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CLASS X · SCIENCE (086) · PHYSICS · CBSE BOARD EXAMINATION 2027

CHAPTER 12

Magnetic Effects of Electric Current

Answer Booklet · CBSE marking-scheme answers with marks for every point

Every question of the chapter booklet | Marks shown point by point | MCQ keys with reasons

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HOW TO USE THE ANSWERS

1. Answer the question in your notebook **first**. Open this booklet only to check.
2. Each answer is written the way the CBSE marking scheme sets it out: **value points**, with the **mark for each point** in orange beside it.
3. Give yourself marks point by point. Use the same **key words** in your own answers.
4. Equations must be balanced; diagrams must be labelled; numericals need formula, substitution and unit.
5. Copy every wrong answer to the My Mistakes page of your booklet.

READ THIS FIRST

Marking Guide

Model answers to every question in the chapter booklet, set out the way a CBSE examiner marks them.

HOW MARKS ARE GIVEN IN SCIENCE ANSWERS

1. **MCQ and assertion–reason (1 mark):** only the correct option scores. The reason given here is for your understanding.
2. **2 and 3 marks:** one mark (or ½) for each correct **value point**. The examiner looks for the key word – a long answer without it scores less than a short answer with it.
3. **Equations:** a correct balanced equation earns its full mark; an unbalanced one, or one with wrong formulae, usually earns ½ or nothing.
4. **Numericals:** formula, substitution and the final answer **with unit** are marked separately.
5. **Diagrams:** marks for a correct drawing and for the labels asked for. An unlabelled diagram earns little.
6. **Case study (4 marks):** 1 + 1 + 2. **Long answer (5 marks):** the split is shown beside each point.

PART A · ANSWERS

A NCERT Practice – Answers

Marking-scheme answers for every question in Part A of the chapter booklet.

Magnetic field and field lines

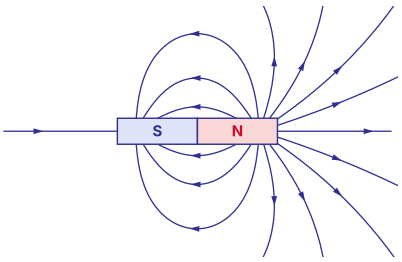
A1. Why is a compass needle deflected when it is brought near a bar magnet? What does this tell us about the space around the magnet? **[2]**

The compass needle is itself a small magnet; the bar magnet exerts a magnetic force on its poles. — 1

So there is a **magnetic field** around the bar magnet – a region in which its force can be detected. — 1

A2. Draw the magnetic field lines around a bar magnet and list three properties of magnetic field lines. **[3]**

Diagram: closed curves from N to S outside the magnet, with arrows; lines crowded near the poles. — 1½



They emerge from the N pole and merge at the S pole outside; inside the magnet they go from S to N (closed curves). — ½

The closer the lines, the stronger the field. — ½

No two field lines cross each other. — ½

Other correct properties (e.g. the tangent gives the direction of the field) are also accepted. No arrows on the diagram: lose ½.

A3. Why do two magnetic field lines never intersect? [1]

If two lines crossed, the field at that point would have two directions; a compass placed there would point two ways at once, which is impossible. 1

A4. How can you find the direction of the magnetic field at a point near a magnet? How is the relative strength of the field shown by field lines? [2]

Place a small compass at the point; the direction in which its **north pole** points is the direction of the field. 1

The degree of closeness of the lines shows strength: crowded lines → strong field (near the poles), widely spaced lines → weak field. 1

Field due to a current

A5. A long straight wire carrying current passes vertically through a horizontal sheet of cardboard. Iron filings are sprinkled on the card and it is tapped gently. **(i)** Describe the pattern formed. **(ii)** What happens to the direction of the field if the current is reversed? **(iii)** What happens to the strength of the field if the current is increased? [3]

Pattern: the filings arrange in **concentric circles** with the wire at the centre. 1

Reversing the current reverses the direction of the field lines (a compass on the card turns round); the pattern stays circular. 1

