CBSE CLASS X

Science (086)

ANSWER KEY

AI-generated question paper

Code: LR6RS2	Questions: 48	Maximum Marks: 119	Generated: 2026-06-25 17:54

SELECTIONS USED

Subject	Science
Lessons	12 Magnetic Effects of Electric Current
Level of understanding	Thorough understanding
Question selection	Curated chapter coverage (~5 questions per section + 8 synthesis)
Model	claude-sonnet-4-6

Composition — Difficulty: 1 straightforward · 30 medium · 17 deep | Types: 36 Short · 6 MCQ · 5 Very short · 1 Long

Q1. medium thorough-understanding § Introduction **[3]**

When a compass needle is placed near a current-carrying wire, it deflects. What does this deflection tell us about the nature of electric current, and what would you expect to happen to the deflection if the direction of the current in the wire is reversed? Justify your answer.

◆ **Magnetic Effects of Electric Current**

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Model Answer

The deflection of the compass needle tells us that an electric current produces a magnetic field around the wire — i.e., electric current has a **magnetic effect**. This was demonstrated by Oersted and shows that electricity and magnetism are linked.

If the direction of current is reversed, the compass needle will deflect in the **opposite direction**. This is because reversing the current reverses the direction of the magnetic field produced around the wire. As shown in Activity 12.4, when current flows north-to-south, the north pole of the needle moves east; on reversing, it moves west.

Source: Chapter 12 – Magnetic Effects of Electric Current, Sections 12.1 and 12.2

Explanation

- **1 mark** for stating that the deflection shows current has a magnetic effect (Oersted's finding).
- **1 mark** for stating the deflection reverses when current direction is reversed.
- **1 mark** for the justification: reversed current → reversed magnetic field → opposite deflection.
- Examiners expect you to link the observation directly to "magnetic effect of electric current" and use the Activity 12.4 result to justify the reversal. Avoid vague language like "the needle moves differently" — say **opposite direction**.

Q2. medium thorough-understanding § Introduction **[3]**

A student sets up a circuit with a straight copper wire placed parallel to a compass needle. When current flows, the needle deflects. The student then moves the compass needle farther from the wire without changing the current. What change, if any, will occur in the deflection of the needle, and why?

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Model Answer

When the compass is moved farther from the wire, the **deflection of the needle will decrease**.

A current-carrying wire produces a magnetic field around it. The strength of this magnetic field decreases as the distance from the wire increases. As stated in the textbook, field lines are drawn closer together where the field is stronger — meaning the field weakens with increasing distance. Since the current remains unchanged, the magnetic force acting on the compass needle becomes weaker at a greater distance, resulting in a smaller (reduced) deflection of the needle.

Source: Chapter 12 — Magnetic Effects of Electric Current, Sections 12.1 and 12.2

Explanation

- The examiner expects you to: (1) state that deflection decreases, (2) link it to the concept that magnetic field strength decreases with distance.
- Key phrase from the chapter: **"field lines are shown closer together where the magnetic field is greater"** — use this to justify weaker field at greater distance.
- Do **not** say the field disappears; it weakens. This distinction matters.
- This question tests conceptual understanding of Activity 12.4 and field line properties from Section 12.1.

Q3. medium thorough-understanding § Introduction **[1]**

Before Oersted's experiment, electricity and magnetism were considered completely unrelated phenomena. What fundamental scientific insight did Oersted's experiment provide, and why is it considered a landmark discovery in physics?

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Model Answer

Oersted's experiment showed that electricity and magnetism are interrelated — a current-carrying conductor produces a magnetic field, proving these were not separate but linked phenomena.

Source: Chapter 12, Introduction

Explanation

The examiner wants ONE key insight: electric current produces a magnetic field, linking electricity and magnetism. Mention Oersted's observation (compass needle deflection) and the conclusion (the two phenomena are related). Avoid over-explaining — one concise line is enough for 1 mark.

Q4. deep thorough-understanding § Introduction **[3]**

The discovery that a current-carrying conductor produces a magnetic field raises the question of whether the reverse is also possible — can a moving magnet produce an electric effect? Based on your study of this chapter, is this reverse effect real? Name the phenomenon and briefly describe one situation in which it occurs.

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Model Answer

Yes, the reverse effect is real. The phenomenon is called **electromagnetic induction**.

Situation: When a coil of wire is connected to a galvanometer and a bar magnet is moved towards or away from the coil, the galvanometer shows a deflection, indicating that an electric current is induced in the coil. This current exists only as long as the magnet is in motion. Thus, a moving (changing) magnetic field produces an electric current in a nearby conductor.

Source: Chapter 12 – Magnetic Effects of Electric Current, Introduction

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Explanation

- The question tests whether students can connect the chapter's opening hint ("reverse possibility of an electric effect of moving magnets") to the concept of electromagnetic induction.
- Name the phenomenon clearly — **electromagnetic induction** — for 1 mark.
- Describe one concrete situation (moving magnet + coil + galvanometer) for the remaining marks.
- Do **not** write about Fleming's left-hand rule or motors here; those are unrelated to the reverse effect.
- The chapter introduction explicitly raises this reverse question; examiners expect students to recall it.

Q5. medium | thorough-understanding | § 12.1 MAGNETIC FIELD AND FIELD LINES **[3]**

A student sprinkles iron filings around a bar magnet and taps the board gently. The filings arrange themselves in a curved pattern. What does this pattern reveal about the space around the magnet, and why do the filings align the way they do?

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Model Answer

The curved pattern of iron filings reveals that a **magnetic field** exists in the region surrounding the magnet. This region, where the magnet's force can be detected, is called the magnetic field, and the curved lines traced by the filings are the **magnetic field lines**.

The filings align this way because the magnet exerts a force on them in the surrounding region. Each iron filing behaves like a tiny magnet and orients itself along the field lines — emerging from the north pole and merging into the south pole. Where the filings (field lines) are closer together, the magnetic field is stronger.

Source: Chapter 12, Section 12.1 – Magnetic Field and Field Lines (Activity 12.2)

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Explanation

- **3 marks = ~3 key points:** (1) the pattern shows a magnetic field exists around the magnet, (2) filings align because the magnet exerts a force on them, (3) the lines go from north to south pole / closeness shows field strength.
- Always use the term **magnetic field lines** — examiners look for correct terminology.
- Do NOT over-explain; the answer above is the right length. Adding more risks wasting time and doesn't earn extra marks.

Q6. straightforward | thorough-understanding | § 12.1 MAGNETIC FIELD AND FIELD LINES **[1]**

State the direction of magnetic field lines (a) outside a bar magnet, and (b) inside a bar magnet. How does this make the field lines form closed loops?

◆ **Magnetic Effects of Electric Current**

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Model Answer

(a) Outside: from North pole to South pole. (b) Inside: from South pole to North pole. This continuous direction makes the field lines form closed loops.

Explanation

The key fact from the textbook is that field lines emerge from the North pole, merge at the South pole (outside), and travel from South to North **inside** the magnet — this unbroken path is what makes them closed curves. Examiners expect both directions stated clearly and a one-line reason for closed loops.

Source: Chapter 12, Section 12.1 (Magnetic Field and Field Lines)

Q7. medium | thorough-understanding | § 12.1 MAGNETIC FIELD AND FIELD LINES **[2]**

Two magnetic field lines can never cross each other. If they did cross, what impossible situation would arise at the point of intersection? Use this to explain why the 'no crossing' rule must hold.

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Model Answer

At the point of intersection, the compass needle would have to point in **two different directions simultaneously**, which is physically impossible. Since a magnetic field has a unique direction at every point, two field lines cannot cross — there can be only one direction of the field at any given point.

