Magnetic Effects of Electric Current

CHAPTER 13

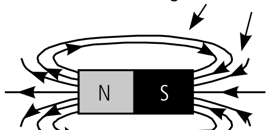
NCERT FOCUS

ANSWERS

Topic 1

1. Compass needle gets deflected due to attractive or repulsive interactions between its magnetic field and the magnetic field of the bar magnet.

2.



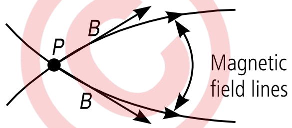
3. The properties of the magnetic field lines are listed below:

(a) Magnetic field lines start at the North pole and end at the South pole.

(b) Magnetic field lines do not intersect each other, because there can not be two directions of the magnetic field at any one point.

(c) The degree of closeness of the field lines depends upon the strength of the magnetic field. Stronger the field, closer are the field lines.

4. The direction of magnetic field (*B*) at any point is obtained by drawing a tangent to the magnetic field line at that point. In case, two magnetic field lines intersect each other at the point *P* as shown in figure, magnetic field at *P* will have two directions, shown by two arrows, one drawn to each magnetic field line at *P*,which is not possible.

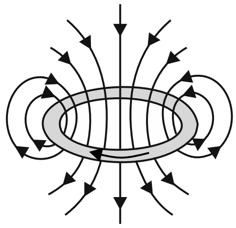


Topic 2

1. **(d) :** The magnetic field lines around a straight wire carrying current are concentric circle whose centre lie on the wire.

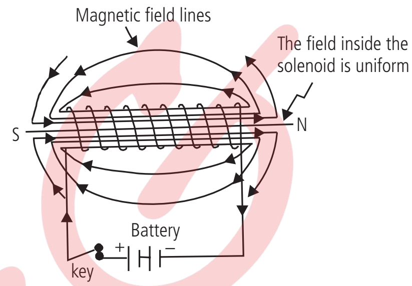
Topic 3

1. The magnetic field inside and outside the current-carrying loop is shown in the given figure.



Topic 4

1. The field lines inside the solenoid are in the form of parallel straight lines. This indicates that the magnetic field inside the solenoid is uniform. This is shown in diagram.



2. (d) : The magnetic field inside a current-carrying solenoid is constant in magnitude and direction, and acts along the axis of the solenoid.

Topic 5

1. **(c, d) :** Each charged particle moving in a magnetic field experiences a force. The direction of force experienced by a positive charge (*i.e.*, a proton) is given by Fleming's left hand rule. The force acting on the proton would change both velocity and momentum.

2. The displacement of the rod *AB*

(a) will increase when the current in rod *AB* is increased.

(b) will increase when a stronger horse-shoe magnet is used.

(c) will increase when length of the rod *AB* is increased.

3. **(d) :** Apply Fleming's left-hand rule, we can infer that the direction of magnetic field is upwards.

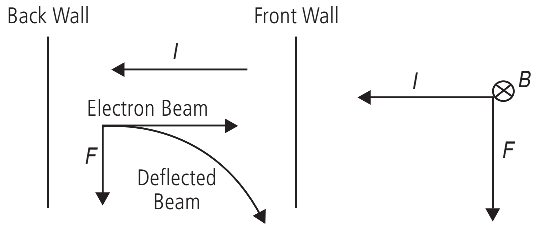
4. Fleming's left-hand rule is as follows:

Stretch out the thumb, the forefinger, and the second(middle) finger of the left hand so that these are at right angles to each other. If the forefinger gives the direction of the magnetic field (N to S), the second (middle) finger gives the direction of current (+ to –), then the thumb gives the direction of the force acting on the conductor.

Since the conductor will move in the direction of the force acting on it hence the thumb gives the direction of motion of the conductor.

5. The force experienced by a current-carrying conductor placed in a magnetic field is the largest when the direction of the current is at right angles to the direction of the magnetic field.

6. The direction of current *I* is opposite to the direction of electron beam as shown in figure. Since the beam is deflected to the right side, the force, *F* acting on the beam is as shown. Applying Fleming's left hand rule, it is found that magnetic field, *B* is acting vertically downwards (*i.e.*, perpendicular to the plane of the paper and directed inwards) as shown by ⊗.



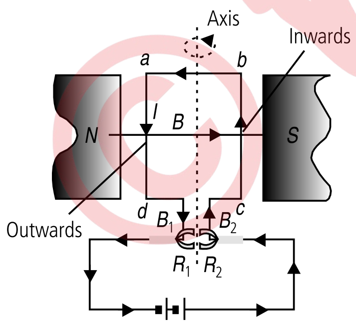
7. An electric motor is based upon the magnetic effect of current. When an electric current is passed through a conductor placed at right angle to a magnetic field, a force perpendicular to both the magnetic field and the conductor acts on it. This makes the conductor move. The direction of motion of the conductor is given by Fleming's left-hand rule.