Increasing the current makes the field stronger – the deflection of a compass at the same point increases. 1

A6. State the right-hand thumb rule. Use it to find the direction of the magnetic field around a vertical wire in which current flows downwards, as seen from above. [2]

Hold the conductor in the right hand with the thumb pointing in the direction of the current; the fingers curl in the direction of the magnetic field lines. 1

Current downwards → the field lines are **clockwise** when seen from above. 1

A7. Current in a horizontal wire flows from south to north. Find the direction of the magnetic field at a point directly **below** the wire and at a point directly **above** it. [2]

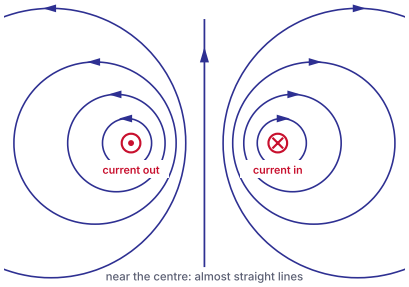
By the right-hand thumb rule (thumb pointing north), the fingers curl from east over the top to west.

Directly below the wire: field points towards the **west**. 1

Directly above the wire: field points towards the **east**. 1

A8. Draw the pattern of field lines due to a current-carrying circular loop. Why do the lines near the centre of the loop appear almost straight? **[3]**

Diagram: concentric circles around each point where the loop cuts the plane, becoming larger towards the centre; arrows in the same direction through the centre. **1**



Every small part of the loop produces circular field lines; near the wire they are small circles. **1**

At the centre the arcs are parts of very large circles, so they look like straight lines; all parts of the loop give a field in the same direction there. **1**

A9. List three factors on which the magnetic field at the centre of a current-carrying circular coil depends. **[3]**

Current through the coil – larger current, stronger field. **1**

Number of turns – field is directly proportional to the number of turns. **1**

Radius of the coil – larger radius, weaker field. **1**

A10. A circular loop of wire lies flat on a table. Current flows through it **anticlockwise** as seen from above. Find the direction of the magnetic field (i) inside the loop (ii) outside the loop. **[2]**

Applying the right-hand thumb rule to each part of the loop:

(i) Inside the loop the field points **vertically upward** (out of the table). **1**

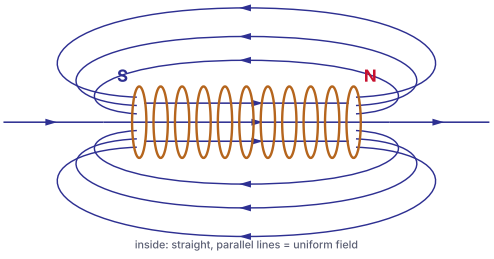
(ii) Outside the loop the field points **vertically downward** (into the table). **1**

Solenoid and electromagnet

A11. What is a solenoid? Draw the field lines in and around a current-carrying solenoid. What does the pattern inside tell you? **[3]**

A coil of many circular turns of insulated copper wire wound closely in the shape of a cylinder. **1**

Diagram: pattern like a bar magnet outside; one end N, the other S; parallel straight lines inside, with arrows S → N inside. **1**



Parallel straight lines inside show that the field is the **same at all points (uniform)** inside the solenoid. **1**

A12. How is an electromagnet made? Give two ways in which it differs from a permanent magnet. **[3]**

A soft-iron core is placed inside a solenoid; when current flows, the core becomes a strong magnet. 1

Its magnetism is temporary (only while current flows); a permanent magnet keeps its magnetism. 1

Its strength can be changed and its poles reversed by changing the current; a permanent magnet's strength and poles are fixed. 1

Force on a current-carrying conductor

A13. Describe an activity to show that a current-carrying conductor placed in a magnetic field experiences a force. How can the direction of the force be reversed? **[3]**

Hang a small aluminium rod horizontally between the poles of a horseshoe magnet (field vertical); connect it in series with a cell, key and rheostat. 1