Source: Chapter 12, Section 12.1 – Magnetic Field and Field Lines

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Explanation

The textbook directly states: *"If they did, it would mean that at the point of intersection, the compass needle would point towards two directions, which is not possible."* Examiners expect you to clearly state (1) what impossible situation arises — two directions at one point — and (2) why that violates the nature of a magnetic field (unique direction at every point). Both points are needed for full 2 marks.

Q8. medium | thorough-understanding | § 12.1 MAGNETIC FIELD AND FIELD LINES **[2]**

Magnetic field lines near the poles of a bar magnet are much closer together than those far away from the poles. What does this difference in spacing tell you about the strength of the magnetic field at those two locations? How would this affect the force experienced by a small compass needle placed at each location?

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Model Answer

Closely spaced field lines near the poles indicate a **stronger magnetic field** there, while widely spaced lines far away indicate a **weaker magnetic field**.

A compass needle near the poles will experience a **greater force**, causing a larger deflection. Far from the poles, the force is weaker, so the needle deflects less.

Source: Chapter 12, Section 12.1 – Magnetic Field and Field Lines

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Explanation

- Key fact to quote: *"The field is stronger where the field lines are crowded."* (directly from the passage)
- Examiners expect two clear points: (1) spacing → field strength, (2) effect on compass needle (force/deflection).
- Don't just say "strong/weak" — link spacing → strength → effect on compass needle for full marks.

Q9. medium | thorough-understanding | § 12.1 MAGNETIC FIELD AND FIELD LINES **[2]**

A compass needle is a small bar magnet. When it is placed near the north pole of a bar magnet, which pole of the compass needle points toward the bar magnet's north pole, and why?

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Model Answer

The **south pole** of the compass needle points toward the north pole of the bar magnet.

This is because unlike poles attract each other. The north pole of the bar magnet attracts the south pole of the compass needle (which is itself a small bar magnet), causing the south pole of the needle to face the bar magnet's north pole.

Source: Chapter 12, Activity 12.3 & Section 12.1

Explanation

The key facts examiners expect:

1. **Which pole** — south pole of compass needle (1 mark).
2. **Why** — unlike poles attract (1 mark).

The passage from Activity 12.3 explicitly states: *"The south pole of the needle points towards the north pole of the magnet."* Always link the observation to the principle: unlike poles attract.

Q10. deep | thorough-understanding | § 12.1 MAGNETIC FIELD AND FIELD LINES **[3]**

The magnetic field is described as a quantity that has both magnitude and direction. How does a magnetic field line diagram convey EACH of these two properties?

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Model Answer

A magnetic field line diagram conveys both properties as follows:

Direction: The arrows marked on field lines show the direction of the magnetic field at any point. By convention, field lines emerge from the north pole and merge at the south pole of a magnet (and run from south to north inside the magnet).

Magnitude: The relative strength (magnitude) of the magnetic field is shown by the degree of closeness (crowding) of the field lines. Where field lines are closer together, the magnetic field is stronger; where they are farther apart, the field is weaker.

Source: Chapter 12, Section 12.1 – Magnetic Field and Field Lines

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Explanation

- The examiner expects **two clearly separated points** — one for direction, one for magnitude — since the question explicitly asks about "EACH of these two properties."
- The key phrases to use: *arrows on field lines* (direction) and *degree of closeness/crowding* (magnitude/strength).
- Do not confuse "magnitude" with "direction" — keep them distinct in your answer.
- These exact statements appear in Section 12.1 of the textbook and are frequently tested in board exams.

Q11. medium thorough-understanding § 12.2 MAGNETIC FIELD DUE TO A CURRENT-CARRYING CONDUCTOR **[3]**

A current-carrying straight wire is held vertically. A compass is placed at point P, close to the wire, and then moved to point Q, which is farther away, while the current remains unchanged. How does the deflection of the compass needle change, and why?

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Model Answer

When the compass is moved from P (closer) to Q (farther), the deflection of the needle **decreases**.

This is because the magnetic field produced by a current-carrying straight wire is **inversely proportional to the distance** from the wire. As the compass moves farther away, the magnetic field strength at that point becomes weaker. A weaker field exerts a smaller force on the compass needle, causing it to deflect less from its original north-pointing position.

Source: Chapter 12 — Magnetic Effects of Electric Current, Section 12.2

Explanation

- The key concept examiners look for is the **inverse relationship** between magnetic field strength and distance from the wire.
- State clearly: deflection **decreases** at Q (don't leave this implicit).
- Link the reason in two steps: greater distance → weaker field → less deflection. This is the logical chain worth full marks.
- The passage states "the magnetic field produced by a current-carrying straight wire depends inversely on the distance from it" — use this directly in your reasoning.

Q12. medium thorough-understanding § 12.2 MAGNETIC FIELD DUE TO A CURRENT-CARRYING CONDUCTOR **[3]**

A horizontal power line carries current from west to east. Determine the direction of the magnetic field at a point directly above the wire and at a point directly below it. Name the rule you used and explain your reasoning.

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Model Answer

Rule used: Right-Hand Thumb Rule — hold the conductor in the right hand with the thumb pointing in the direction of current (west to east); the curled fingers show the direction of the magnetic field.

Above the wire: The field is directed **from south to north** (i.e., towards north).

Below the wire: The field is directed **from north to south** (i.e., towards south).

Reasoning: Applying the right-hand thumb rule with thumb pointing east, the fingers curl over the top from south to north and under the bottom from north to south. Thus the field circles the wire in an anticlockwise sense when viewed from the west end.

Source: Chapter 12, Section 12.2.2 (Right-Hand Thumb Rule)

Explanation

- The examiner expects you to (1) name the rule, (2) state the direction above the wire, and (3) state the direction below the wire — these are the three marking points.
- The textbook Example 12.1 has current flowing **east to west**; this question reverses it to **west to east**, so the directions above and below are also reversed. Make sure you apply the rule fresh each time rather than memorising the textbook answer directly.
- A common mistake: confusing "above" and "below" — use the thumb-and-fingers image mentally to avoid this.

Q13. deep thorough-understanding § 12.2 MAGNETIC FIELD DUE TO A CURRENT-CARRYING CONDUCTOR **[3]**

A single circular loop and a coil of 50 turns carry the same current. (i) Explain why the coil produces a much stronger magnetic field at its centre than the single loop does. (ii) What do the magnetic field lines look like at the centre of a current-carrying circular loop, and why do they have this appearance?

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Model Answer

(i) A coil of 50 turns produces a much stronger magnetic field than a single loop because the current in each turn flows in the same direction, so the magnetic field due to each turn adds up. The total field at the centre is **n times** (here 50 times) that produced by a single turn.

(ii) At the centre of a current-carrying circular loop, the magnetic field lines appear as **straight parallel lines**. This is because the concentric circular field lines around each part of the wire become larger and larger away from the wire. By the time they reach the centre, their arcs are so large that they appear straight. Also, every section of the wire contributes field lines in the **same direction** at the centre (by the right-hand rule), reinforcing this appearance.

Source: Chapter 12, Section 12.2.3 — Magnetic Field due to a Current through a Circular Loop

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Explanation

- For part (i), the key phrase examiners look for is "field due to each turn adds up" and "n times as large." Mention same direction of current in all turns.
- For part (ii), the two ideas needed are: (a) arcs of large concentric circles appear straight at the centre, and (b) all sections contribute in the same direction. Both points together earn full credit.
- Avoid vague language like "stronger" without reason — always explain *why* in terms of the textbook mechanism.

Q14. medium | thorough-understanding | § 12.2.1 Magnetic Field due to a Current through a Straight Conductor **[3]**

When a compass is placed near a current-carrying straight wire, the deflection of its needle increases as the current is increased and decreases as the compass is moved farther away. What do these two observations tell us about the nature of the magnetic field produced by the wire?

