EXAM DRILL

Magnetic Effects of Electric Current

CHAPTER 13

ANSWERS

1. Soft iron loses its magnetism easily.

OR

A current carrying wire produces a magnetic field around it. On the other hand, no magnetic field is associated with a wire that carries no current.

2. Using Fleming's left hand rule on the current carrying wire, a downward (towards south) force acts on the wire by the magnet.

3. No, alpha particle will not experience any force if it is at rest, because only moving charged particles can experience force when placed in a magnetic field.

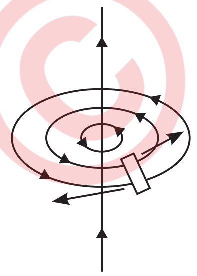
4. **(c) :** 220 V, 50 Hz.

5. When an unduly high electric current flows through the circuit, the fuse wire melts due to joule heating effect and breaks the circuit. Hence, it keeps an eye on the amount of current flowing and also stops the current if exceeds the maximum value. So, fuse acts like a watchman in an electric circuit.

6. Michael Faraday invented electric generator.

OR

Based on the right-hand grip rule, the magnetic field caused by the current carrying wire is as shown. This circular magnetic field will cause the magnet to rotate clockwise.



7. **(c) :** Both points are correct and these are the result of experiments done by Danish physicist Hans Christian Oersted in 1820.

8. **(c) :** Force acts in upward direction (top).

9. **(d) :** Needles of the magnetic compasses will defect in opposite direction.

OR

(c) : An overloading as well as short circuit.

10. **(c) :** Half rotation.

11. **(a) :** The pointer returns to zero. After some time, there is no relative change in magnetic field, therefore there is no induced current flow in the circuit.

OR

(a) : The direction of flow of d.c. current does not change with time therefore frequency of direct current (d.c.) is 0 Hz.

12. **(c) :** In DC motor and DC generator commutator ensures the rotation of the armature in clockwise direction throughout.

OR

(c) : By Fleming's left hand rule.

13. **(a) :** Since the copper ring does not form a complete loop, no induced emf is set up in it when a magnet is dropped through it. Hence, the motion of the magnet is unopposed, *i.e.*, the magnet has a free fall with acceleration g.

14. **(b) :** The magnetic field produced by solenoid is independent of its length and cross-sectional area.

15. **(b) :** A moving charge always produce a magnetic field whether it is accelerated or not accelerated. But once the charge becomes stationary, it does not produce any magnetic field.

16. **(c) :** The magnitude of magnetic field produced by a current carrying circular coil is maximum at the centre and is not proportional to the distance of a point from the circular coil.

OR

(a) : The magnetic lines of force due to current carrying straight solenoid is same as that of bar magnet.

17. **(i) (c) :** No two magnetic field lines are found to cross each other. If two field lines crossed each other, it would mean that at the point of intersection, the compass needle would point in two directions at the same time, which is not possible.

(ii) (d) : The magnetic field and hence the magnetic line of force exist in all the planes all around the magnet.

(iii) (d) : The relative strength of the magnetic field is shown by the degree of closeness of the field lines and the direction of the magnetic field is obtained by tangent to the field lines at the point of intersect.

(iv) (d) : The magnetic field lines due to a bar magnet are closed continuous curves directed from N to S outside the magnet and directed from S to N inside the magnet. Hence option (d) is correct.

(v) (d) : Inside a bar magnet, the direction of field lines is from south pole to north pole.

18. (i) (d) : The deflection in galvanometer can be seen if bar magnet moved towards or away from coil parallel to the axis of the coil.

(ii) (c) : If the needle of the galvanometer deflects it means there is change in magnetic field and current is induced and this phenomenon is called as electromagnetic induction.

(iii) (a) : By Faraday's law of electromagnetic induction, the e.m.f. induced in a conductor is proportional to the rate of change of magnetic lines of force linking the circuit. Hence, by pushing in the magnet faster, the rate of change of magnetic lines will increase. This results in a larger induced e.m.f. and hence, larger deflection of the meter.

(iv) (d)

(v) (d) : Resistivity of coil will determine the resistance of the coil and induced current through it, as induced current $= \dfrac{\text{emf}}{\text{resistance}}$

19. (i) (d)

(ii) (b) : The direction of the current has no effect on the size of the turning effect on the coil.

(iii) (b) : Electric fan works on the principle of electric motor. It converts electrical energy to mechanical energy.

(iv) (b)

(v) (c)

20. (i) (a) : The capacity of a domestic refrigerator is expressed in tons.