Close the key: the rod is displaced (pushed out of or into the magnet) – a force acts on it. 1

Reverse the current (or interchange the poles of the magnet): the rod is displaced in the opposite direction. 1

A14. State Fleming's left-hand rule. **[2]**

Stretch the thumb, first finger and second finger of the left hand so that they are mutually perpendicular. 1

If the first finger points along the magnetic field and the second finger along the current, the thumb gives the direction of force (motion) on the conductor. 1

A15. An alpha particle (positively charged) moves vertically downwards. It is deflected towards the east by a magnetic field. What is the direction of the field? **[2]**

A moving positive charge is a current in the same direction: current is vertically downwards; force is towards the east. 1

By Fleming's left-hand rule (second finger down, thumb east), the first finger points towards the **north**: the field is towards the north. 1

Domestic circuits

A16. Name the three wires used in a domestic circuit and give the colour of the insulation on each. What is the potential difference between the live and the neutral wire in India? **[2]**

Live – red; neutral – black; earth – green. 1½

Potential difference between live and neutral = 220 V. ½

A17. What is the function of an earth wire? Why is it necessary to earth metallic appliances? **[2]**

The earth wire provides a low-resistance conducting path from the metal body of an appliance to the earth. 1

If the live wire touches the body, the current leaks to the earth; the body stays at zero potential, so the user does not get a severe electric shock. 1

A18. An electric oven of 2.2 kW is used in a domestic circuit (220 V) that has a current rating of 5 A. What result do you expect? Show your calculation. [2]

$$I = \frac{P}{V} = \frac{2200\ \text{W}}{220\ \text{V}} = 10\ \text{A}$$ 1

10 A is more than the 5 A rating: the circuit is overloaded, the fuse melts (or the MCB trips) and the supply is cut off. 1

A19. What precautions should be taken to avoid overloading of domestic circuits? Give two. [2]

Do not connect too many appliances to a single socket. 1

Use high-power appliances only on the 15 A circuit, and use a fuse / MCB of the correct rating. 1

PART B · ANSWERS

B Exemplar Practice – Answers

Marking-scheme answers for every question in Part B of the chapter booklet.

Multiple choice

Q	Answer	Working / reason
B1	**(c)** The field lines are concentric circles centred on the wire	The field lines around a straight wire are concentric circles in a plane perpendicular to the wire.
B2	**(d)** is the same at all points	Inside a long solenoid the lines are parallel and equally spaced: the field is uniform.
B3	**(b)** They cross each other where the field is strongest	Field lines never cross; crowding (not crossing) shows a strong field.
B4	**(c)** increasing the number of turns	Field ∝ number of turns and current, and decreases with radius.
B5	**(c)** 90°	Force is largest when the current is perpendicular to the field and zero when parallel (0° or 180°).
B6	**(b)** south	Current is opposite to electron flow: east to west. First finger down, second finger west → thumb points south.
B7	**(b)** 1/100 s	Frequency 50 Hz: 50 cycles per second, two reversals per cycle → 100 reversals per second.
B8	**(c)** high resistance and low melting point	It must heat up and melt quickly when excess current flows; it is joined in series with the live wire.
B9	**(c)** Using an earth wire	The earth wire is a safety device; the other three increase the current drawn.
B10	**(c)** reversing the direction of the current	Reversing the current reverses the direction of the field, so the poles exchange places.

Short answer

B11. Two compasses are placed at points P and Q near a straight wire carrying current. P is 2 cm from the wire and Q is 6 cm from it. At which point will the deflection be larger? What happens to both deflections if the current is doubled? [2]

At **P**: the field is stronger nearer the wire, so the deflection is larger. 1

If the current is doubled the field at each point increases, so both deflections increase. 1

B12. Look at an end of a current-carrying solenoid. The current there appears to flow clockwise. Is that end a north pole or a south pole? Give two ways to make the solenoid a stronger magnet. [3]