◆ **Magnetic Effects of Electric Current**

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Model Answer

The two observations reveal the following properties of the magnetic field produced by a current-carrying wire:

1. **Strength depends on current:** When current increases, the compass deflects more, showing that the magnetic field strength is directly proportional to the current flowing through the wire.
1. **Strength decreases with distance:** When the compass is moved farther from the wire, deflection decreases, showing that the magnetic field strength decreases as distance from the wire increases (inversely dependent on distance).

Together, these observations confirm that the magnetic field around a current-carrying conductor has both magnitude and direction, and its strength varies with current and distance.

Source: Chapter 12, Section 12.2 – Magnetic Field due to a Current-Carrying Conductor

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Explanation

Examiners expect two distinct, clearly labelled points — one for each observation — plus a concluding line tying both to the nature of the magnetic field. Use the phrases **"directly proportional to current"** and **"inversely proportional to distance"** (or equivalent) for full marks. Avoid vague statements like "the field is strong." The concluding sentence about magnitude and direction earns the third mark.

Q15. medium thorough-understanding § 12.2.1 Magnetic Field due to a Current through a Straight Conductor **[3]**

A current-carrying straight wire is held vertically and you look at it from the top. The current flows upward (towards you). Using the right-hand thumb rule, determine the direction of the magnetic field lines — are they clockwise or anti-clockwise as seen from the top? Justify your answer.

◆ **Magnetic Effects of Electric Current**

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Model Answer

Direction of magnetic field: Anti-clockwise (as seen from the top).

Justification using Right-Hand Thumb Rule:
Hold the vertical wire in the right hand such that the thumb points **upward** (direction of current, i.e., towards you). The fingers curl around the wire in the direction of the magnetic field. When viewed from the top, the fingers wrap in an **anti-clockwise** direction. Therefore, the magnetic field lines form concentric circles around the wire in the **anti-clockwise** direction as seen from the top.

Source: Chapter 12, Section 12.2.2 — Right-Hand Thumb Rule

Explanation

- Examiners expect you to: (1) state the answer clearly first, (2) apply the rule step-by-step (thumb = current direction, fingers = field direction), and (3) relate it to the viewpoint (from top).
- A common mistake is confusing "current towards you" with clockwise — remember: anti-clockwise when current comes toward you (like a screw rule).
- Mentioning "concentric circles" earns credit as it shows understanding of the field pattern around a straight wire.

Q16. medium thorough-understanding § 12.2.1 Magnetic Field due to a Current through a Straight Conductor **[1]**

When iron filings are sprinkled on a cardboard through which a current-carrying wire passes vertically, they arrange themselves in a pattern around the wire. (i) What shape does this pattern take, and what does it indicate about the direction of the magnetic field? (ii) The spacing between adjacent rings increases as we move away from the wire — what does this tell you about the magnetic field at those points?

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Model Answer

(i) Iron filings arrange in **concentric circles** around the wire, indicating that the magnetic field lines form closed loops around a current-carrying straight conductor.

(ii) Wider spacing between rings shows the magnetic field **decreases (weakens)** as distance from the wire increases.

Source: Chapter 12, Section 12.2.1

Explanation

Since this is 1 mark, examiners expect only the key terms: **concentric circles** for part (i) and **field decreases with distance** for part (ii). Avoid lengthy explanations. The passage explicitly states rings grow larger farther away, meaning field lines are less crowded = weaker field — this is the core point to mention.

Q17. deep thorough-understanding § 12.2.1 Magnetic Field due to a Current through a Straight Conductor **[1]**

An overhead power line runs from east to west and carries current in the east-to-west direction. A compass is placed at a point directly below the wire. In which direction does the north pole of the compass needle point?

A North
B South
C East
D West

◆ **Magnetic Effects of Electric Current**

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Model Answer

Answer: B – South

Using the right-hand thumb rule, with current flowing east to west, the magnetic field directly below the wire points towards the **south**. So the north pole of the compass needle deflects towards **south**.

Source: Chapter 12, Section 12.2.2 – Right-Hand Thumb Rule (Example 12.1)

Explanation

- Point your right-hand thumb **eastward** → **westward** (direction of current). Your fingers curl **downward and southward** on the underside of the wire, meaning the field at a point **directly below** points **south**.
- Example 12.1 in the textbook confirms: the field turns **clockwise** when viewed from the east end, so below the wire the field points **south**.
- The north pole of a compass aligns with the field direction, hence it points **south**.
- Common mistake: confusing "above" and "below" — above the wire the field points north, below it points south.

Q18. medium thorough-understanding § 12.2.1 Magnetic Field due to a Current through a Straight Conductor **[3]**

A student reverses the connections of the battery in a circuit containing a straight current-carrying wire placed above a compass. She notices that the compass needle deflects in the opposite direction compared to before. (i) Why does the needle deflect in the opposite direction? (ii) What does this experiment reveal about the relationship between the direction of current and the magnetic field it produces?

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Model Answer

(i) When the battery connections are reversed, the direction of current through the wire also reverses (from south-to-north instead of north-to-south). This reverses the direction of the magnetic field produced around the wire. Since the compass needle aligns with the magnetic field, it deflects in the opposite direction.

(ii) This experiment reveals that the direction of the magnetic field produced by a current-carrying conductor depends on the direction of the current. When the direction of current is reversed, the direction of the magnetic field produced is also reversed.

Source: Chapter 12, Section 12.2, Activity 12.4

Explanation

- The key idea is the **cause-and-effect link**: reversed current → reversed magnetic field → opposite needle deflection.
- For part (i), explicitly state **why** the field reverses (current direction reversed), not just that it does.
- For part (ii), frame it as a **conclusion/revelation** — examiners expect a generalised statement, not just a description of the activity.
- These two points together are worth 3 marks (approx. 1.5 each), so keep each answer concise but complete.

Q19. medium thorough-understanding § 12.2.2 Right-Hand Thumb Rule **[3]**

A vertical wire carries a current directed straight upward. Using the right-hand thumb rule, determine the direction of the magnetic field at a point (i) to the north of the wire, and (ii) to the east of the wire. Explain your reasoning in each case.

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Model Answer

The magnetic field around a vertical current-carrying wire forms **concentric circles** in the horizontal plane, with direction given by the right-hand thumb rule: point the right thumb upward (direction of current); the fingers curl in the direction of the magnetic field.

(i) To the north of the wire: The fingers at the north side curl from east to west, so the magnetic field points **towards the west**.

(ii) To the east of the wire: The fingers at the east side curl from north to south, so the magnetic field points **towards the south**.

Source: Chapter 12, Section 12.2.2 — Right-Hand Thumb Rule

Explanation

- The key step is applying the right-hand thumb rule correctly: thumb = current direction (up), curling fingers = field direction.
- Visualise the wire from above: the field circles **anticlockwise** when viewed from above (since current is upward). At the north point, anticlockwise means the field goes west; at the east point, it goes south.
- Examiners award 1 mark for stating the rule, 1 mark for each correct direction with brief reasoning. Don't just state directions — mention the rule and curl direction.

Q20. deep thorough-understanding § 12.2.2 Right-Hand Thumb Rule **[3]**

A current flows through a long straight wire from west to east. A compass is placed first directly above the wire and then directly below it. How does the direction of deflection of the compass needle differ between these two positions, and why?

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Model Answer

Current flows west to east. Using the **Right-Hand Thumb Rule** (thumb pointing east, fingers curl around the wire):

- **Above the wire:** The magnetic field at that point is directed **from south to north** (northward). The compass needle deflects so its north pole points **north** (or towards north).
- **Below the wire:** The magnetic field at that point is directed **from north to south** (southward). The compass needle deflects in the **opposite direction**, with its north pole pointing **south**.

Reason: The magnetic field lines form concentric circles around the wire. Above and below the wire, the field lines run in opposite directions, so the compass needle deflects in opposite directions at the two positions.

