current carrying straight conductor or a current carrying coil.

(c) A very good method to produce magnetic field is due to flow of current in a solenoid.

28. 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 : When current is passed through a solenoid coil, magnetic field is produced due to presence of turns in same direction. As a result, the resultant magnetic field is very strong and uniform. Solenoid behaves like a strong bar magnet. We can determine the poles of magnet formed by solenoid. The end of solenoid connectd with positive terminal behaves like South Pole and the end connected with negative terminal behaves as North Pole.

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

10. Imagine that you are sitting in a chamber with your back to one wall. An electron beam, moving horizontally from the back wall towards the front wall, is deflected by a strong magnetic field to your right side. What is the direction of magnetic field?
Ans: The direction of the magnetic field could be given by Fleming's left-hand rule. Magnetic field inside the chamber would be perpendicular to the direction of current (opposite to the direction of electron) and direction of deflection/force i.e., either upward or downward. The direction of current is from the front wall to the back wall as the negatively charged electrons are moving from the back wall to the front wall. Also, the direction of magnetic force is rightward.

Now, by using Fleming's left-hand rule, it could 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?
Ans: An electric motor is known to convert electrical energy into mechanical energy. It works based on the principle of the magnetic effect of current. We

know that a current-carrying coil rotates in a magnetic field. The following figure shows a simple electric motor.

(Image will be uploaded soon)

Initially, current is allowed to flow through the coil ABCD by closing the switch. Current in the length AB will flow from A to B and the magnetic field acts from left to right, normal to length AB. Hence, according to Fleming's left-hand rule, a downward force would act along the length AB and at the same time, an upward force acts along the length CD. As a result, the coil would rotate anti-clockwise.

After half a rotation, the position of AB and CD can be interchanged. The half-ring P comes in contact with brush X and half-ring Q comes in contact with brush Y. Hence, the direction of current in the coil ABCD gets reversed.

The current flows through the coil in the direction DCBA. The reversal of current through the coil ABCD repeats after each half rotation. As a result, the coil rotates unidirectional. The split rings help to reverse the direction of current in the circuit. These are called the commutators.

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

13. A coil of insulated copper wire is connected to a galvanometer. What will happen if a bar magnet is:
a. Pushed into the coil?
Ans: If a bar magnet is moved relative to a solenoid, a current would be induced in it. This is known to be the principle of electromagnetic induction.

When a bar magnet is pushed towards a coil of insulated copper wire, a current would be induced momentarily in the coil. As a consequence, the galvanometer's needle would momentarily deflect in a particular direction.

b. Withdrawn from inside the coil?
Ans: When the bar magnet is withdrawn from inside the coil of insulated copper wire, a current would be again induced momentarily in the coil in the opposite direction. As a result, the galvanometer's needle would momentarily deflect in the opposite direction.

c. held stationary inside the coil?
Ans: When a bar magnet is held stationary inside the coil, no current can be induced in the coil. Therefore, the galvanometer would not show any deflection.

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 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 the 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.

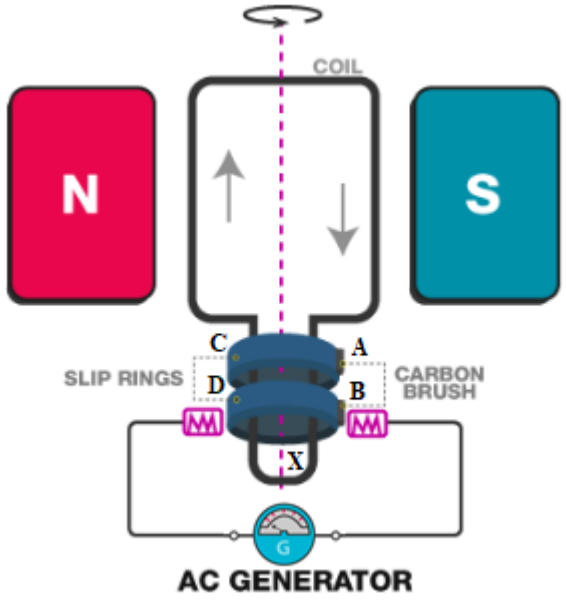
(iii) The rule used to determine the current induced in a coil due to its rotation in a magnetic field is the Fleming's right-hand rule.

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 coverts the mechanical energy into the electrical energy. The working principle of the electric generator is the 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, 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 on to two slip rings separately. Outer ends of brushes are connected to the galvanometer. Thus, brushes help in transferring current from coil to the external circuit.

1. **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 have worn off come in contact with each other, the current flowing in the circuit increases abruptly which results in a short circuit.

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

Solution : The earth wires functions as a safety measure, especially for those appliances that have a metallic body, like heater, electric, press, room cooler etc.
The metallic body of the appliance is connected to the earth wire, which provides a low resistance conducting path for electric current. It ensures that any leakage of current to the metallic body of an appliance keeps it potential same as of earth. As a result, the user would not get severe electric shock, even if he touches the body of appliance.