(ii) (b) : In parallel combination each resistor gets same potential from the source. We can use separate on/off switches with each appliance. In case if any one resistor fails then the circuit will not break. So, it is safe and convenient to connect household circuit in parallel combination of resistor.

(iii) (a) : Lightening has maximum current.

(iv) (b) : Galvanometer is an instrument that can detect the presence of electric current in a circuit.

(v) (d) : At the time of short circuit, the live and neutral wire come in direct contact, thus increasing the current in the circuit abruptly.

21. Yes, there will be an induced current in both the cases as there is a change in the number of magnetic field line associated with the coil or we can say that there is a motion of a magnet with respect to the coil.

Same amount of current will be induced and the direction of flow of current will also be the same in the two cases.

OR

The magnetic field due to a straight current carrying wire depend upon following two factors :

(i) current flowing in wire. (ii) distance from wire.

22. Kicking wire experiment shows that when a current-carrying conductor is placed in a magnetic field, it experiences a force, except when it is placed parallel to the magnetic field.

The force (F) acting on a current-carrying conductor placed in a magnetic field in a direction perpendicular to the direction of magnetic field is :

(i) directly proportional to the current (I) flowing through the conductor, *i.e.*,

$$F \propto I \qquad \text{... (i)}$$

(ii) Directly proportional to the length (l) of the conductor, *i.e.*,

$$F \propto l \qquad \text{... (ii)}$$

(iii) directly proportional to the magnitude (B) of the magnetic field, *i.e*,.

$$F \propto B \qquad \text{... (iii)}$$

Combining eqn. (i), (ii) and (iii), we get

$$F \propto I\,l\,B$$

23. (a) As the amount of magnetic field strength is directly proportional to the amount of current, so the deflection of compass needle increases.

(b) Since magnetic field strength at a point is inversely proportional to the distance from the wire. Hence deflection of compass decreases when it is displaced away from the conductor.

OR

(a) When the amount of current in the coil P is changed, an induced current will induce in the coil Q due to change in magnetic field lines *i.e.*, magnetic flux.

(b) If both the coils are moved in the same direction with the same speed, then there is no net change in magnetic flux. Hence there will be no deflection in the galvanometer.

24.

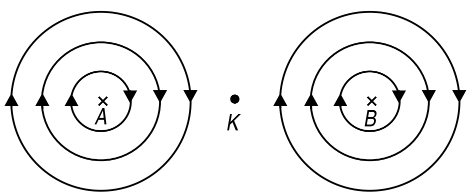
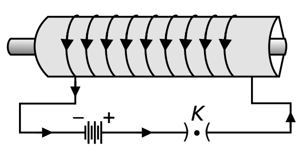


Figure shows the sketch of magnetic lines of force produced by current in wires A and B.

The point K is equidistant from the wires A and B, the wires A and B carry equal current, so the magnetic fields at K due to wires A and B are equal in magnitude but opposite in direction. Due to the wire A it is downward, while due to the wire B it is upward. So the net magnetic field at K is zero.

25. (a)



(i) Direct current should be passed through the solenoid.

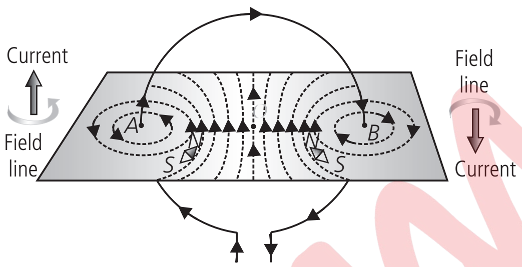
(ii) The rod placed inside should be made of a magnetic material such as steel, alnico etc.

(b) (i) Yes. As a thin beam of moving alpha particles are positively charged, they constitute a current in the direction of motion and therefore produce a magnetic field around it.

(ii) No. As a thin beam of moving neutrons does not constitute current because they are electrically neutral and therefore does not produce magnetic field.

26. 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.

27.

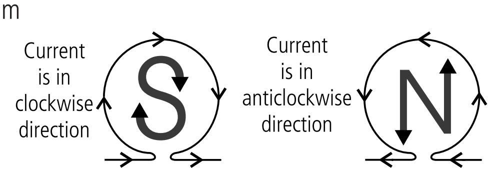


(b)

The clock rule, helps us to determine the polarities of the faces of a current-carrying coil.

Looking at the face of the coil, if the current around that face is in clockwise direction, the face is the South-pole; while if the current around that face is in the anti-clockwise direction, the face is the North-pole.