Source: Chapter 12, Section 12.2.2 – Right-Hand Thumb Rule (Example 12.1)

Explanation

- The key concept is the **Right-Hand Thumb Rule**: thumb → direction of current, curling fingers → direction of magnetic field.
- Examiners expect you to correctly state that the deflections are **opposite** to each other and give the rule as the reason.
- Example 12.1 in the textbook is almost identical (east-to-west current); here current is west-to-east, so directions reverse accordingly.
- Avoid vague phrases — state the actual directions (north/south) clearly for full marks.

Q21. medium thorough-understanding § 12.2.3 Magnetic Field due to a Current through a Circular Loop **[3]**

A circular loop carries a steady current. Describe how the nature and shape of the magnetic field lines change as you move from a point close to the wire of the loop towards the centre of the loop. What does the field look like at the centre, and in which direction does it point relative to the plane of the loop?

◆ **Magnetic Effects of Electric Current**

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Model Answer

Near the wire of the loop, the magnetic field lines form **small concentric circles** around the wire. As we move towards the centre of the loop, these circles grow larger and larger. By the time we reach the centre, the arcs of these large circles appear as **straight parallel lines**.

At the centre, the field looks like straight lines passing through the loop. Every section of the wire contributes to the field in the **same direction** at the centre (verified by right-hand rule). The field at the centre is directed **perpendicular to the plane of the loop** (along the axis of the loop).

Source: Chapter 12, Section 12.2.3 — Magnetic Field due to a Current through a Circular Loop

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Explanation

- Examiners look for **three key points**: (1) concentric circles near wire → becoming larger → straight lines at centre, (2) all contributions add in the same direction, (3) field is perpendicular to the plane of the loop.
- The phrase "arcs of big circles appear as straight lines" is directly from the textbook — use it.
- Don't confuse "perpendicular to the plane" with "parallel to the plane" — the field at the centre is along the **axis**, i.e., perpendicular to the loop's plane.

Q22. medium thorough-understanding § 12.2.3 Magnetic Field due to a Current through a Circular Loop **[3]**

A single circular loop and a coil of 50 turns of the same radius carry the same current. How does the magnetic field at the centre of the coil compare with that at the centre of the single loop? Justify your answer.

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Model Answer

The magnetic field at the centre of the coil of 50 turns is **50 times stronger** than that at the centre of the single loop.

Justification: The magnetic field at the centre of a circular loop depends directly on the current and the number of turns. In a multi-turn coil, the current in each turn flows in the same direction, so the magnetic field due to each turn adds up. Therefore, for a coil of *n* turns carrying the same current:

$$B_{coil} = n \times B_{single}$$

Here, $n = 50$, so $B_{coil} = 50 \times B_{single}$.

Source: Chapter 12, Section 12.2.3

Explanation

- The key principle from the textbook is: *"If there is a circular coil having n turns, the field produced is n times as large as that produced by a single turn."*
- Examiners award marks for: (1) stating the field is 50 times greater, (2) giving the reason (fields due to each turn add up because current direction is the same in all turns), and (3) writing the relation $B = nB_0$.
- Do not forget to justify — simply stating "50 times" without reasoning will lose marks.

Q23. medium thorough-understanding § 12.2.3 Magnetic Field due to a Current through a Circular Loop **[1]**

The magnetic field at the centre of a current-carrying circular loop is directed perpendicularly into the plane of the loop. If you reverse the direction of the current in the loop, which of the following correctly describes the resulting field at the centre?

(A) It remains directed into the plane of the loop, but doubles in magnitude.
(B) It is directed perpendicularly out of the plane of the loop.
(C) It becomes zero because the contributions from opposite sides cancel.
(D) It rotates to lie within the plane of the loop.

A It remains directed into the plane of the loop, but doubles in magnitude.
B It is directed perpendicularly out of the plane of the loop.
C It becomes zero because the contributions from opposite sides cancel.
D It rotates to lie within the plane of the loop.

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Model Answer

(B) It is directed perpendicularly out of the plane of the loop.

Reversing the current reverses the direction of the magnetic field at the centre, as confirmed by the right-hand thumb rule.

Explanation

By the right-hand thumb rule, the direction of the magnetic field at the centre of a circular loop depends on the direction of current. Reversing the current reverses the field direction — from into the plane to out of the plane (or vice versa). The magnitude stays the same; only direction changes. Examiners expect students to apply the right-hand thumb rule correctly here.

Q24. deep thorough-understanding § 12.2.3 Magnetic Field due to a Current through a Circular Loop **[3]**

State one similarity and one important difference in the nature of the magnetic field produced by (i) a long straight current-carrying conductor and (ii) a current-carrying circular loop at its centre. Why does the circular geometry produce a uniform, unidirectional field at the centre, unlike the field around a straight wire?

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Model Answer

Similarity: In both cases, the magnetic field lines form concentric circles around each small element of the wire, and the field strength decreases as distance from the wire increases.

Difference: Around a straight wire, the field lines are concentric circles in planes perpendicular to the wire with no single direction. At the centre of a circular loop, the field is **unidirectional** (all field lines point the same way — either into or out of the loop).

Why circular geometry gives uniform, unidirectional field at centre:
By the right-hand rule, every section of the circular loop contributes magnetic field lines in the **same direction** at the centre. The arcs of the large concentric circles from each part of the wire all appear as parallel straight lines at the centre, so all contributions add up in one direction, producing a uniform, unidirectional field there.

Source: Chapter 12, Section 12.2.3 — Magnetic Field due to a Current through a Circular Loop

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Explanation

- Examiners award 1 mark each for similarity, difference, and the explanation of why the circular loop produces a uniform field — stick to this structure.
- The key phrase to use is "every section of the wire contributes in the **same direction**" — this comes directly from the textbook and is what examiners look for.
- Don't confuse "uniform" (same at all points) with "unidirectional" (same direction) — at the centre of a single loop the field is unidirectional and approximately uniform, unlike the varying concentric-circle pattern of a straight wire.

Q25. medium thorough-understanding § 12.2.4 Magnetic Field due to a Current in a Solenoid **[3]**

A current-carrying solenoid is often described as equivalent to a bar magnet. (i) What does the pattern of magnetic field lines inside a solenoid tell you about the nature of the field there? (ii) Why is this property particularly useful when a solenoid is used to make an electromagnet?

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Model Answer

(i) The field lines inside a solenoid are parallel straight lines. This indicates that the magnetic field is **uniform** (the same in magnitude and direction) at all points inside the solenoid.

(ii) The uniform and strong magnetic field inside the solenoid is particularly useful because when a soft iron core is placed inside, this strong field magnetises it effectively and uniformly, producing a powerful **electromagnet**. The strength can also be controlled by varying the current.

Source: Chapter 12, Section 12.2.4 – Magnetic Field due to a Current in a Solenoid

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Explanation

- **(i)** The key phrase examiners want is **"parallel straight lines → uniform field."** Write both the observation and the conclusion.
- **(ii)** Link the uniform/strong field to **magnetising a soft iron core** — that is the direct application stated in the textbook. Mentioning controllability is a bonus point.
- Avoid writing about bar-magnet similarity here unless asked; keep focus on what the question asks.
- For 3 marks, roughly 1 mark per concept: parallel lines, uniform field, usefulness for electromagnet.

Q26. deep thorough-understanding § 12.2.4 Magnetic Field due to a Current in a Solenoid **[3]**

A solenoid has 200 turns of wire. A student argues that replacing it with a single-turn circular loop carrying the same current would produce the same magnetic field at the centre, since the current value is unchanged. Is the student correct? Explain why or why not.

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Model Answer

The student is **incorrect**.

The magnetic field at the centre of a circular coil depends not only on the current but also on the **number of turns**. As stated, *"if there is a circular coil having n turns, the field produced is n times as large as that produced by a single turn"* — because the current in each turn flows in the same direction and the fields add up.

