Application and Case Studies

Grade: 10 CBSE

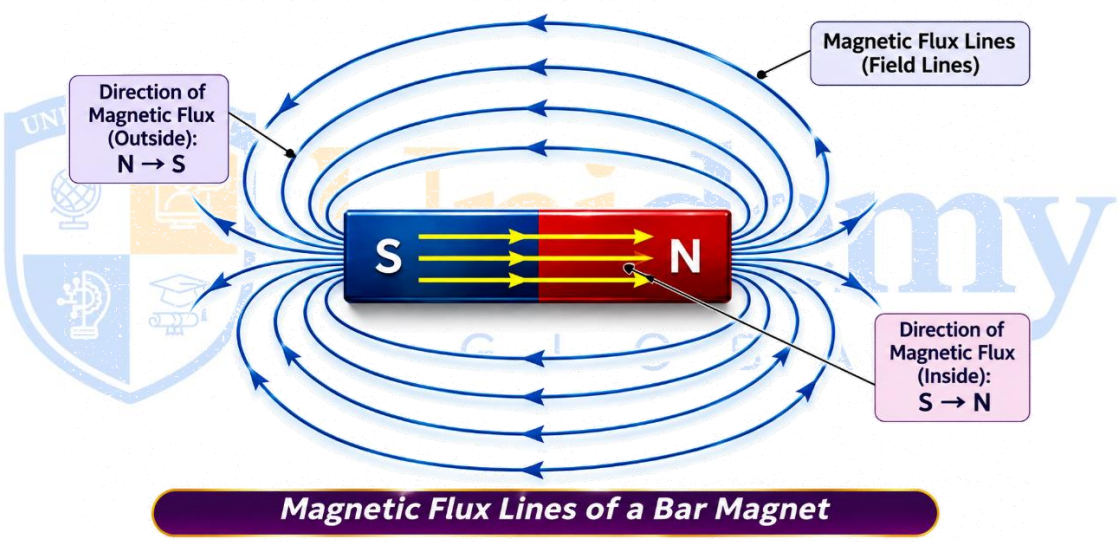
Subject: Physics

Chapter: Magnetic Effects of Electric Current

Part 1: Image & Circuit-Diagram Application Cases (1 to 5)

Suggested Marks: 4–5 marks per question

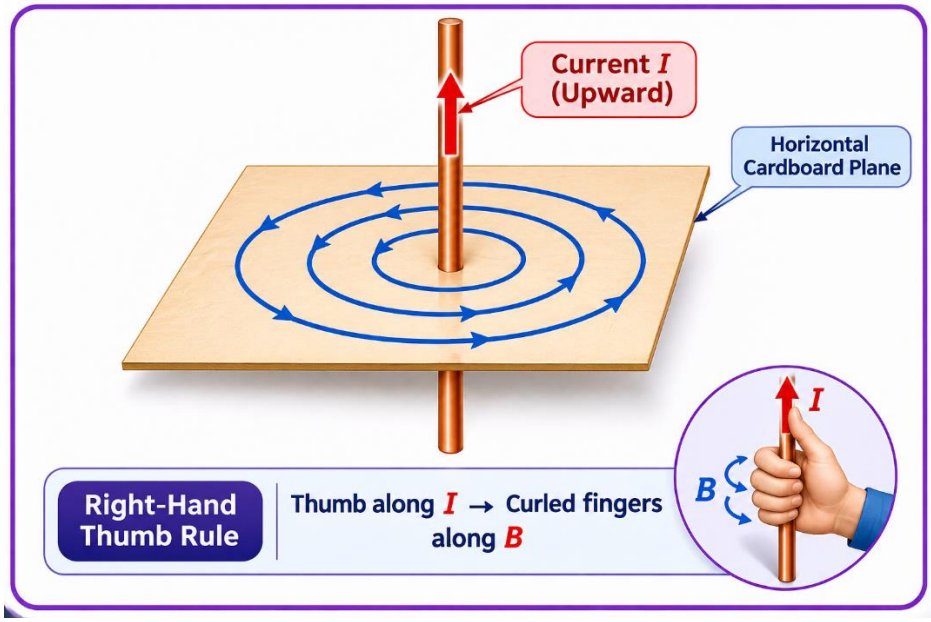
1. Magnetic Field Lines Analysis: Refer to Figure (Bar Magnet Field Pattern). A student claims that the magnetic field is strongest inside the magnet near its center.



