NCERT SOLUTIONS

Magnetic Effect of Electric Current

Homework Index

Magnetic Effect of Electric Current

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IN CHAPTER QUESTIONS

PART - 1

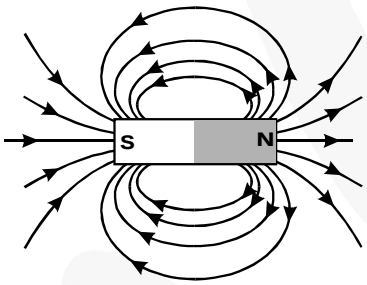
Q1. Why does a compass needle get deflected when brought near a bar magnet ?

Ans. Compass needle is a small magnet which experiences a force in the magnetic field of a bar magnet. Due to this force, it gets deflected.

PART - 2

Q1. Draw magnetic field lines around a bar magnet.

Ans.



Q2. List the properties of magnetic lines of force.

Ans. (i) Magnetic lines of force are closed continuous curves.
(ii) The tangent at any point on the magnetic line of force gives the direction of the magnetic field at that point.
(iii) Two magnetic lines of force never cross each other.

Q3. Why do no two magnetic lines of force intersect each other ?

Ans. The tangent at any point on a magnetic field line gives the direction of magnetic field at that point. If two magnetic field lines cross each other, then at the point of intersection, there will be two tangents. Hence, there will be two directions of the magnetic field at the point of intersection. This is not possible. Hence, no two magnetic field lines can cross each other.

PART - 3

Q1. 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 magnetic field inside and outside the loop.

Ans. Magnetic field inside the loop is perpendicular to the plane of table and in the downward direction. Outside the loop, magnetic field is perpendicular to the plane of the table and in the upward direction.

Q2. The magnetic field in a given region is uniform. Draw a diagram to represent it.

Ans.

Q3. Choose the correct option. The magnetic field inside a long straight solenoid carrying current

(1) is zero
(2) decreases as we move towards its ends
(3) increases as we move towards its ends
(4) is the same at all points

Ans. The magnetic field inside a long straight solenoid carrying current decreases as we move towards its ends. At the ends of solenoid, the strength of the magnetic field is almost the half that in the middle of the solenoid. Thus, the correct option is (2).

PART - 4

Q1. Which of the property a proton can change when it moves freely in a magnetic field ? (There may be more than one correct answer)

(1) mass
(2) speed
(3) velocity
(4) momentum

Ans. Motion of a charged particle like proton in a magnetic field is a circular path. Hence, its velocity and momentum can change. Thus, option (3) and (4) are correct.

Q2. In activity 13.7, how do we think the displacement of rod PQ will be affected if (i) current in rod PQ is increased (ii) a stronger horseshoe magnet is inserted (iii) length of the rod PQ is increased.

Ans. (i) When current in rod increases, force on the rod also increases. Hence, the displacement of the rod increases.

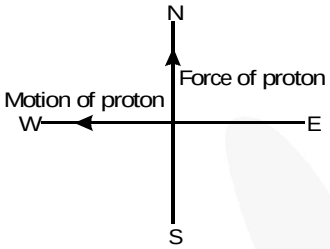
(ii) When a stronger horseshoe magnet is inserted, magnetic field increases. Thus, force on the rod also increases. Hence, displacement of the rod increases.

(iii) When length of the rod increases, force on the rod also increases and hence, displacement increases.

Q3. A positively charged particle (alpha particle), projected towards 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

Ans.



By applying Fleming's left hand rule, we find that the magnetic field is in upward direction. Thus, option (4) is correct.

PART - 5

Q1. State Fleming's left hand rule.

Ans. 'Stretch the thumb, forefinger and central finger of your left hand such that they are mutually perpendicular. If the fore finger points in the direction of magnetic field and the central finger in the direction of current, then the thumb will point in the direction of motion or the force acting on the conductor'.

Q2. What is the principle of electric motor ?

Ans. It is based on the principle that a current-carrying coil experiences equal and opposite forces on its edges which rotates it continuously.

Q3. What is the role of the split-ring in an electric motor?

Ans. The split-ring in an electric motor reverses the direction of current in the coil of the motor. Therefore, the direction of the force acting on the two arms of the coil is also reversed. As a result of this, the coil of d.c. motor continues to rotate in the same direction.