The rule can be remembered with the help of the following diagram



OR

The magnitude of force (F) acting on a conductor of length (l) and carrying a current (I) when placed in a magnetic field of magnitude (B) depends upon I, l and B as follows :

(i) $F \propto I$ (ii) $F \propto l$ (iii) $F \propto B$.

Yes, force acts on a current carrying conductor could be zero when it is parallel to magnetic field.

28. **(a)** Live wire is at 220 V and neutral wire is at zero volt. Since the electric current flows from higher potential to lower potential, we can get an electric shock by touching live wire.

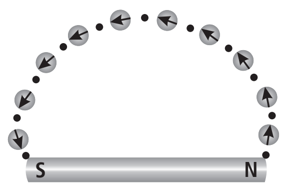
(b) In parallel combination, each resistor gets same potential from the source. We can use separate on/off switches with each appliance. Also in case if any one resistor fails then the circuit will not break. So, it is safe and convenient to connect household circuit in parallel combination of resistors

(c) Fuse is an important safety device. It is used in series with any electrical appliance and protects it from short-circuiting and overloading.

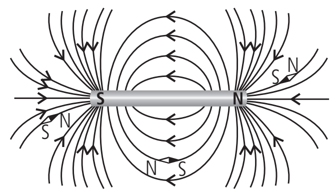
29. The space around a magnet in which the force of attraction and repulsion due to the magnet can be detected is called the magnetic field.

Tracing (or mapping) Magnetic Field due to Bar magnet using Compass :

To trace the magnetic field due to bar magnet, fix a paper sheet on a drawing board by means of brass pins. Place a bar magnet on the sheet and mark its boundary with a find pencil. Now place a small compass needle close to South-pole of the magnet and mark two pencil dots exactly at the two ends of the needle. Note that the North pole of the needle (represent by an arrow) is being attracted by the South pole of the magnet. Now move the compass in such a manner that one end (North-pole) of the needle coincides with the second pencil dot. Mark the position of the other end (South-pole) of the needle with a dot. Repeat this process of moving the needle and marking dots at its two ends till its South-pole reaches the North-pole of the magnet. Obtain a smooth curve by joining the various dots. This smooth curve represents a magnetic field line.



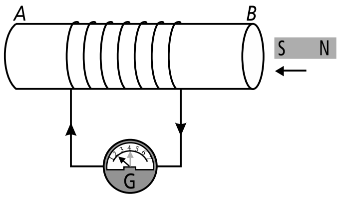
1.



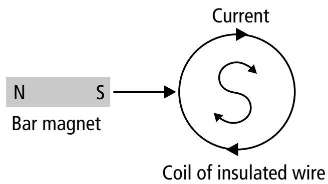
2.

30. In right hand thumb rule, direction of thumb indicates the direction of current in the straight conductor held by curled fingers which gives the direction of field lines, whereas the Fleming's left hand rule gives the direction of force experienced by current carrying conductor placed in an external magnetic field.

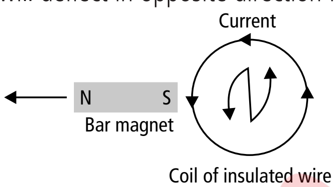
31. If a coil of insulated wire is connected to a galvanometer and a bar magnet with South pole is moved towards one face of the coil then, given situation is shown in the figure.



(i) Moved quickly towards the coil : A current is induced in clockwise direction in the coil with respect to the side facing the North pole of the magnet and needle of galvanometer will deflect in one direction from zero position.



(ii) Moved quickly away from coil : A current is induced in anti-clockwise direction in the coil with respect to the side facing the North pole of the magnet and the needle of the galvanometer will deflect in opposite direction from (i).



(iii) Placed near its one face : No deflection of the needle of galvanometer is observed.

32. (a) The rule used in finding the direction of motion of the conductor placed in a magnetic field is Fleming's left hand rule. 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 the direction of current then the thumb gives the direction of the force acting on the conductor.

(b) Principle : Current carrying conductor when placed at right angle to a magnetic field, experiences a force due to which we get motion. The direction of the force is given by Fleming's left hand rule.

(c) Armature is a conductive part of motor which generates motion in the motor.

33. (a) When a current carrying wire is placed in a magnetic field, it experiences a magnetic force that depends on

(i) current flowing in the conductor

(ii) strength of magnetic field

(iii) length of the conductor

(iv) angle between the element of length and the magnetic field.

(b) Force experienced by a current carrying conductor placed in a magnetic field is largest when the direction of current is perpendicular to the direction of magnetic field.

