

# UNIQUE STUDY POINT

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<b>Class:</b> X	<b>Subject:</b> Science	<b>Session:</b> 2025-26
<b>Chapter:</b> 12 - Magnetic Effects of Electric Current	<b>Time:</b> 1½ Hours	<b>Max. Marks:</b> 40

## General Instructions:

1. All questions are compulsory.
2. This question paper contains 20 questions divided into five sections A, B, C, D and E.
3. Section A contains 10 MCQs of 1 mark each.
4. Section B contains 4 questions of 2 marks each.
5. Section C contains 3 questions of 3 marks each.
6. Section D contains 1 question of 5 marks.
7. Section E contains 2 Case Study Based questions of 4 marks each.

## SECTION A - Multiple Choice Questions (1 mark each)

1. A compass needle is deflected when brought near a current-carrying wire because:
  - (a) Electric current heats the wire
  - (b) Electric current produces a magnetic field
  - (c) Compass needle is attracted to copper
  - (d) Air around the wire becomes magnetic
2. The direction of magnetic field lines outside a bar magnet is:
  - (a) From south pole to north pole
  - (b) From north pole to south pole
  - (c) Parallel to the magnet
  - (d) Perpendicular to the magnet
3. The magnetic field inside a long straight solenoid carrying current is:
  - (a) Zero
  - (b) Non-uniform
  - (c) Uniform and parallel to the axis
  - (d) Circular in shape
4. Which rule helps to find the direction of magnetic field produced by a straight current-carrying conductor?
  - (a) Fleming's left-hand rule
  - (b) Fleming's right-hand rule
  - (c) Right-hand thumb rule
  - (d) Cork screw rule only
5. An electromagnet is made of:
  - (a) Permanent magnet

- (b) Soft iron core wrapped with insulated copper wire
  - (c) Hard steel wrapped with wire
  - (d) Copper core with iron wire
6. The force on a current-carrying conductor placed in a magnetic field is maximum when the angle between the conductor and magnetic field is:
- (a)  $0^\circ$
  - (b)  $45^\circ$
  - (c)  $90^\circ$
  - (d)  $180^\circ$
7. In a domestic electric circuit, the color of the live wire is:
- (a) Green
  - (b) Red
  - (c) Black
  - (d) Blue
8. The purpose of earth wire in domestic circuits is:
- (a) To carry current to appliances
  - (b) To complete the circuit
  - (c) Safety measure to prevent electric shock
  - (d) To reduce electricity bill
9. Short-circuiting occurs when:
- (a) Too many appliances are connected
  - (b) Live wire and neutral wire come in direct contact
  - (c) Fuse is removed
  - (d) Switch is turned off
10. The strength of magnetic field produced by a current-carrying circular coil:
- (a) Decreases with increase in current
  - (b) Increases with increase in current
  - (c) Remains constant
  - (d) Becomes zero at the center

### SECTION B - Short Answer Questions (2 marks each)

11. State two properties of magnetic field lines.
12. Why does a magnetic compass needle show deflection when brought near a current-carrying conductor? Name the scientist who discovered this phenomenon.
13. Draw the pattern of magnetic field lines around a current-carrying straight conductor. How does the strength of magnetic field vary with distance from the conductor?
14. What is meant by overloading of an electrical circuit? List two possible causes.

### SECTION C - Short Answer Questions (3 marks each)

15. Explain with the help of a diagram, how the strength of magnetic field at the center of a current-carrying circular coil depends on:
- (i) Current flowing through it

(ii) Number of turns in the coil

- 16.** State Fleming's left-hand rule. Apply this rule to find the direction of force on a conductor carrying current from east to west in a magnetic field directed vertically upward.
- 17.** What is an electromagnet? Describe its construction and mention two uses of electromagnets.

#### SECTION D - Long Answer Question (5 marks)

- 18.** (a) Draw a neat labeled diagram showing the magnetic field lines around a bar magnet. Indicate the direction of magnetic field lines.
- (b) Why do two magnetic field lines never intersect each other?
- (c) Compare the magnetic field produced by a current-carrying solenoid with that of a bar magnet.

#### SECTION E - Case Study Based Questions (4 marks each)

##### **19. Case Study 1: Hans Christian Oersted's Discovery**

In 1820, Danish scientist Hans Christian Oersted accidentally discovered that a compass needle got deflected when an electric current passed through a metallic wire placed nearby. He placed a wire parallel to a compass needle and passed electric current through it. The compass needle showed deflection, indicating that electricity and magnetism are related phenomena. When he reversed the direction of current, the needle deflected in the opposite direction. This observation led to the development of electromagnetism.