PART - 6

Q1. Explain different ways to induce current in a coil.

Ans. (i) By moving a bar magnet towards or away from the coil.
(ii) By placing a coil near another coil which carries a variable current.

PART - 7

Q1. State the principle of electric generator.

Ans. It is based on the principle of electromagnetic induction, that is, the changing magnetic field induces current in the coil.

Q2. Name some sources of direct current.

Ans. A dry cell, a battery, a solar cell, d.c. generator, etc. are some sources of direct current.

Q3. Which source produces alternating current ?

Ans. AC generator is the source which produces alternating current.

Q4. 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

Ans. The direction of induced current changes twice in one revolution i.e., it changes after every half revolution. Thus, option (3) is correct.

PART - 8

Q1. Name two safety measures commonly used in electric circuit and appliances.

Ans. (i) Electric fuse (ii) Earthing (or grounding).

Q2. 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.

Ans. Power, P = 2 kW = 2000 W ; V = 220 V

Now, $P = V \times I$ or $I = P/V$

or $I = (2000)/220 = 9.09$ A.

This shows that current flowing through the oven is more than the current rating (5 A). Hence, the fuse in the circuit melts i.e., the circuit breaks preventing the oven from damage.

Q3. What precautions should be taken to avoid the overloading of domestic electric circuit ?

Ans. (i) We should not connect many appliances in the same socket.

(ii) Electrical appliances of high power rating should not be switched on simultaneously.

(iii) Electric wires with good quality insulating covers should be used to prevent the short-circuiting.

EXERCISES

Q1. Which of the following correctly describes the magnetic field near a long straight current-carrying 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.

Ans. The magnetic field lines around a long straight current-carrying conductor are concentric circles with the conductor located at their centre. Thus, the option (4) is correct.

Q2. The phenomenon of electromagnetic induction is
(1) The process of charging a body.
(2) The process of generating magnetic field due to 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.

Ans. Here, option (3) is correct.

Q3. The device used for producing electric current is called a/an
(1) Generator
(2) galvanometer
(3) Ammeter
(4) Motor

Ans. Option (1) is correct.

Q4. 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.

Ans. An AC generator has slip rings while a DC generator has split-ring commutator. Thus, option (4) is correct.

Q5. At the time of short-circuit, the current in the circuit
(1) Reduces substantially
(2) Does not change
(3) Increases heavily
(4) Varies continuously

Ans. Short-circuit takes place when the live wire and the neutral wire come into direct contact, the resistance in the circuit becomes very low and the current in the circuit abruptly increases. Thus, option (3) is correct.

Q6. 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 centre of a long circular coil carrying current will be parallel straight lines.
(4) A wire with a green insulation is usually the live wire.

Ans. (1) False. It converts electrical energy into mechanical energy.
(2) True.
(3) True.
(4) False. Live wire has red insulation cover.

Q7. List three sources of magnetic fields.

Ans. (i) A permanent magnet.
(ii) A current-carrying conductor.
(iii) A current-carrying solenoid.

Q8. 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.

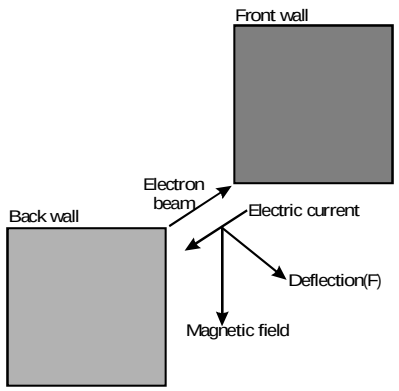
Ans. When electric current flows through a solenoid, magnetic field is set up around the solenoid. One end of the solenoid behaves as north pole and the other end of the solenoid behaves as south pole. To determine the north and south poles of a current-carrying solenoid, bring the north pole of a bar magnet towards one end of the solenoid. If the solenoid attracts towards the magnet, then that face of the solenoid is south pole. If the solenoid moves away from the bar magnet, then that face of the solenoid is the north pole.

Q9. When is the force experienced by a current-carrying conductor placed in magnetic field the largest ?

Ans. When current-carrying conductor is placed perpendicular to the magnetic field.

