Magnetic Effects of Electric Current

CHAPTER 13

EXAM DRILL

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.

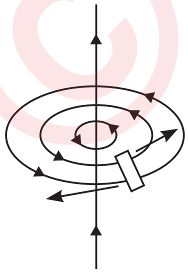
4. **(c) :** 220 V, 50 Hz.

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. The person attracted towards AC power line may receive a shock and may even be electrocuted.

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. Earth wire.

11. Heating effect of current.

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) :** By Fleming's left hand rule.

OR

(d)

13. **(d) :** This question can be easily solved by using Fleming's left-hand rule. Note that, the direction of current flow is opposite to the direction of flow of electron.

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) (c) :** The iron core is a soft magnetic material which is easily magnetised. When the iron core is placed inside a solenoid, it is being induced as a strong magnet by the magnetic field of the solenoid. The magnetic fields of both the solenoid and the iron core combine to produce a stronger magnetic field around the solenoid as compared to the solenoid without the iron core.

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

(iii) (c) : The magnetic field lines inside the solenoid are nearly straight and parallel to its axis.

(iv) (c) : The magnetic field of a solenoid increases when we insert a iron core.

(v) (a) : The magnetic field of a solenoid is directly proportional to the number of turns in it. Hence as the number of turns increases, the magnetic field also increase.

19. **(i) (b)**

(ii) (a)

(iii) (a)

(iv) (d) : When electrons are moving towards west, the direction of current is towards east. According to right hand thumb rule, the direction of magnetic field just above the wire is towards south. Hence, option (d) is correct.

(v) (d) : A current in a wire will always produce a circular magnetic field around the wire.

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. Direct current always flows in one direction, whereas the alternating current reverses its direction periodically.

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.*,

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

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

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

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

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

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

The current that we receive from domestic circuit is alternating current (A.C.) and the current that is use to run clock is direct current (D.C.). Direct current always flow in one direction whereas the alternating current reverses its direction periodically.

24.

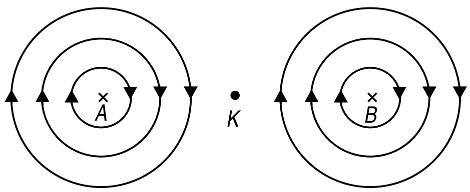
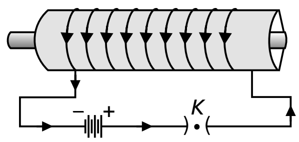


Figure shows the sketch of magnetic lines of force produced by current in wires A and B.

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.

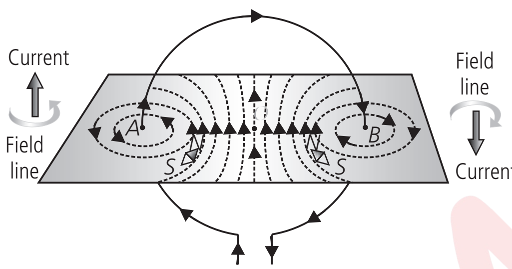
(ii) The rod placed inside should be made of a magnetic material such as steel, alnico etc.

(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.

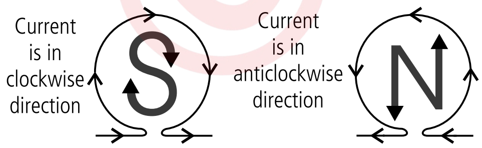


(b)

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.

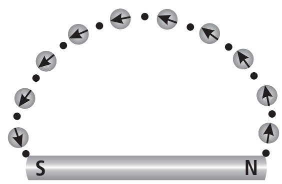
(b) In parallel combination, each resistor gets same potential from the source. We can use separate on/off switches with each appliance. Also in case if any one resistor fails then the circuit will not break. So, it is safe and convenient to connect household circuit in parallel combination of resistors

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

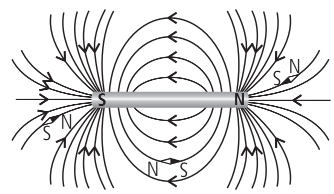
29. The space around a magnet in which the force of attraction and repulsion due to the magnet can be detected is called the magnetic field.