Based on the above case study, answer the following questions:

- (i) What was the key observation made by Oersted during his experiment? (1 mark)
- (ii) What does the deflection of compass needle indicate about the current-carrying wire? (1 mark)
- (iii) What happens to the deflection when the direction of current is reversed? Why? (2 marks)

##### **20. Case Study 2: Safety in Domestic Electric Circuits**

In Ramesh's house, the electricity connection has three wires - a red (live) wire, a black (neutral) wire, and a green (earth) wire. The potential difference between live and neutral wires is 220V. His house has two separate circuits - one of 15A rating for high power appliances like geyser and AC, and another of 5A rating for bulbs and fans. Recently, when multiple appliances were connected to a single socket, the fuse wire melted and broke the circuit, preventing any damage.

Based on the above case study, answer the following questions:

- (i) Why are appliances connected in parallel in a domestic circuit? (1 mark)
- (ii) What is the function of a fuse in an electric circuit? (1 mark)
- (iii) Why is it dangerous to connect too many appliances to a single socket? Explain with reference to the concept of overloading. (2 marks)



**SECTION A - Answers to MCQs****1. (b) Electric current produces a magnetic field**

When electric current flows through a wire, it produces a magnetic field around it. This magnetic field interacts with the magnetic field of the compass needle, causing deflection.

**2. (b) From north pole to south pole**

By convention, magnetic field lines emerge from the north pole and merge at the south pole outside the magnet. Inside the magnet, they go from south to north, forming closed loops.

**3. (c) Uniform and parallel to the axis**

Inside a long straight solenoid, the magnetic field lines are parallel straight lines, indicating that the field is uniform at all points inside the solenoid.

**4. (c) Right-hand thumb rule**

The right-hand thumb rule states: If you hold a current-carrying straight conductor in your right hand with the thumb pointing in the direction of current, then the fingers wrap around the conductor in the direction of the magnetic field.

**5. (b) Soft iron core wrapped with insulated copper wire**

An electromagnet consists of a soft iron core wrapped with many turns of insulated copper wire. When current passes through the coil, the iron core becomes magnetized.

**6. (c) 90°**

The force on a current-carrying conductor is maximum when it is placed perpendicular (at 90°) to the magnetic field. When parallel, the force is zero.

**7. (b) Red**

In domestic wiring, the live wire (positive) has red insulation, neutral wire has black insulation, and earth wire has green insulation.

**8. (c) Safety measure to prevent electric shock**

The earth wire provides a low-resistance path for leakage current to flow to the earth, preventing electric shock to the user.

**9. (b) Live wire and neutral wire come in direct contact**

Short-circuiting occurs when live and neutral wires touch each other directly, usually due to damaged insulation, causing a sudden increase in current.

**10. (b) Increases with increase in current**

The magnetic field strength at the center of a circular coil is directly proportional to the current flowing through it. More current means stronger magnetic field.

**SECTION B - Answers to Short Answer Questions****11.**

**Two properties of magnetic field lines:**

- (i) Magnetic field lines emerge from the north pole and merge at the south pole outside a magnet. Inside the magnet, they travel from south to north, forming closed loops.
- (ii) The relative strength of the magnetic field is indicated by the degree of closeness of field lines. Where field lines are crowded (closer together), the magnetic field is stronger.

**12.**

A current-carrying conductor produces a magnetic field around it. When a compass needle (which is itself a small magnet) is brought near such a conductor, it experiences the magnetic field produced by the current. This causes the compass needle to deflect from its original north-south position.

**Scientist:** Hans Christian Oersted discovered this phenomenon in 1820.

**13.****Pattern of magnetic field lines:**

The magnetic field lines around a current-carrying straight conductor form concentric circles centered on the wire. The direction of field lines can be found using the right-hand thumb rule.

**Variation with distance:**

The strength of the magnetic field decreases as we move away from the conductor. This is evident from the fact that the concentric circles representing the field lines become larger and more spaced out at greater distances from the wire.

**14.**

**Overloading:** Overloading occurs when the total current drawn by all appliances connected in a circuit exceeds the safe limit (current rating) of the circuit wiring.

**Two possible causes:**

- (i) Connecting too many appliances to a single socket simultaneously, causing the total current to exceed the circuit's capacity.
- (ii) Accidental hike in supply voltage, which increases the current drawn by appliances beyond safe limits.

**SECTION C - Answers to Short Answer Questions****15.**

The magnetic field strength at the center of a current-carrying circular coil depends on:

**(i) Current flowing through it:**

The magnetic field at the center is directly proportional to the current. If current is increased, the magnetic field strength increases proportionally. This is because each current element contributes to the total field, and more current means stronger contribution from each element.

**(ii) Number of turns in the coil:**

The magnetic field strength is directly proportional to the number of turns. If a coil has 'n' turns, the field produced is 'n' times as large as that produced by a single turn. This is because the current in each circular turn has the same direction, and the fields due to all turns add up.