(c) The rule used in finding the direction of motion of the conductor placed in a magnetic field is Fleming's left hand rule. 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 the direction of current then the thumb gives the direction of the force acting on the conductor.

34. (a) Right-Hand Thumb Rule : Imagine the straight conductor in your right hand such that the thumb points in the direction of current. The direction of curling of fingers of the right hand gives the direction of magnetic field lines.

(b) Fleming's Left-Hand Rule (or Motor rule): Stretch the thumb, the first finger and the central finger of the left hand so that they are mutually perpendicular to each other. If the first (fore)finger points in the direction of the magnetic field, the central finger points in the direction of current, then the thumb points in the direction of motion of the conductor (*i.e.*, direction of force on the conductor).

(c) Fleming's Right-Hand Rule (or Dynamo rule) : Stretch the thumb, the first finger and the central finger of the right hand so that they are mutually perpendicular to each other. If the first (fore) finger points in the direction of magnetic field, the thumb points in the direction of motion of the conductor, then the central finger points in the direction of induced current.

OR

The phenomena in which an electromotive force and current is induced by changing magnetic field is called electromagnetic induction.

Faraday, on the basis of his experiments, formulated the following two laws of electromagnetic induction.

(1) Whenever there is a change in magnetic flux linked with a coil, an electric current (and potential difference) is induced. This induced potential difference lasts so long as there is a change in the magnetic flux linked with the coil.

(2) The magnitude of the induced current (and potential difference) is directly proportional to the rate of change of magnetic flux linked with the coil.

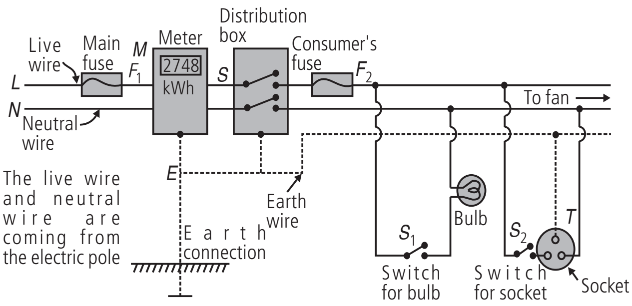
If the rate of change of magnetic flux remains uniform, a steady potential difference is induced. If the circuit of the coil is closed, a current flows in the coil due to induced potential difference at it ends. It is clear that the magnitude of induced potential difference depends on :

(i) the change in magnetic flux and

(ii) the time in which flux changes.

Obviously, (i) more the change in magnetic flux, more is the induced potential difference and (ii) faster the change in magnetic flux, more is the induced potential difference.

35. (a)



Domestic electric wiring from electric pole to room

(b) Overloading : The condition in which a high current flows through the circuit and at the same time too many appliances are switched on then the total current drawn through the circuit may exceed its rated value.

Short circuiting : The condition when the live wire comes in direct contact with the neutral wire, due to which a high current flows in the circuit.

OR

(a) When a current carrying wire is placed in a magnetic field, it experiences a magnetic force that depends on

(i) current flowing in the conductor

(ii) strength of magnetic field

(iii) length of the conductor

(iv) angle between the element of length and the magnetic field.

(b) Force experienced by a current carrying conductor placed in a magnetic field is largest when the direction of current is perpendicular to the direction of magnetic field.

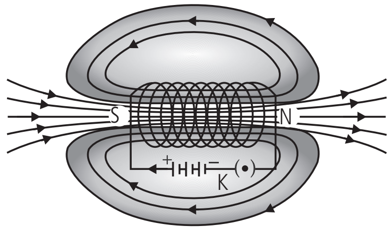
(c) The rule used in finding the direction of motion of the conductor placed in a magnetic field is Fleming's left hand rule. Fleming's left hand rule is as follows:

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 the direction of current then the thumb gives the direction of the force acting on the conductor.

(d) (i) Direction of force will be reversed when direction of magnetic field is reversed, *i.e.*, now force on conductor will act from left to right.

(ii) Direction of force will be reversed, if the direction of current is reversed, *i.e.*, the force on the conductor will act from left to right.

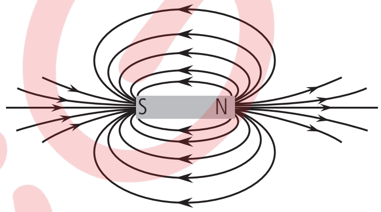
36. Solenoid : A coil of many circular turns of insulated copper wire wrapped in the shape of cylinder is called solenoid.