A solenoid with 200 turns produces a field **200 times stronger** than a single-turn loop carrying the same current. Replacing it with a single loop would reduce the magnetic field drastically.

Source: Chapter 12, Section 12.2.3 – Magnetic Field due to a Current through a Circular Loop

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Explanation

- The key principle examiners look for: **B ∝ n** (field is proportional to number of turns).
- Quote or paraphrase the textbook line about *n turns producing n times the field* — it directly addresses the question.
- Clearly state the student is wrong and give the correct reasoning. Avoid vague answers like "the solenoid is different" without explaining *why*.
- No formula is required at Class 10 level, but stating "200 times stronger" shows conceptual clarity and fetches full marks.

Q27. medium thorough-understanding § 12.2.4 Magnetic Field due to a Current in a Solenoid **[1]**

Which of the following best explains why one end of a current-carrying solenoid behaves as a north pole and the other as a south pole?

(A) The copper wire conducts current better at one end than the other, creating an asymmetry.

(B) The direction of current flow as seen from each end of the solenoid is opposite (clockwise at one end, anticlockwise at the other), producing opposite magnetic poles.

(C) The combined magnetic fields of all the turns reinforce each other along the axis, producing a net field that exits from one end and enters the other, just as in a bar magnet.

(D) The solenoid develops poles only when a soft-iron core is inserted inside it.

A The insulation on the copper wire creates a charge separation at each end.
B Current flows in opposite directions at the two ends of the solenoid, creating opposite poles.
C The combined magnetic fields of all the turns reinforce each other, producing a net field that exits from one end and enters the other, just as in a bar magnet.
D The solenoid develops poles only when a magnetic material is placed inside it.

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Model Answer

Answer: (C)

The combined magnetic fields of all the turns reinforce each other, producing a net field that exits from one end and enters the other, just as in a bar magnet.

Source: Magnetic Field due to a Current in a Solenoid, Chapter 12

Explanation

- Option C is correct because the textbook explicitly states that the field pattern of a current-carrying solenoid is **similar to that of a bar magnet**, with one end acting as north pole and the other as south pole due to the reinforcement of fields of all turns along the axis.
- Option B is partially true (current direction does appear opposite at each end) but it is **not the complete or best explanation** — the textbook emphasises field reinforcement and the bar magnet analogy, not asymmetry in current direction.
- Option D is wrong: poles form even without a magnetic core; the soft-iron core only strengthens the field (electromagnet).
- For MCQs, pick the option that **most completely matches the textbook explanation**.

Q28. deep thorough-understanding § 12.3 FORCE ON A CURRENT-CARRYING CONDUCTOR IN A MAGNETIC FIELD **[3]**

A current-carrying aluminium rod is suspended horizontally between the poles of a horseshoe magnet with the magnetic field directed vertically upward. When current flows through the rod from end B to end A, the rod is displaced to the left. What will happen to the direction of displacement if both the direction of the current AND the direction of the magnetic field are simultaneously reversed? Justify your answer.

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Model Answer

When both the direction of current and the direction of the magnetic field are simultaneously reversed, the rod will still be displaced **to the left** — the direction of displacement remains unchanged.

Justification: According to Fleming's Left-Hand Rule, the direction of force on a current-carrying conductor depends on both the direction of current and the direction of the magnetic field. When only the current is reversed, the force reverses (rod moves right). When only the field is reversed, the force also reverses (rod moves right). But when **both** are reversed simultaneously, the two reversals cancel each other out, and the net force acts in the **original direction** — to the left.

Source: Chapter 12, Section 12.3 – Force on a Current-Carrying Conductor in a Magnetic Field

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Explanation

- The key concept here is that force direction depends on **both** current and field. Reversing either one alone reverses the force. Reversing **both together** is equivalent to no net change — the effects cancel.
- Examiners expect you to explicitly state the final direction (left) and give a clear reason using Fleming's Left-Hand Rule logic or the principle that double reversal restores the original direction.
- A common mistake is saying the displacement reverses — avoid this by thinking of the two reversals as multiplying two negatives: (−1) × (−1) = +1.

Q29. medium thorough-understanding § 12.3 FORCE ON A CURRENT-CARRYING CONDUCTOR IN A MAGNETIC FIELD **[2]**

A straight current-carrying conductor is placed in a uniform magnetic field. Under what condition is the force experienced by the conductor the greatest? What is the force when the conductor is placed parallel to the magnetic field?

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Model Answer

Condition for greatest force: The force on a current-carrying conductor is greatest when the direction of current is **perpendicular (at right angles)** to the direction of the magnetic field.

Force when parallel to the field: When the conductor is placed **parallel** to the magnetic field, the force experienced by it is **zero**.

Source: Chapter 12, Section 12.3 — Force on a Current-Carrying Conductor in a Magnetic Field

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Explanation

- The textbook explicitly states: *"the displacement of the rod is largest when the direction of current is at right angles to the direction of the magnetic field."*
- When conductor is parallel to field, the angle between them is 0°, so no force acts (this follows from $F = BIL \sin\theta$; $\sin 0° = 0$, though the formula itself is not required at Class 10 level — just state the result).
- Examiners expect both parts answered clearly. Missing either part loses a mark.

Q30. deep thorough-understanding § 12.3 FORCE ON A CURRENT-CARRYING CONDUCTOR IN A MAGNETIC FIELD **[3]**

An alpha particle (positively charged) moves horizontally towards the east and enters a magnetic field directed vertically downward. Using Fleming's left-hand rule, determine the direction of force acting on the alpha particle.

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Model Answer

Applying Fleming's Left-Hand Rule:

- **Stretch** the left hand so that the forefinger, middle finger, and thumb are mutually perpendicular.
- **Forefinger** → direction of magnetic field: **vertically downward**
- **Middle finger** → direction of current (conventional, same as motion of positive charge): **towards east**
- **Thumb** → direction of force on the alpha particle: **towards north**

Therefore, the force acting on the alpha particle is directed **towards the north**.

(The alpha particle, being positively charged, has its conventional current direction same as its velocity, i.e., eastward.)

Source: Chapter 12, Section — A current-carrying conductor in a magnetic field experiences a force given by Fleming's left-hand rule.

Explanation

- **Key point:** An alpha particle is positively charged, so conventional current direction = direction of its motion (east).
- In Fleming's Left-Hand Rule: **F**orefinger = **F**ield, **M**iddle finger = current (**M**otion for positive charge), **T**humb = **T**hrust (force).
- Setting forefinger downward (field) and middle finger eastward (current), the thumb points **north** — that is the answer examiners expect.
- Do not confuse with Fleming's Right-Hand Rule (used for induced current/generators).

Q31. medium thorough-understanding § 12.3 FORCE ON A CURRENT-CARRYING CONDUCTOR IN A MAGNETIC FIELD **[1]**

A current-carrying conductor is placed near a magnet. The magnet exerts a force on the conductor. What does Newton's third law imply about the force the conductor exerts on the magnet? How does this relate to the principle behind the working of an electric motor?

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Model Answer

By Newton's third law, the conductor exerts an equal and opposite force on the magnet. This mutual force between current and magnet is the principle behind the electric motor.

Explanation

The examiner expects two points in one line: (1) Newton's third law → equal and opposite reaction force on the magnet, and (2) linking this interaction to the electric motor. Ampere's suggestion (from the passage) directly states the magnet exerts equal and opposite force on the conductor — so the reverse is the conductor on the magnet. Keep it concise for 1 mark.

Q32. deep thorough-understanding § 12.3 FORCE ON A CURRENT-CARRYING CONDUCTOR IN A MAGNETIC FIELD **[3]**

An electron moves into a magnetic field directed into the page, travelling vertically upward. In which direction will the electron be deflected? Show your reasoning using Fleming's left-hand rule. (Recall that conventional current is opposite to the direction of electron motion.)