Clockwise current as seen from an end → that end is the **south pole**. 1

Increase the number of turns of the coil. 1

Increase the current, or put a soft-iron core inside it. 1

B13. A wire carrying current from east to west lies in a magnetic field pointing vertically upwards. In which direction will it move? What will happen if both the current and the field are reversed? [2]

First finger up, second finger west → thumb points towards the **north**; the wire moves north. 1

Reversing both the current and the field leaves the force in the **same direction** (north). 1

B14. Distinguish between a short circuit and overloading. Name the device that protects a circuit from both. [3]

Short circuit: the live and neutral wires come into direct contact, so the resistance becomes nearly zero and a very large current flows. 1

Overloading: more current is drawn than the circuit is designed for – too many appliances, or a voltage surge. 1

A fuse (or MCB) joined in series with the live wire protects against both. 1

B15. Why are all the appliances in a house connected in parallel and not in series? Give two reasons. [2]

In parallel each appliance gets the full supply voltage (220 V). 1

Each appliance can be switched on or off independently; if one fails the others keep working. 1

C

PART C · ANSWERS

Board Pattern Practice – Answers

Marking-scheme answers for every question in Part C of the chapter booklet.

Field lines and their properties

Q	Answer	Working / reason
C1	**(b)** N pole and end at the S pole	Outside the magnet the lines go from N to S; inside, from S to N.
C2	**(a)**	Both true; because the field has one direction at a point, two lines cannot pass through it. R explains A.
C3	**(a)**	Crowded lines indicate a strong field, so R explains A.

C4. What is meant by a magnetic field line? Give two reasons why we say field lines are closed curves. [3]

A field line is the path along which a free north pole would tend to move in a magnetic field. 1

Outside the magnet the lines run from the N pole to the S pole. 1

Inside the magnet they run from S back to N, so each line is a closed loop. 1

Straight conductor and right-hand thumb rule

Q	Answer	Working / reason
C5	**(b)** anticlockwise circles	Thumb up, fingers curl anticlockwise when seen from above.

C6. Three points X, Y and Z are 1 cm, 3 cm and 5 cm from a long straight wire AB carrying a steady current. At which point is the magnetic field strongest and at which is it weakest? Justify your answer. [2]

Strongest at **X**, weakest at **Z**. 1

The field due to a straight wire decreases as the distance from the wire increases. 1

C7. Why does the pattern of the magnetic field around a current-carrying wire depend on the shape of the wire? [2]

Each small part of the wire produces its own circular field lines around it. 1

The field at any point is the sum of the fields of all the parts, so the shape decides how they add up (circles for a straight wire, almost straight lines at the centre of a loop, uniform field in a solenoid). 1

C8. Two long straight parallel wires P and Q carry equal currents in **opposite** directions. What is the direction of the field due to each at the midpoint O between them? Is the total field at O larger or smaller than that due to one wire? What would happen if the currents were in the same direction? [3]

By the right-hand thumb rule, the fields of P and Q at O are in the **same direction** (perpendicular to the plane of the wires). 1

So they add: the total field at O is **twice** that of one wire (larger). 1

With currents in the same direction, the two fields at O are opposite and equal, so the net field at O is **zero**. 1

C9. A compass is placed near a straight wire carrying current. List three observations you make when (i) the current is reversed (ii) the current is increased (iii) the compass is moved away from the wire. [3]

(i) The needle deflects in the opposite direction. 1

(ii) The deflection increases. 1

(iii) The deflection decreases. 1

Circular loop, solenoid and electromagnet

Q	Answer	Working / reason
C10	**(b)** nearly straight and parallel	At the centre the arcs are parts of very large circles and all point the same way.

C11	**(d)** A copper core instead of soft iron	Copper is not magnetic; it does not strengthen the field.
C12	**(a)**	The strong uniform field inside magnetises the soft iron; R explains A.