Q10. Think 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 ?

Ans. Movement of electron beam from back wall to the front wall is equivalent to the flow of electric current from front wall to the back wall. The deflection of the beam means, the force is acting towards our right side. According to Fleming's Left Hand Rule, the direction of magnetic field is vertically downward.



Q11. 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 a rotating device that converts electrical energy to mechanical energy.

Principle involved : It is based on the fact that a current-carrying coil experiences equal and opposite forces on its edges which rotates it continuously.

Construction : An electric motor consists of a rectangular coil ABCD made of an insulated copper wire. The coil consists of large number of turns and it is wound on a soft iron core. The coil is placed between the two poles of a magnetic field such that the arms AB and CD are perpendicular to the direction of the magnetic field. The ends of the coil are connected to the two half-rings R_1 and R_2 called **split rings**. The inner sides of split rings are insulated and attached to an axle (not shown in figure). The external conducting edges of R_1 and R_2 touch two conducting stationary brushes (usually made of carbon) B_1 and B_2 respectively.

Working

(1) Current in the coil ABCD enters from the source battery through conducting brush B_2 and flows back to the battery through brush B_1. The current in arm AB of the coil flows from B to A and in arm CD it flows from D to C, that is, opposite to the direction of current through arm AB. That is, the current flows along the path DCBA.

(2) On applying Fleming's left hand rule, we find that the force acting on arm AB pushes it upwards while the force acting on arm CD pushes it downwards. Thus, the coil and the axle, mounted free to turn about an axis, start rotating.

(3) After half rotation, R_2 makes contact with the brush B_1 and R_1 with brush B_2. Thus, the current in the coil gets reversed and flows along the path ABCD. As a result, the directions of force acting on the two arms AB and CD are also reversed. The arm AB of the coil that was earlier pushed up is now pushed down and the arm CD previously pushed down is now pushed up. Due to this, the direction of rotation of the coil remains unchanged. The reversing of the current is repeated after every half rotation, giving rise to a continuous rotation of the coil and the axle.

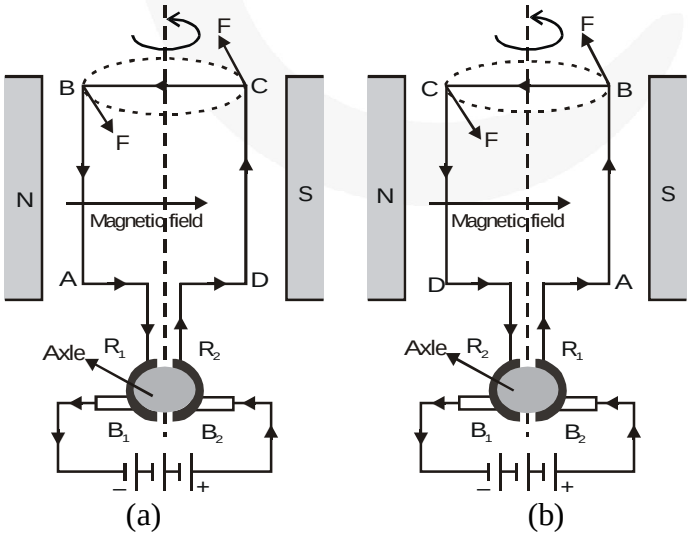


Fig.34 An electric motor.

☞ The work of the split ring is to reverse the direction of current in the circuit. It acts as a commutator in the circuit. The reversal of current, reverses the direction of force acting on the two arms of the coil.

Q12. Name some devices in which electric motors are used.

Ans. Pump sets, electric cars, rolling mills, electric fans, hair dryer, etc.

Q13. 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 ?

Ans. (i) When a bar magnet is pushed into the coil, induced current flows through the coil due to the phenomenon of electromagnetic induction. This induced current is indicated by the deflection of the needle of the galvanometer inserted into the coil.
(ii) When a bar magnet is withdrawn from inside the coil, again induced current flows through the coil due to the phenomenon of electromagnetic induction. In this case, the direction of induced current is opposite to the direction of the current in case (i).
(iii) When the bar magnet is held stationary inside the coil, there is no change in magnetic field around the coil. Hence, no induced current flows through the coil. Therefore, galvanometer shows no deflection.