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. The current drawn by the 2000 W heater is

$$I = \frac{P}{V} = \frac{2000\text{ W}}{220\text{ V}} = \frac{100}{11}\text{A}$$

The maximum current the bulbs can draw is

$$15\text{ A} - \frac{100}{11}\text{ A} = \frac{65}{11}\text{ A}$$

Each bulb will take a current

$$I = \frac{P}{V} = \frac{100\text{ W}}{220\text{ V}} = \frac{5}{11}\text{A}$$

The number of bulbs that can be used is

$\frac{65}{11} \times \frac{11}{5} = 13$

31. (i) (a) The compass needle will deflect to the left and point West.

(b) The compass needle will deflect to the right and point East.

(ii) The alternating current will change the direction of the current 50 times per second. Hence, the compass needle will deflect to the left and then to the right and then back to the left 50 times per second.

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) Characteristic features of circuit for both high power rating devices and low power rating devices :

(i) All wires are covered with proper insulating materials.

(ii) There should be a separate circuit for both high power rating devices and low power rating devices.

(iii) The distribution circuits are always connected in parallel combination.

(iv) Metallic body of all appliances must be connected to the earth wire. This is a safety measure.

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) When we touch the live wire bare footed, our body is directly in contact with the earth. So, current passes through the body to the earth. As our body is good conductor of electricity, we get a severe shock. Hence, we should not handle live wires bare footed.

(b) When many high power rating appliances are switched on simultaneously, a large amount of current flows through the main circuit and current may exceed the bearing capacity of the connecting wires. This causes overloading, which may cause fire. Hence, we must not use many electrical appliances simultaneously.

(c) Water is a good conductor of electricity as it contains salt and impurities. When we touch the switch with wet hand, it is possible that electric current will pass through our body and we get a severe shock.

OR

(a) DC in case I and AC in the case II.

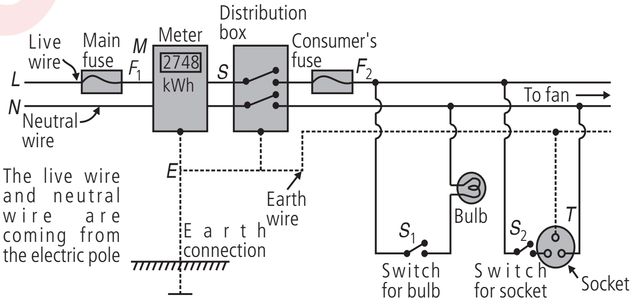
(b) Cell or a battery – Source of DC.
Generator – Source of AC.

(c) Frequency of AC is 50 Hz in India while DC has zero frequency.

(d) In case I, current remains constant and frequency is zero whereas in case II, current varies periodically with a frequency of $\frac{1}{0.02\text{ sec}}$ = 50 Hz in India.

(e) From graph, the time interval after which AC current changes its direction is 0.01 second.

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.

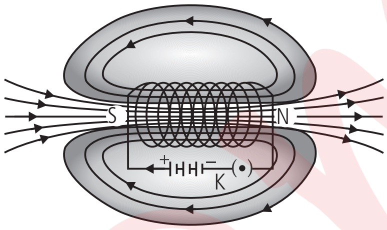
Fleming's left hand rule is as follows:

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.

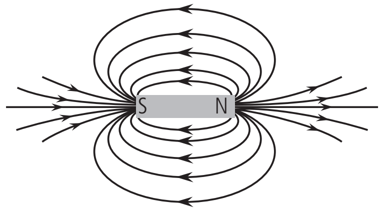
36. Solenoid : A coil of many circular turns of insulated copper wire wrapped in the shape of cylinder is called solenoid.



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

The force on a current-carrying conductor in a magnetic field is due to interaction between :

(i) magnetic field due to current carrying conductor and

(ii) the external magnetic field in which the conductor is placed.

The direction of the force acting on the current carrying conductor placed in the magnetic field depends upon

(i) direction of the current through the conductor and

(ii) direction of the magnetic field in which the conductor is placed.

The direction of the force acting on the current carrying conductor placed in the magnetic field is determined by using Fleming's left hand rule.

According to this rule, stretch the thumb, forefinger and middle finger of your left hand such that they are mutually perpendicular. If the fore finger in the direction of magnetic field and the middle finger in the direction of current, then the thumb will point in the direction of motion or force acting on the conductor.