**Mathematical relation:**  $B \propto n \times I$

Where B = magnetic field strength, n = number of turns, I = current

**16.**

**Fleming's Left-Hand Rule:**

Stretch the thumb, forefinger, and middle finger of your left hand such that they are mutually perpendicular to each other. If the forefinger points in the direction of the magnetic field and the middle finger in the direction of current, then the thumb points in the direction of motion or force acting on the conductor.

**Application:**

Given: Current flows from east to west, Magnetic field is vertically upward

Using Fleming's left-hand rule:

- Middle finger (current): East to West
- Forefinger (field): Vertically upward
- Thumb (force): Points towards North

Therefore, the force on the conductor will be directed towards the north.

17.

**Electromagnet:** An electromagnet is a temporary magnet made by passing electric current through a coil wound around a soft iron core. It behaves as a magnet only when current flows through it.

**Construction:**

An electromagnet consists of:

- A soft iron core (usually in cylindrical shape)
- Many turns of insulated copper wire wound closely around the core
- When electric current passes through the coil, the soft iron core gets magnetized and behaves like a strong magnet
- When current is switched off, the magnetism disappears

**Two uses of electromagnets:**

- In electric bells, electric motors, and loudspeakers
- For lifting and moving heavy iron materials in scrap yards and industry
- In magnetic resonance imaging (MRI) machines for medical diagnosis

**SECTION D - Answer to Long Answer Question**

18.

**(a) Magnetic field lines around a bar magnet:**

[The diagram would show:]

- A rectangular bar magnet labeled with N (North) at one end and S (South) at the other
- Curved field lines emerging from the North pole
- Field lines entering the South pole
- Arrows on field lines showing direction from N to S outside the magnet
- Field lines are denser near the poles and spread out away from the magnet
- Field lines form closed loops

**(b) Why two magnetic field lines never intersect:**

Two magnetic field lines never intersect each other because if they did, it would mean that at the point of intersection, the magnetic field would have two different directions simultaneously. This is impossible because a compass needle placed at that point can only point in one direction at a time. The direction of magnetic field at any point is unique and is given by the tangent to the field line at that point.

**(c) Comparison between solenoid and bar magnet:****Similarities:**

- Both have north and south poles
- The pattern of magnetic field lines outside both is very similar
- Both can attract magnetic materials like iron filings
- Field lines form closed loops in both cases

**Differences:**

- Bar magnet is a permanent magnet, while a solenoid is a temporary magnet (only magnetic when current flows)
- The strength of a bar magnet is fixed, but the strength of a solenoid can be varied by changing current or number of turns
- Inside a solenoid, field lines are parallel and uniform; inside a bar magnet, field lines converge from south to north

## SECTION E - Answers to Case Study Based Questions

19.

**(i) Key observation:** (1 mark)

Oersted observed that when electric current passed through a wire placed near a compass needle, the compass needle got deflected from its north-south position. This was the key observation that linked electricity and magnetism.

**(ii) Indication about current-carrying wire:** (1 mark)

The deflection of the compass needle indicates that the current-carrying wire produces a magnetic field around it. The compass needle, being a small magnet, responds to this magnetic field and gets deflected.

**(iii) Effect of reversing current direction:** (2 marks)

When the direction of current is reversed, the compass needle deflects in the opposite direction. This happens because the direction of the magnetic field produced by a current-carrying conductor depends on the direction of current flow. When current direction is reversed, the magnetic field direction also reverses, as given by the right-hand thumb rule. Therefore, the compass needle, which aligns itself along the direction of the resultant magnetic field, deflects in the opposite direction.

20.

**(i) Why appliances are connected in parallel:** (1 mark)

Appliances are connected in parallel in a domestic circuit so that each appliance gets the full voltage (220V) and can be operated independently. If one appliance is switched off or fails, others continue to work. Also, each appliance can be controlled by its own switch.

**(ii) Function of fuse:** (1 mark)

A fuse protects the electric circuit and appliances from damage due to short-circuiting or overloading. When excessive current flows through the circuit, the fuse wire heats up, melts, and breaks the circuit, thus preventing any damage to the wiring and appliances.

**(iii) Danger of connecting too many appliances - Overloading:** (2 marks)

When too many appliances are connected to a single socket, the total current drawn becomes very large and may exceed the safe current rating of the circuit wiring. This condition is called overloading.

Overloading is dangerous because:

- The excessive current causes excessive heating of the wires (due to Joule heating:  $H = I^2Rt$ )
- This can damage the insulation of wires and may cause fire
- The wires may melt and cause short-circuiting

- If proper fuse is not installed, overloading can lead to serious fire hazards

In Ramesh's case, the fuse wire melted when overloading occurred, which broke the circuit and prevented damage. This shows the importance of using proper fuses in electrical circuits.

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