8. The role of split ring is to change the direction of current flowing through the coil after each half-rotation of coil.

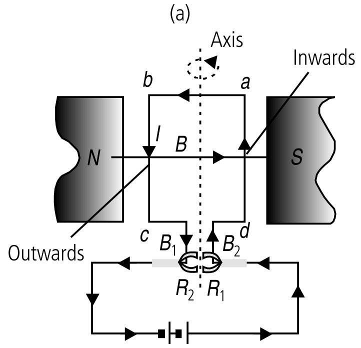
9. An electric motor is a device for converting electric energy into mechanical energy. Thus, an electric motor is the reverse of an electric generator.

There are two types of electric motors :

(i) AC motor and (ii) DC motor. We shall here be describing DC motor. The principle of a DC motor is very much different from that of an AC motor. It is important to remember that all the electric appliances like fan, air-conditioner, coolers, washing machines, mixers and blenders work on DC (house-hold power supply) and as such have DC motors installed in them.



(a)



(b)

Principle : When a coil carrying current is placed in a magnetic field, it experiences a torque. As a result of this torque, the coil begins to rotate.

Working :

(a) Let us suppose that the battery sends current to the armature in the direction shown in figure. Applying Fleming's left hand rule we find that arm *ad* experiences a force which is acting outwards and perpendicular to it and arm *bc* experiences a force which is acting inwards and perpendicular to it. These two forces form a couple whose moment (*i.e.*, torque) makes the armature rotate in the clockwise direction.

(b) After the armature has completed half a revolution (*i.e.*, has turned through 180°), the direction of current in the arms *ad* and *bc* is reversed. Now arm *bc* experiences an outward force and arm *ad* experiences an inward force, as shown in figure. The armature thus continues to rotate about its axis in the same, *i.e.*, clockwise direction.

Split-ring in an electric motor takes the current from the battery and passes it on to the coil through the brushes after reversing its direction after every half revolution. The reversal of current in the coil reverses the direction of forces acting on the sides of the loop.

10. Electric fans, water-pumps, coolers, refrigerators, mixers, blenders, washing machines etc.

Topic 6

1. (a) By keeping the magnet in a fixed position and moving the coil towards and away from the magnet.

(b) By pushing or pulling a bar magnet into or away from a coil.

2. Electric generators are based on the principle of electromagnetic induction, that is, when a conductor is moved perpendicular to magnetic field or vice-versa, an induced current is produced.

3. Dry cell, Lead-acid battery.

4. AC generator, Thermal power station, Hydroelectric stations.

5. **(c) :** half revolution

6. **(c) :** Producing induced current in a coil due to relative motion between a magnet and the coil.

7. **(a) :** Generator.

8. **(d)**

9. (i) The magnetic field lines (flux) linked with the coil changes (*i.e.*, increases). As a result of this, an induced current flows in the coil and the galvanometer shows a momentary deflection (say towards right) *i.e.*, the needle of the galvanometer moves momentarily in one direction.

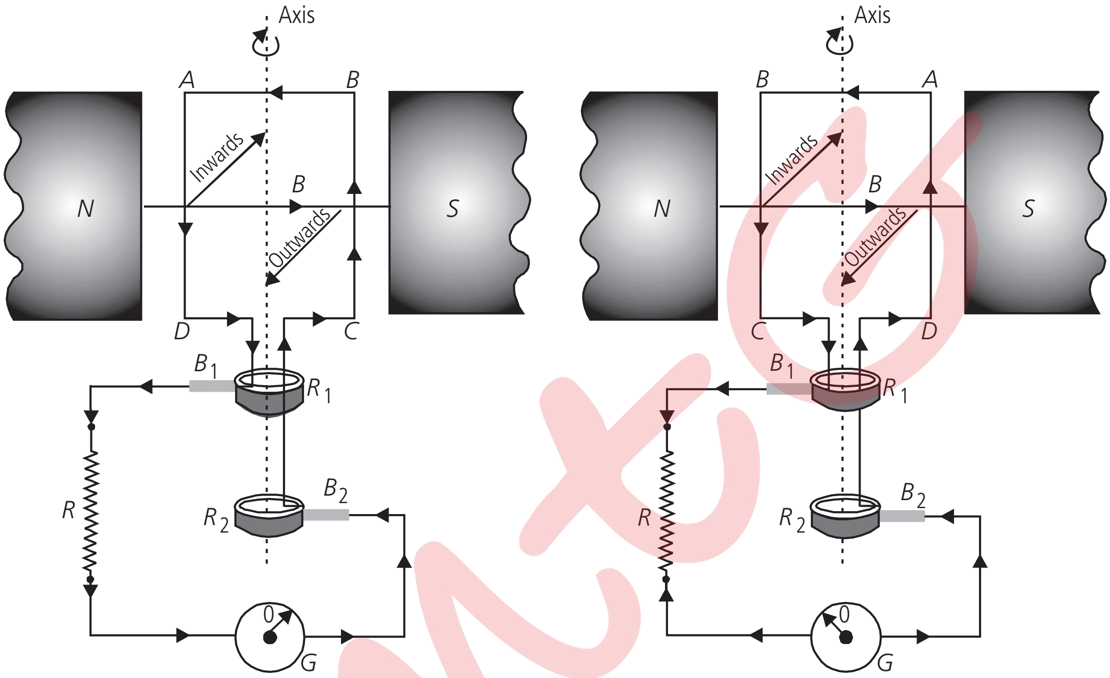
(ii) The magnetic field lines (flux) linked with the coil changes (*i.e.*, decreases). As a result of this, an induced current flows in the coil but in a direction opposite to that in case (i).