C13. Draw the field lines of a current-carrying solenoid and mark its N and S ends. State two ways in which the field of a solenoid is similar to, and one way it differs from, that of a bar magnet. **[3]**

Correct diagram with arrows, N and S marked (anticlockwise end N). 1

Similar: the pattern outside is the same; one end acts as N and the other as S. 1

Different: a solenoid's field exists only while current flows and its poles reverse when the current is reversed (bar magnet is permanent). 1

C14. Why is the field produced by a coil of 50 turns 50 times that produced by a single turn, for the same current? **[2]**

The current in every turn flows in the same direction. 1

So the fields of all the turns add up at the centre: total field = 50 × field of one turn. 1

Force on a conductor and Fleming's left-hand rule

Q	Answer	Working / reason
C15	**(c)** current	First finger = field, second finger = current, thumb = force.
C16	**(b)** zero	Current parallel to the field → no force.
C17	**(a)**	Reversing the field reverses the force; R explains A.

C18. A beam of electrons enters a magnetic field directed **into the page**, moving from left to right. In which direction will the beam be deflected? Explain. **[2]**

The electrons move left to right, so the current is from **right to left**. 1

Fleming's left-hand rule (first finger into the page, second finger to the left) → thumb points **downwards** (towards the bottom of the page); the beam bends down. 1

C19. Rod AB lies east–west between the poles of a horseshoe magnet, with the N pole above it and the S pole below it. Current flows from A (west) to B (east). **(i)** What is the direction of the magnetic field on the rod? **(ii)** In which direction does the rod move? **(iii)** Give one way to make the rod move farther. **[3]**

(i) Field from the N pole (above) to the S pole (below): **vertically downwards**. 1

(ii) First finger down, second finger east → thumb points **north**: the rod moves towards the north. 1

(iii) Increase the current, or use a stronger magnet (or a longer rod in the field). 1

AC, DC and domestic circuits

Q	Answer	Working / reason
C20	**(a)** 50 Hz	220 V, 50 Hz in India.
C21	**(c)** in the live wire	Switches and fuses are always placed in the live wire.

C22 **(c)** A is true; R is false – the earth wire is a low-resistance path that carries leaking current to the earth.

C23. Give two differences between direct current and alternating current, and one advantage of AC over DC. **[3]**

DC flows in one direction only; AC reverses its direction periodically. 1

DC is obtained from cells/batteries; AC from power stations (mains) – in India at 50 Hz. 1

Advantage: AC can be transmitted over long distances without much loss of energy. 1

C24. A house has a 15 A line and a 5 A line. Which line should be used for (i) a 2 kW geyser (ii) four 60 W bulbs? Justify with a calculation (supply 220 V). **[2]**

(i) $I = \dfrac{2000}{220} \approx 9.1$ A > 5 A, so the geyser goes on the **15 A** line. 1

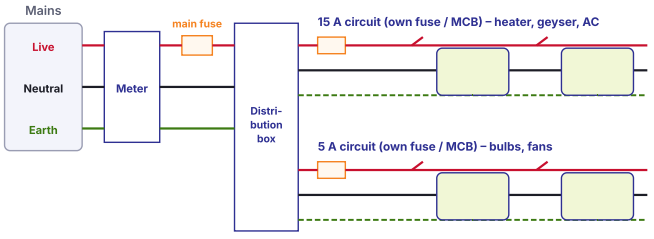
(ii) $I = \dfrac{4 \times 60}{220} \approx 1.1$ A, so the bulbs can be on the **5 A** line. 1

C25. Draw a labelled schematic diagram of a common domestic circuit showing the main fuse, meter, distribution box, earth wire and two separate circuits. **[3]**

Mains with live, neutral and earth; main fuse in the live wire; electricity meter; distribution box. 1

Two separate circuits (15 A and 5 A), each with its own fuse in the live wire; appliances joined in parallel with a switch in the live wire. 1

Earth wire joined to the metal bodies of appliances and to a plate buried in the ground; labels and colours. 1



Live: red / brown (220 V) · Neutral: black / blue (0 V) · Earth: green
Fuse and switches are always on the LIVE wire; appliances are joined in PARALLEL
The earth wire joins the metal body of each appliance