(a) Evaluate this claim based on field line density.

(b) Explain how the magnetic field vector direction differs between points outside and points inside the bar magnet.

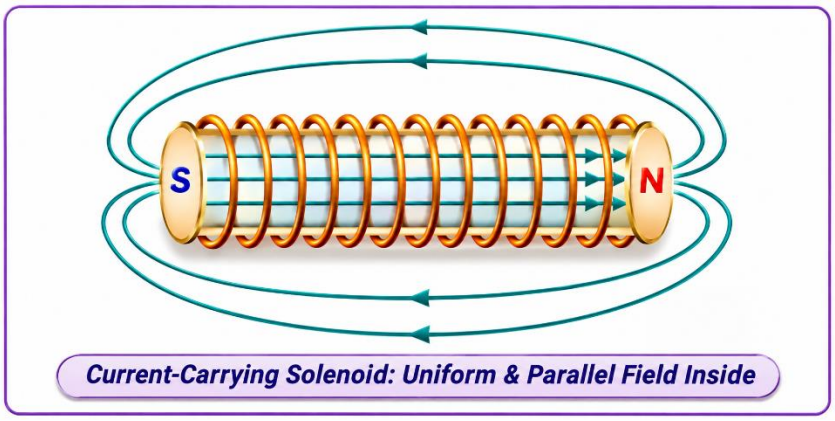
2. Straight Conductor Case: Refer to Figure. A vertical wire passes through a cardboard plane sprinkled with iron filings.



(a) Explain why iron filings arrange themselves in concentric circles.

(b) If the current through the wire is reversed from upward to downward, describe what happens to the orientation of the compass needle on the cardboard.

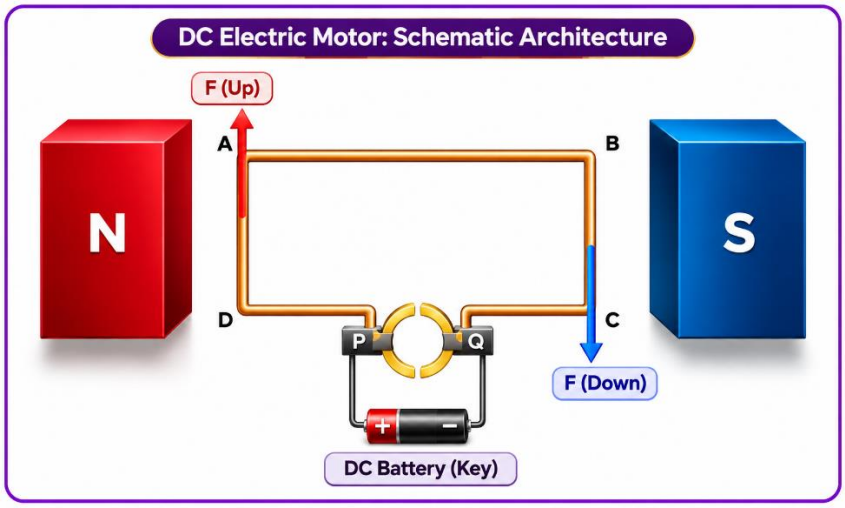
3. Solenoid Field Mapping: Refer to Figure. A solenoid of length 50 cm with 500 turns carries 2 A of current.



(a) Compare the nature of field lines inside the core with those outside.

(b) If an aluminum rod is inserted instead of soft iron, will it form a powerful electromagnet? Justify.