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Model Answer

Given: Electron moves vertically upward; magnetic field (B) directed into the page.

Step 1: Conventional current is opposite to electron motion, so conventional current flows **vertically downward**.

Step 2 – Apply Fleming's Left-Hand Rule:

- Forefinger (B): into the page
- Middle finger (current): downward
- Thumb (force): points **towards the right**

Therefore, the electron is deflected towards the right.

(Source: Chapter 12, Section 12.3 – Force on a Current-Carrying Conductor in a Magnetic Field)

Explanation

What examiners look for (3 marks):

1. **(1 mark)** Correctly reversing electron direction to get conventional current direction.
2. **(1 mark)** Correctly stating which finger represents B, current, and force in Fleming's Left-Hand Rule.
3. **(1 mark)** Correct final direction of deflection.

Key tip: The most common mistake is forgetting to reverse the electron's direction before applying the rule. Always state "conventional current is opposite to electron motion" explicitly — examiners award a mark for this step alone.

Q33. medium · thorough-understanding · § 12.3 FORCE ON A CURRENT-CARRYING CONDUCTOR IN A MAGNETIC FIELD **[1]**

A current-carrying rod is placed in a magnetic field. When the current in the rod is doubled and the strength of the magnetic field is also doubled, how does the force on the rod change compared to the original force?

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Model Answer

The force becomes **4 times** the original force, since force on a current-carrying conductor is directly proportional to both current and magnetic field strength ($F \propto I \times B$). Doubling both doubles each factor: $2 \times 2 = 4$.

Explanation

The key concept is that the force on a current-carrying conductor is proportional to the product of current (I) and magnetic field (B). The textbook states that displacement (force) is largest at right angles and depends on both current and field strength. Since both are doubled, the force multiplies: F_new = (2I)(2B) = 4F. Examiners expect the factor "4 times" stated clearly with brief reasoning.

Source: Chapter 12, Section 12.3 — Force on a Current-Carrying Conductor in a Magnetic Field.

Q34. medium · thorough-understanding · § 12.3 FORCE ON A CURRENT-CARRYING CONDUCTOR IN A MAGNETIC FIELD **[1]**

Which of the following changes will NOT increase the displacement (force) of a current-carrying rod suspended in a magnetic field?
(A) Increasing the current through the rod
(B) Using a stronger magnet
(C) Increasing the length of the rod
(D) Reversing the direction of the current

- A Increasing the current through the rod
- B Using a stronger magnet
- C Increasing the length of the rod
- D Reversing the direction of the current

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Model Answer

(D) Reversing the direction of the current

Reversing the current reverses the *direction* of displacement, not its magnitude. It does not increase the force on the rod.

Explanation

Options A, B, and C all increase the magnitude of the force (displacement). Reversing current only changes the direction of deflection (left→right), as shown in Activity 12.7. Examiners expect students to distinguish between *magnitude* and *direction* of force.

Q35. deep thorough-understanding § 12.3 FORCE ON A CURRENT-CARRYING CONDUCTOR IN A MAGNETIC FIELD **[3]**

A student claims that a stationary charged particle placed in a magnetic field will always experience a force due to that field. Do you agree? Explain your answer, and state the condition under which a charged particle actually experiences a force in a magnetic field.

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Model Answer

No, I do not agree with the student's claim.

A stationary charged particle has no velocity ($v = 0$). The magnetic force on a charged particle depends on its motion through the field. If the particle is stationary, it experiences **no force**, regardless of the strength of the magnetic field.

Condition for force: A charged particle experiences a force in a magnetic field only when it is **moving**, and the force is maximum when the direction of motion is **perpendicular** to the magnetic field. If current (motion of charge) and field are mutually perpendicular, Fleming's left-hand rule gives the direction of force.

Source: Section 12.3, Force on a Current-Carrying Conductor in a Magnetic Field, Chapter 12

Explanation

- The key concept: magnetic force requires *motion* of the charge. A stationary charge contributes zero current, so no force acts.
- The textbook states: "the displacement of the rod is largest when the direction of current is **at right angles** to the direction of the magnetic field" — this implies force depends on current (moving charges) and angle.
- Examiners expect: (1) clear disagreement with the claim, (2) reason (no velocity = no force), (3) the condition (particle must be moving, ideally perpendicular to field). All three earn the 3 marks.

Q36. medium thorough-understanding § 12.4 DOMESTIC ELECTRIC CIRCUITS **[3]**

In a domestic electric circuit, all the appliances — bulbs, fans, electric press — are connected in parallel with each other. Why is this arrangement used instead of a series connection?

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Model Answer

Parallel connection is preferred over series connection in domestic circuits for the following reasons:

1. **Equal voltage**: Each appliance gets the same potential difference (220 V) as required for proper functioning. In series, voltage gets divided.

1. **Independent operation**: Each appliance has its own switch, so it can be turned ON/OFF independently without affecting others. In series, all appliances would stop if one fails.

1. **Different current ratings**: Appliances of different power ratings draw their required current independently, which is not possible in a series circuit.

Source: Chapter 12, Section 12.4 — Domestic Electric Circuits

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Explanation

The examiner expects **three distinct reasons**, one per mark. The key phrase from the textbook is: *"In order that each appliance has equal potential difference, they are connected parallel to each other."* Always include: (i) equal voltage, (ii) independent working, and (iii) different power ratings/current. Avoid vague answers — name the advantage clearly and contrast with series where relevant.

Q37. deep thorough-understanding § 12.4 DOMESTIC ELECTRIC CIRCUITS **[3]**

A household has a 15 A circuit for high-power appliances and a 5 A circuit for lights and fans. A student suggests connecting a 2 kW electric geyser (operating at 220 V) to the 5 A circuit since a socket is available there. Calculate whether this is safe and explain what would happen if the student went ahead.

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Model Answer

Current drawn by the geyser:

$$I = \frac{P}{V} = \frac{2000}{220} \approx 9.1 \text{ A}$$

This exceeds the 5 A rating of the light-and-fan circuit, so **it is not safe** to connect the geyser there.

What would happen: The current (9.1 A) would exceed the circuit's 5 A limit, causing overloading. The fuse in the 5 A circuit would melt due to Joule heating, breaking the circuit to prevent damage to the wiring and appliances. If no fuse were present, the wires could overheat, potentially causing a fire.

Source: Chapter 12, Section 12.4 Domestic Electric Circuits

Explanation

- **Key formula:** $I = P/V$ — examiners expect this calculation shown clearly.
- The 5 A circuit is meant for bulbs and fans, **not** high-power appliances like geysers (which belong on the 15 A circuit).
- Always link the conclusion to the fuse mechanism: excess current → Joule heating → fuse melts → circuit breaks. This is the core concept from Section 12.4.
- The word "overloading" must appear in your answer for full marks.

Q38. medium thorough-understanding § 12.4 DOMESTIC ELECTRIC CIRCUITS **[3]**

What is the difference between overloading and short-circuiting in a domestic circuit? Can both situations blow the same fuse? Justify your answer.

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Model Answer

Overloading occurs when too many appliances are connected to a single circuit or there is an accidental rise in supply voltage, causing excessive current flow.

Short-circuiting occurs when the live wire and neutral wire come into direct contact (due to damaged insulation or a fault), causing current to increase abruptly.

Yes, the same fuse can blow in both situations. In both cases, the current in the circuit rises beyond the fuse's rated value. The excessive Joule heating melts the fuse wire, breaking the circuit and protecting the appliances.