Q14. Two circular coils A and B are placed close to each other. If the current in the coil A is changed, will some current be induced in the coil B ? Give reason.

Ans. When current in coil A is changed, a changing magnetic field is set up around it. This changing magnetic field also links with coil B and hence some current will be induced in coil B due to electromagnetic induction.

Q15. 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.

Ans. (i) Right hand thumb rule.
(ii) Fleming's left hand rule.
(iii) Fleming's right hand rule.

Q16. Explain the underlying principle and working of an electric generator by drawing a labelled diagram. What is the function of brushes ?

Ans. An electric generator is a device which converts mechanical energy to electrical energy using the phenomenon of electromagnetic induction.

Principle involved : When a coil is rotated about an axis perpendicular to the direction of uniform magnetic field, an emf is induced in it (electromagnetic induction).

Construction : It consists of a rectangular coil ABCD having a large number of turns of a conducting insulated wire wound on a soft iron core. The coil is rotated between the poles of a strong permanent magnet with its axis perpendicular to the magnetic field lines. The ends of the coil are connected to two slip rings R_1 and R_2 respectively. The slip rings R_1 and R_2 are internally attached to an axle. The axle is mechanically rotated from outside to rotate the coil inside the magnetic field. The slip rings R_1 and R_2 are in sliding contact (moving contact) with two metallic (or carbon) brushes B_1 and B_2.

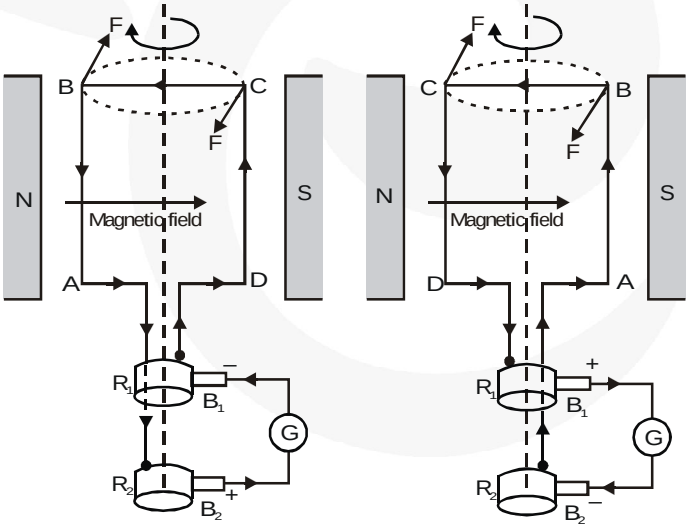
Working

(1) Let initially coil ABCD is in horizontal position and it is rotated in between the poles of the magnet. Due to the rotation of coil, the arm AB moves down while the arm CD moves up. Thus, magnetic field lines through them changes and an electric current is induced in AB and CD.

(2) By Fleming's right hand rule, in AB current flows B to A and in CD current flows D to C. As a result, an electric current flows through the whole circuit i.e., B_2 to B_1 in external circuit. As the coil rotates, the induced current varies in magnitude as well as direction. After half rotation, arms AB and CD of the coil interchange their position. Now, the arm AB is on right and CD on left side. Thus, the directions of induced currents in AB and CD are reversed. As a result, an electric current flows through the circuit in reverse direction i.e., B_1 to B_2 in external circuit [see fig.41(b)].

(3) The polarities of two ends of coil changes after every half rotation of the coil. In one complete cycle (rotation), the direction of current changes twice. Such a current, which changes direction after equal intervals of time is called an **alternating current (AC)**.

Brush provide the contact between coil and split rings. One brush is at all time in contact with the arm moving up and the other in the contact with the arm moving down.



Q17. When does an electric short-circuit occur ?

Ans. When live wire and neutral wire touch each other (i.e. come in direct contact).

Q18. What is the function of an earth wire ? Why is it necessary to earth metallic casings of electric appliances.

Ans. Earth wire acts as a safety measure. When the live wire touches the metallic casing of an electric appliance, the electric current flows from the casing of the appliance to the earth through the copper wire. An electric current flows along the path of low resistance thus, current passes through the copper wire instead of human body. Thus, the human body is saved from electric shock.