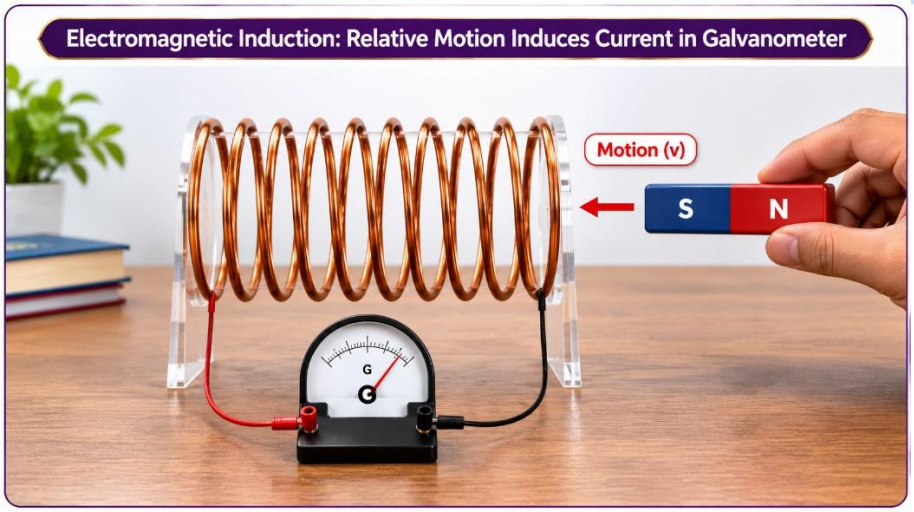
4. Motor Commutator Diagnostics: Refer to Figure (DC Motor Schematic).



(a) State what happens to the rotation of the motor coil if the split rings P and Q are replaced by two complete, solid continuous slip rings.

(b) Identify the arm of the coil experiencing an upward force when current flows into brush X.

5. Faraday Induction Case: Refer to Figure. A bar magnet's North pole is thrust quickly into the coil.



(a) What deflection is observed in galvanometer G?

(b) What is observed if the magnet is held completely stationary inside the coil?

(c) What happens if the North pole is rapidly pulled out?

Part 2: Written Experimental & Scenario Cases (6 to 10)

6. Laboratory Investigation on Electromagnetic Force.
Students set up an experiment where an aluminum rod AB is suspended horizontally between the poles of a strong horseshoe magnet. The magnet is oriented such that its magnetic field is directed vertically upwards. A steady current is passed through rod AB from end B to end A.
(a) In which direction will rod AB get displaced? State the rule used.
(b) What will happen to the displacement of the rod if: (i) current is increased? (ii) a weaker horseshoe magnet is used?
(c) If the direction of current is reversed simultaneously with the reversal of the magnetic field poles, what will be the direction of displacement?

7. Commercial Electric Motor Design & Industrial Applications.
An engineering company designs electric motors for electric vehicles (EVs). To achieve maximum torque and mechanical efficiency, their design team evaluates several parameters: coil wire diameter, number of turns, permanent magnets vs high-permeability electromagnets, and soft iron core lamination.
(a) Explain why commercial high-power motors use electromagnets instead of permanent magnets.
(b) Why is the armature coil wound over a soft iron core?
(c) How does increasing the number of turns in the coil enhance the motor's power output?

8. Domestic Electrical Safety Audit.
An electrical inspector audits a residential apartment and discovers: (1) The main distribution board has a 30 A copper wire installed in place of the rated 15 A fuse; (2) The geyser's metallic body is connected to the neutral line instead of the earth wire; (3) Multiple high-power kitchen appliances are connected to a single multi-socket adapter.
(a) Identify the severe electrical hazard associated with using a 30 A fuse wire in a 15 A circuit.
(b) Explain why connecting an appliance's metallic casing to the neutral line is dangerous.
(c) What phenomenon will occur when all kitchen appliances in the multi-socket adapter are switched on together?

9. Oersted Deflection and Field Superposition.
A straight conducting wire AB is held horizontally in the geomagnetic North-South direction directly above a magnetic compass needle. When current flows through the wire from South to North, the north pole of the compass needle deflects towards the West.
(a) Name and state the rule (SNOW rule) that predicts this deflection direction.
(b) If the wire is placed below the compass needle with current still flowing from South to North, predict the direction of deflection.
(c) At a certain point, the magnetic field produced by the wire is exactly equal and opposite to Earth's horizontal magnetic field. What will be the net deflection of the compass needle placed at that point?

10. Induction in Smart Card Readers and Wireless Power.
Modern contactless payment cards (RFID/NFC) and wireless smartphone chargers operate on the principle of electromagnetic induction. The payment terminal / charging pad contains a primary transmitter coil carrying high-frequency alternating current. When the smartphone or card is placed in close proximity, power is transferred without physical metallic contact.
(a) Identify the physical phenomenon responsible for power transfer between the pad and the phone.
(b) Explain why direct current (DC) in the transmitter pad cannot charge the phone wirelessly.
(c) How does the distance between the phone and the charging pad affect the charging rate?

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