Source: Chapter 12, Section 12.4 — Domestic Electric Circuits

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Explanation

- Examiners expect **two distinct definitions** (1 mark each) and a justified **yes/no** for the fuse question (1 mark).
- Key link: both overloading and short-circuiting raise current above safe limits → fuse melts due to Joule heating. Mentioning Joule heating strengthens the justification.
- Don't confuse the two: overloading is gradual/excessive load; short-circuit is a direct wire-to-wire fault causing sudden surge.

Q39. deep thorough-understanding § 12.4 DOMESTIC ELECTRIC CIRCUITS **[2]**

The metallic casing of an electric iron is connected to the earth wire, but a plastic-bodied electric kettle is not provided with an earth connection. Explain the reasoning behind this difference in treatment.

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Model Answer

The metallic casing of an electric iron can conduct electricity. If a fault causes current to leak into the casing, the earth wire provides a low-resistance path to the earth, keeping the casing's potential equal to earth potential, thus preventing a severe electric shock to the user.

A plastic body is a poor conductor (insulator), so even if current leaks internally, it cannot flow through the plastic casing to the user. Hence, no earth connection is needed.

Source: Chapter 12, Section 12.4 – Domestic Electric Circuits

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Explanation

- The key concept is **conductivity**: metals conduct, plastics insulate.
- The earth wire's role is to provide a **low-resistance path** so leakage current flows to earth rather than through the user.
- Examiners expect you to explain **why** metal needs earthing (shock hazard) and **why** plastic doesn't (non-conductor = no shock risk). Both parts needed for full 2 marks.

Q40. medium thorough-understanding § 12.4 DOMESTIC ELECTRIC CIRCUITS **[1]**

Which of the following correctly describes what happens inside a fuse wire when a short circuit occurs?
(A) The fuse wire increases its resistance, reducing the current to a safe level.
(B) The high current causes Joule heating in the fuse wire, melting it and breaking the circuit.
(C) The fuse wire deflects the excess current to the earth wire, protecting the appliance.
(D) The fuse wire expands and disconnects the live wire from the neutral wire mechanically.

A The fuse wire increases its resistance, reducing the current to a safe level.
B The high current causes Joule heating in the fuse wire, melting it and breaking the circuit.
C The fuse wire deflects the excess current to the earth wire, protecting the appliance.
D The fuse wire expands and disconnects the live wire from the neutral wire mechanically.

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Model Answer

(B) The high current causes Joule heating in the fuse wire, melting it and breaking the circuit.

Explanation

The textbook (Section 12.4) explicitly states: "The Joule heating that takes place in the fuse melts it to break the electric circuit." During a short circuit, current increases abruptly; the fuse wire, having a low melting point, melts due to this Joule heating, thus breaking the circuit. Options A, C, and D describe mechanisms not associated with fuse operation.

Q41. deep thorough-understanding § 12.4 DOMESTIC ELECTRIC CIRCUITS **[3]**

In a domestic supply, the live wire is at 220 V and the neutral wire is at approximately 0 V (earth potential). The earth wire is also at 0 V. If the neutral and earth wires are both at the same potential, why is the earth wire still considered a critical safety feature for appliances with metallic bodies?

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Model Answer

Although both the neutral and earth wires are at 0 V (earth potential) under normal conditions, they serve different purposes. The neutral wire carries the return current during normal operation, while the earth wire is a **dedicated safety conductor** connected to a metal plate deep in the earth.

For appliances with metallic bodies (e.g., electric press, refrigerator), the body is connected to the earth wire. If a fault occurs and the live wire accidentally touches the metallic body, the earth wire provides a **low-resistance conducting path** for the leakage current directly to the earth. This keeps the potential of the metallic body at earth potential (0 V), preventing the user from receiving a severe electric shock.

Without the earth wire, the faulty metallic body would become live at 220 V, making contact with it dangerous.

Source: Chapter 12, Section 12.4 — Domestic Electric Circuits

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Explanation

- Examiners expect you to distinguish between the **function** of the neutral wire (carries return current) and the earth wire (safety path for fault current).
- Key phrase to include: **"low-resistance conducting path"** — this exact language comes from the textbook and is likely expected.
- Mention at least one example appliance (refrigerator, electric press, etc.) to show context.
- The core logic: under a fault, the earth wire diverts leakage current safely away, keeping the appliance body at 0 V so the user is not shocked. This is different from the neutral wire, which is part of the active circuit and not dedicated to fault protection.

Q42. medium thorough-understanding § (whole-chapter synthesis) **[3]**

A solenoid carrying current behaves like a bar magnet, yet the magnetic field inside a solenoid is described as uniform, while the field near the poles of a bar magnet is not. Explain why the field lines inside a solenoid are parallel and straight, and identify ONE way in which the field pattern outside both a solenoid and a bar magnet is similar.

◆ **Magnetic Effects of Electric Current**

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Model Answer

Inside a solenoid, each circular turn produces a small magnetic field. When many such turns are wound closely together, the fields of all turns add up inside, and their effects cancel on the outside. This results in a **strong, uniform field** with **parallel, straight field lines** inside the solenoid — indicating equal field strength at all interior points.

Similarity with a bar magnet: The field pattern *outside* both a current-carrying solenoid and a bar magnet is identical — field lines emerge from the north pole, curve around the outside, and re-enter at the south pole.

Source: Chapter 12, Section 12.2.4 — Magnetic Field due to a Current in a Solenoid

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Explanation

- Examiners expect two things clearly addressed: **(1) why the interior field is uniform/parallel** — due to superposition of fields from multiple closely-wound turns — and **(2) one similarity** in the external field pattern.
- The textbook explicitly states: "The field lines inside the solenoid are in the form of parallel straight lines... the field is uniform inside the solenoid" and "one end behaves as north, the other as south" — mirroring a bar magnet's external field.
- Avoid over-explaining; state the cause (additive effect of turns) and the result (parallel lines = uniform field) concisely.
- The similarity point is straightforward: identical external dipole-like field pattern — this scores the third mark.

Q43. deep thorough-understanding § (whole-chapter synthesis) **[3]**

An aluminium rod suspended horizontally between the poles of a horseshoe magnet experiences a sideways force when current is passed through it. A student claims that this force arises because the rod is in a magnetic field and carries current, and that the same principle must apply to every part of a circular coil placed in an external magnetic field. (i) Name and state the rule that gives the direction of force on the straight rod. (ii) Using the same principle, explain why a rectangular coil carrying current in a uniform magnetic field tends to rotate rather than translate sideways.

◆ Magnetic Effects of Electric Current

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Model Answer

(i) Fleming's Left-Hand Rule:
Stretch the thumb, forefinger, and middle finger of the left hand so they are mutually perpendicular. 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 the **force** on the conductor.

(ii) In a rectangular coil placed in a uniform magnetic field, the two sides carrying current in **opposite directions** experience forces in **opposite directions** (by Fleming's left-hand rule). These two equal and opposite forces act at different positions on the coil, forming a **couple**. This couple produces a **turning effect (torque)**, causing the coil to rotate rather than move sideways as a whole.

Source: Chapter 12, Section 12.3 — Force on a Current-Carrying Conductor in a Magnetic Field

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Explanation

- **(i)** Always name the rule first, then state it clearly with all three — field, current, and force/motion. Examiners expect all three fingers to be mentioned.
- **(ii)** The key idea is that opposite sides carry current in opposite directions → forces are opposite → they form a couple → rotation, not translation. Use the word **couple** or **torque** for full marks. Don't just say "force acts" — explain *why* it rotates.
- Keep the rectangular coil explanation tied to the same principle (Fleming's left-hand rule) as the question links both parts together.

Q44. medium thorough-understanding § (whole-chapter synthesis) **[3]**

In a domestic circuit, the earth wire does not carry current during normal operation, yet it is considered a critical safety component. Using your understanding of both domestic wiring and the behaviour of current-carrying conductors, explain what happens inside a faulty appliance whose metallic body becomes live, and how the earth wire prevents a dangerous electric shock.