Field lines of the magnetic field through and around a current-carrying solenoid

The pattern of magnetic field lines inside the solenoid indicates that the magnetic field is the same at all points inside the solenoid. That is, the field is uniform inside the solenoid.

Magnetic field lines around a bar magnet.



Following are the distinguishing features between the two fields.

(a) A bar magnet is a permanent magnet whereas solenoid is an electromagnet, therefore field produced by solenoid is temporary and stay till current flows through it.

(b) Magnetic field produced by solenoid is more stronger than magnetic field of a bar magnet.

OR

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.

Construction : It consists of the following four parts.

1. Armature (*abcd*), also called the coil, consists of a large number of turns of insulated copper wire wound over a soft iron core. It revolves around an axle between the two poles of a strong magnet.

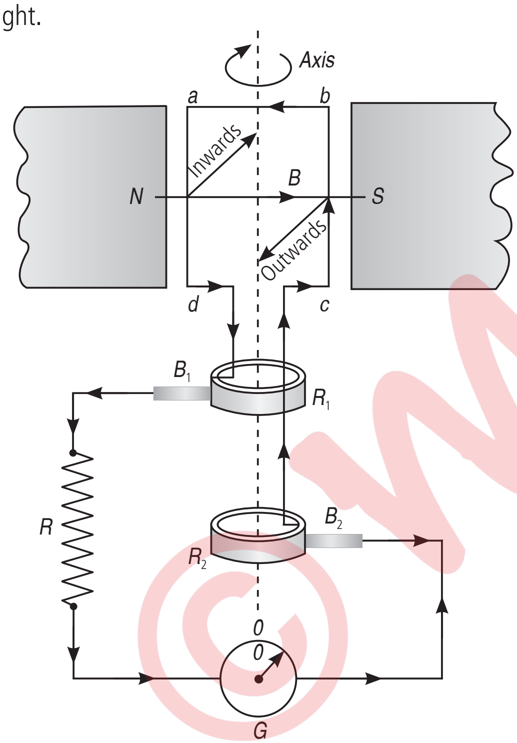
2. Field Magnet : The magnetic field (B) is supplied by a permanent magnet in a small dynamo (also called a *magneto*) and by an electromagnet in case of a big commercial dynamo (usually called a generator). The poles of the magnet are shown as *N-S* in Figure.

3. Slip Rings R_1 and R_2 are two hollow metal rings held at different heights. The end d of the armature coil is connected to ring R_1. The end c of the coil is passed through R_1 without touching it and is connected to R_2. These rings rotate with the rotation of the armature.

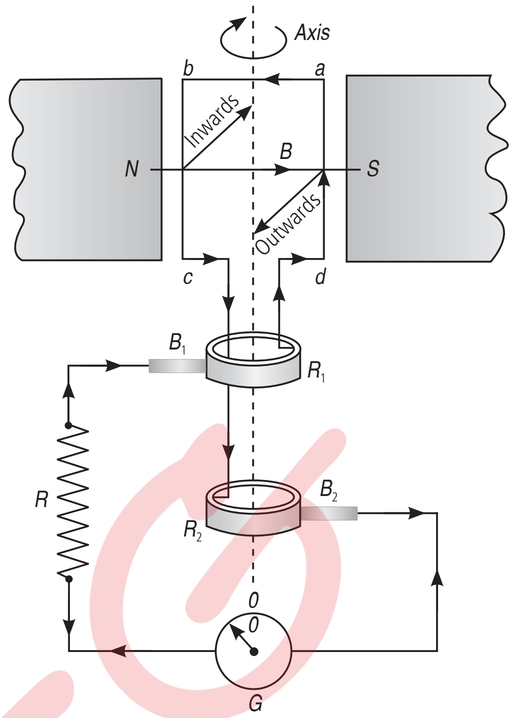
4. Brushes or Sliding Contacts B_1 and B_2 are flexible metal plates or carbon rods. These are called brushes or sliding contacts. B_1 is in constant touch with R_1 and B_2 is in constant touch with R_2. It is with the help of these brushes that the induced current is passed on from the armature and the rings to the external circuit containing a resistance, R and a galvanometer, G. Brushes are stationary *i.e.*, these do not rotate with the rotation of the armature.

Working : The working of an AC generator is clear from figures (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.

I. 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) ue to which *G* shows deflection towards the right.



(a)



(b)

II. 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.

Magnitude of induced emf in a generator can be increased by (i) increasing the number of turns of its armature (ii) increasing area of the armature (iii) increasing speed of rotation of the armature and (iv) increasing the strength of the magnetic field.