

Moving Charges and Magnetism — CBSE Pattern Test 2

Class 12 Physics · 90 minutes · 40 marks · Sections A–D with answer key · Narayan Gurukul Academy

Test 2 — CBSE Pattern (90 minutes, 40 marks)

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General Instructions: (1) This paper has four sections — Section A (1×10), Section B (2×4), Section C (3×4) and Section D (5×2) — total 40 marks. Time allowed: 90 minutes.

(2) All questions are compulsory. No overall choice is given; internal choice, where allowed, is clearly marked.

(3) For MCQ questions choose the single correct option; for VSA answers write a single line.

(4) Take $g = 10 \text{ m/s}^2$. All symbols carry their usual meaning. Use of a calculator is not permitted.

Section A — MCQ & VSA ($10 \times 1 = 10$ marks)

- A charged particle moving parallel to B experiences a magnetic force of
 - zero
 - qvB
 - $qvB/2$
 - maximum
- The direction of the magnetic field due to a current element is given by the
 - right-hand rule
 - left-hand rule
 - Faraday rule
 - Fleming rule only
- Ampere's circuital law is analogous to
 - Gauss's law in electrostatics
 - Faraday's law
 - Lenz's law
 - Coulomb's law
- The force per unit length between two long parallel wires carrying currents I_1 and I_2 separated by d is
 - $\mu_0 I_1 I_2 / 2\pi d$
 - $\mu_0 I_1 I_2 / 4\pi d$
 - $\mu_0 I_1 I_2 / d$
 - $2\pi \mu_0 I_1 I_2 / d$
- A galvanometer can be converted into an ammeter by connecting
 - a low resistance (shunt) in parallel with it
 - a high resistance in series with it
 - a capacitor in series
 - an inductor in parallel
- A galvanometer can be converted into a voltmeter by connecting
 - a high resistance in series with it
 - a low resistance in parallel with it
 - a capacitor in parallel
 - nothing at all
- The cyclotron frequency is independent of the
 - speed (energy) of the particle

- (B) charge of the particle
 - (C) mass of the particle
 - (D) magnetic field
8. A cyclotron is used to
- (A) accelerate charged particles to high energies
 - (B) measure current
 - (C) store charge
 - (D) rectify alternating current
9. Define magnetic field.
10. On what principle does a moving coil galvanometer work?

Section B — Short Answer I ($4 \times 2 = 8$ marks)

11. Two 8 A currents flow in opposite directions in two parallel wires 0.2 m apart. Find the force per unit length.
12. A long straight wire carries 5 A. Find the field at 0.1 m from it.
13. Calculate the cyclotron frequency of a proton in a 2 T magnetic field.
14. State the definition of an ampere.

Section C — Short Answer II ($4 \times 3 = 12$ marks)

15. Derive the expression for the magnetic field on the axis of a circular current loop using the Biot-Savart law.
16. State Ampere's circuital law and use it to find the magnetic field inside a long solenoid.
17. Describe how a galvanometer is converted into (i) an ammeter and (ii) a voltmeter.
18. A charged particle enters a magnetic field at right angles. Derive its time period and show it is independent of speed.

Section D — Long Answers ($2 \times 5 = 10$ marks)

19. State the Biot-Savart law. Derive the expression for the magnetic field due to a long straight current-carrying conductor, and hence obtain the force between two long parallel current-carrying wires.
20. Describe the working of a cyclotron, derive its frequency, and state its limitations. Explain why it cannot accelerate electrons.

Answer Key (Marking Scheme)

- Q1 — (A) zero. Q2 — (A) right-hand rule. Q3 — (A) Gauss's law in electrostatics. Q4 — (A) $\mu_0 I_1 I_2 / 2\pi d$.
- Q5 — (A) a low resistance (shunt) in parallel. Q6 — (A) a high resistance in series. Q7 — (A) speed (energy) of the particle. Q8 — (A) accelerate charged particles.
- Q9 — The region where a moving charge or a current-carrying conductor experiences a force.
- Q10 — A current-carrying coil in a magnetic field experiences a torque proportional to the current.
- Q11 — $F/L = \mu_0 I_1 I_2 / 2\pi d = 1.6 \times 10^{-4}$ N/m, repulsive.
- Q12 — $B = \mu_0 I / 2\pi r = 1 \times 10^{-5}$ T.
- Q13 — $\nu = qB / 2\pi m \approx 3.0 \times 10^7$ Hz.
- Q14 — One ampere is the current which, flowing in two long parallel wires 1 m apart in vacuum, produces a force of 2×10^{-7} N per metre.

Q15 — Resolve dB into axial and perpendicular components; perpendicular parts cancel, axial parts add, giving $B = \mu_0 N I R^2 / 2(R^2 + x^2)^{3/2}$.

Q16 — Take a rectangular Amperian loop; contributions outside and along the sides vanish; $B L = \mu_0 n L I$, so $B = \mu_0 n I$.

Q17 — Ammeter: low shunt $S = I_g G / (I - I_g)$ in parallel. Voltmeter: high resistance $R = V / I_g - G$ in series.

Q18 — Magnetic force provides the centripetal force, $r = mv / qB$, so $T = 2\pi m / qB$ is independent of v .

Q19 — $dB = (\mu_0 / 4\pi)(I dl \times \hat{r}) / r^2$; integrate for a straight wire to get $B = \mu_0 I / 2\pi r$; two wires then give $F/L = \mu_0 I_1 I_2 / 2\pi d$.

Q20 — Dees and an alternating voltage of frequency $\nu = qB / 2\pi m$; as v grows r grows until the particles leave; at relativistic speeds the frequency is no longer constant; electrons have very small m , so they reach such speeds almost immediately.