◆ Magnetic Effects of Electric Current

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Model Answer

In a faulty appliance, the insulation inside breaks down, causing the live wire (220 V) to come in contact with the metallic body. The body becomes live and carries current at high potential.

The earth wire connects this metallic body to a metal plate buried deep in the earth. Since earth is at zero potential, it provides a **low-resistance path** for the leakage current to flow safely into the ground. This prevents the body's potential from rising above earth potential. So, if a person touches the appliance, no dangerous current passes through them and they are protected from severe electric shock.

Source: Chapter 12, Section 12.4 — Domestic Electric Circuits

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Explanation

- **3 marks → 3 clear points**: (1) How the body becomes live, (2) what the earth wire does physically (low-resistance path to earth), (3) why this prevents shock (potential stays at earth level).
- Examiners look for the phrase **"low-resistance conducting path"** — use it exactly.
- Mention that earth potential = 0 V to explain *why* current flows through the earth wire rather than through the user.
- Don't confuse the role of the **fuse** (protects the circuit from overloading) with the **earth wire** (protects the *user* from shock) — keep them distinct here.

Q45. medium thorough-understanding § (whole-chapter synthesis) **[5]**

Two safety devices used in domestic electric circuits are the electric fuse and the earth wire. Answer the following: (i) State the specific hazard each device is designed to protect against. (ii) Explain the physical principle by which each device operates when the hazard occurs. (iii) A student argues that if a circuit has a fuse, an earth wire is unnecessary. Do you agree? Justify your answer with a specific scenario in which the fuse alone would fail to prevent an electric shock.

◆ **Magnetic Effects of Electric Current**

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Model Answer

(i) Hazard each device protects against:

- **Electric fuse** protects against **overloading and short-circuiting** — situations where excess current could damage the circuit or cause fire.
- **Earth wire** protects against **electric shock** due to leakage of current to the metallic body of an appliance.

(ii) Physical principle of operation:

- **Fuse:** When current exceeds the rated value, **Joule heating** melts the fuse wire, breaking the circuit and stopping current flow.
- **Earth wire:** It provides a **low-resistance path** to the earth for any leaked current, keeping the metallic body at earth potential so the user does not receive a shock.

(iii) Disagreement with the student's argument:

No, the earth wire is **not** made unnecessary by a fuse. Consider a scenario where the live wire inside a refrigerator loosens and touches its metallic body — current leaks to the body, but this leakage current is **too small to blow the fuse**. A person touching the refrigerator would receive a severe shock. The earth wire, however, immediately provides a safe conducting path, preventing this shock. The fuse alone cannot protect against such leakage.

Source: Chapter 12, Section 12.4 — Domestic Electric Circuits

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Explanation

- Examiners expect **two distinct roles** clearly separated — fuse = overcurrent/fire protection; earth wire = shock protection from leakage.
- The key physics terms to use: **Joule heating** (fuse), **low-resistance conducting path / earth potential** (earth wire).
- For part (iii), the critical insight is that leakage current to a metallic body is usually **too small to blow a fuse** but **large enough to electrocute** — this is the scenario that earns full marks. Many students lose marks by only saying "they protect against different things" without giving a concrete scenario.

Q46. deep thorough-understanding § (whole-chapter synthesis) **[3]**

A horizontal power line carries current from west to east. A current-carrying aluminium rod is held directly below this power line, parallel to it, also carrying current from west to east. Using the right-hand thumb rule to determine the direction of the power line's magnetic field at the rod's location, and then Fleming's left-hand rule to determine the force on the rod, predict whether the rod is attracted towards or repelled away from the power line.

◆ **Magnetic Effects of Electric Current**

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Model Answer

Step 1 – Direction of magnetic field (Right-Hand Thumb Rule):
The power line carries current from west to east. Holding the conductor in the right hand with the thumb pointing east, the fingers below the wire wrap from north to south (i.e., pointing south). So the magnetic field at the rod's location (directly below) is directed **towards the south**.

Step 2 – Force on the rod (Fleming's Left-Hand Rule):

- Middle finger (current in rod): points **east**
- Forefinger (magnetic field): points **south**
- Thumb (force): points **upward**, towards the power line

Conclusion: The aluminium rod is **attracted towards** the power line.

Source: Chapter 12, Sections 12.2.2 and 12.3

Explanation

- The examiner expects you to apply **both rules in sequence** — one mark each for the field direction, force direction, and final conclusion.
- Remember: two parallel conductors carrying current **in the same direction attract** each other (Ampere's result). This question is a direct application of that principle, but you must show the step-by-step reasoning using the two named rules.
- A common error is pointing the field north instead of south — always curl the fingers *below* the wire, not above.

Q47. medium thorough-understanding § (whole-chapter synthesis) **[1]**

Which of the following statements correctly links the direction conventions used for magnetic fields and forces on current-carrying conductors?
(A) The right-hand thumb rule gives the direction of force on a conductor, while Fleming's left-hand rule gives the direction of the field around it.
(B) Both the right-hand thumb rule and Fleming's left-hand rule can independently give the direction of the magnetic field around a straight wire.
(C) The right-hand thumb rule gives the direction of the magnetic field around a current-carrying straight conductor, while Fleming's left-hand rule gives the direction of force on a current-carrying conductor placed in an external magnetic field.
(D) Fleming's left-hand rule applies only to circular loops and solenoids, not to straight conductors.

A The right-hand thumb rule gives the direction of force on a conductor, while Fleming's left-hand rule gives the direction of the field around it.
B Both the right-hand thumb rule and Fleming's left-hand rule can independently give the direction of the magnetic field around a straight wire.
C The right-hand thumb rule gives the direction of the magnetic field around a current-carrying straight conductor, while Fleming's left-hand rule gives the direction of force on a current-carrying conductor placed in an external magnetic field.
D Fleming's left-hand rule applies only to circular loops and solenoids, not to straight conductors.

◆ **Magnetic Effects of Electric Current**

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Model Answer

(C) The right-hand thumb rule gives the direction of the magnetic field around a current-carrying straight conductor, while Fleming's left-hand rule gives the direction of force on a current-carrying conductor placed in an external magnetic field.

Explanation

The textbook clearly states that the right-hand thumb rule is used to find the direction of the magnetic field around a straight current-carrying conductor, and that Fleming's left-hand rule gives the direction of force on a conductor in a magnetic field. Options A, B, and D are factually incorrect as per the source.

Q48. deep thorough-understanding § (whole-chapter synthesis) **[3]**

Oersted demonstrated that a current-carrying conductor deflects a nearby compass needle. A student tries to repeat this observation at home by placing a compass near a live wire in the wall but observes no noticeable deflection. Give TWO reasons, based on principles studied in this chapter, why the deflection is not easily observed in this domestic setting. (Hint: Consider how the magnetic field of a straight conductor depends on current and distance.)

◆ Magnetic Effects of Electric Current

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Model Answer

Two reasons why no noticeable deflection is observed:

1. **Large distance from the wire:** The magnetic field due to a straight current-carrying conductor decreases as the distance from it increases. The compass is placed far from the wire inside the wall, so the field at that point is very weak.
1. **Low current through the wire:** The magnetic field strength depends directly on the current flowing through the conductor. Household wires carry only a small current during normal use, producing a magnetic field too weak to noticeably deflect the compass needle.

Source: Chapter 12 – Magnetic Effects of Electric Current, Section 12.2

Explanation

The examiner expects two distinct, principle-based reasons worth ~1.5 marks each. The two key relationships from the chapter are: (i) B decreases with increasing distance from the wire, and (ii) B increases with current. Mentioning both clearly with a brief justification earns full marks. Avoid vague answers like "the wire is inside the wall" without linking it to the field-distance principle.

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