Long answer

C26. (a) Draw the pattern of field lines due to a current-carrying circular loop. (b) Write two factors on which the field at its centre depends. (c) A coil carries current anticlockwise as seen from the front. Which pole does the front face act as? (d) Why is the field produced by a solenoid used to make an electromagnet? **[5]**

(a) Correct diagram: concentric loops around each crossing point, larger towards the centre, nearly straight lines at the centre, arrows consistent. 2

(b) Current through the coil; number of turns (or radius – larger radius, weaker field). ½ + ½ 1

(c) Anticlockwise current → the front face acts as a **north pole**. 1

(d) The field inside a solenoid is strong and uniform, so it magnetises a soft-iron core placed inside it. 1

C27. (a) State Fleming's left-hand rule. (b) Describe an activity to show that a force acts on a current-carrying conductor in a magnetic field. (c) When is this force (i) largest (ii) zero? (d) Name one device that uses this force. [5]

(a) Thumb, first finger, second finger of the left hand mutually perpendicular; first finger – field, second finger – current, thumb – force. 1

(b) Aluminium rod hung between poles of a horseshoe magnet, joined to cell, key and rheostat; on closing the key the rod is displaced; reversing current reverses the displacement. 2

(c) (i) When the current is perpendicular to the field; (ii) when the current is parallel to the field. 1

(d) Electric motor / loudspeaker / galvanometer (any one). 1

PART D · ANSWERS

D Case-Based Questions – Answers

Marking-scheme answers for every question in Part D of the chapter booklet.

D1. Case Study · The Science-Fair Electromagnet [4]

(i) What name is given to the coil Aarav made? [1]

A **solenoid** (with the nail inside it, an electromagnet). 1

(ii) Why did the pins fall off when the switch was opened? [1]

The soft-iron nail is magnetised only while current flows; when the current stops it loses its magnetism. 1

(iii) Give two ways in which Aarav could lift even more pins. [2]

Increase the number of turns. 1

Increase the current (use a stronger battery). 1

OR

(iii) How can Aarav find out which end of the coil is the N pole? What change would interchange the poles? [2]

Bring a compass near an end: the end that attracts the S pole of the compass (repels its N pole) is the N pole – or: the end where current looks anticlockwise is N. 1

Reverse the direction of the current (interchange the battery connections). 1

D2. Case Study · The Jumping Rod [4]

(i) State the rule used to find the direction of the force on the rod. [1]

Fleming's left-hand rule. 1

(ii) In which direction does the rod roll? [1]

First finger up, second finger east → thumb points **south**: the rod rolls towards the south. 1

(iii) What would happen if (a) the current is reversed (b) the magnet is turned so that the field is along the rod? [2]

(a) The rod rolls the opposite way (north). 1

(b) No force acts, because the current is parallel to the field; the rod does not move. 1

OR

(iii) Why does the rod move faster when a battery of higher voltage is used? Name one device that works on this principle. **[2]**

Higher voltage → larger current through the rod → larger force on it. 1

Electric motor (or loudspeaker). 1

D3. Case Study · Wiring a New House [4]

(i) Which wire is joined to the metal body of the heater, and what is its colour? **[1]**

The **earth** wire – green. 1

(ii) Why is each line given its own MCB? **[1]**

So that a fault or overload on one line cuts off only that line; the MCB switches off when the current is too large. 1

(iii) Find the current drawn by the heater and say whether the owner's plan is safe. **[2]**

$I = \dfrac{P}{V} = \dfrac{2200}{220} = 10\ \text{A}$ 1

10 A is more than 5 A – the line will be overloaded and the MCB will trip; not safe. Use the 15 A line. 1

OR

(iii) What is a short circuit? How does the MCB protect the house when it happens? **[2]**

Short circuit: the live and neutral wires touch directly, so resistance is nearly zero and a very large current flows. 1

The large current makes the MCB switch off (or the fuse melt), cutting off the supply and preventing fire. 1