(iii) When the magnet is held stationary in the coil, there will be a magnetic flux in the coil but it will remain constant. Since the magnetic flux does not change, there is no induced current in the coil and the galvanometer shows no deflection.

10. By changing current in the coil *A*, a current will be induced in the coil *B* which is placed close to *A*. This is due to the reason that magnetic field lines linked with *A* also get linked with *B* due to its being close to *A*. When the current in *A* changes, magnetic field lines linked with *A* change. Obviously, magnetic field lines linked with *B* also change. As a result of this, current is induced in the coil *B*. (This phenomenon is called mutual induction).

11. An AC generator converts mechanical energy into electric energy.

Principle : Whenever in a closed circuit (*i.e.*, a coil), the magnetic field lines change, an induced current is produced.



(a) (b)

Working : The working of an AC generator is clear from figure (a) and (b). As the armature is rotated about an axis (shown dotted), the magnetic flux linked with the armature changes. Therefore, an induced current is produced in the armature.

(a) Let us suppose that the armature *ABCD* is rotating anticlockwise so that the arm *AD* moves inwards and *BC* moves outwards. Applying Fleming's right-hand rule, we find that the induced current in the armature and in the circuit is as shown in figure (a) due to which *G* shows deflection towards the right.

(b) After the armature has turned through 180°, it occupies the position shown in figure. (b). With the armature rotating in the same direction (*i.e.*, anticlockwise), *BC* moves inwards and *AD* moves outwards. Thus, again applying Fleming's right-hand rule, we find the induced current in the external circuit (*R* and *G*) flows in the opposite direction due to which the direction of deflection in the galvanometer is towards left.

Thus, we see that the direction of induced current changes in external circuit after every half revolution of the armature, *i.e.*, after the armature has turned through an angle of 180° from its initial position. Hence, the induced current is alternating in nature.

The brushes draw current from battery and supply it to the armature of generator.

Topic 7

1. The safety devices that are used in electric circuits and appliances are (i) Fuse (ii) Earthing. MCBs are also used as safety device in electrical circuits.

2. Rating of the oven = 2 kW

Line voltage = 220 V

Then, Current drawn by the oven $= \dfrac{\text{Power}}{\text{Voltage}}$

$$= \frac{2\text{ kW}}{220\text{ V}} = \frac{2000}{220}\text{ A} = 9.1\text{ A}$$

Since the domestic circuit is rated for 5 A, and the oven draws a current of 9.1 A, the following might result.

(a) The fuse (if there) will blow off.

(b) The wiring may burn out.

3. (a) Do not connect appliances exceeding the total load capacity of the circuit.

(b) Provide fuses/MCBs of proper rating.

4. **(c)** Increases heavily.

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

(b) True

(c) True

(d) False: A wire with a green insulation is usually the Earth wire.

6. Electric short-circuit occurs when the live wire and the neutral wire come in direct contact. This occurs when

(i) the insulation of wires is damaged or

(ii) there is a fault in the electric appliance.

7. Many electric appliances of daily use like electric press, heater, toaster, refrigerator, table fan etc. have a metallic body. If the insulation of any of these appliances melts and makes contact with the metallic casing, the person touching it is likely to receive a severe electric shock. This is due to the reason that the metallic casing will be at the same potential as the applied one. Obviously, the electric current will flow through the body of the person who touches the appliance. To avoid such serious accidents, the metal casing of the electric appliance is earthed. Since the Earth does not offer any resistance, the current flows to the Earth through the Earth wire instead of flowing through the body of the person.