

## Moving Charges and Magnetism — CBSE Pattern Test 1

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

### Test 1 — CBSE Pattern (90 minutes, 40 marks)

Class 12 Physics · Moving Charges and Magnetism · Narayan Gurukul Academy (ClassApna)

General Instructions: (1) This paper has four sections — Section A ( $1 \times 10$ ), Section B ( $2 \times 4$ ), Section C ( $3 \times 4$ ) and Section D ( $5 \times 2$ ) — 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)

1. The magnetic force on a charge  $q$  moving with velocity  $v$  in a magnetic field  $B$  is

- (A)  $q(v \times B)$
- (B)  $q(v \cdot B)$
- (C)  $q(E + v \times B)$
- (D)  $q(v/B)$

2. The work done by the magnetic force on a moving charged particle is

- (A) zero
- (B) positive
- (C) negative
- (D) always maximum

3. The magnetic field due to a long straight conductor at distance  $r$  is

- (A)  $\mu_0 I / 2\pi r$
- (B)  $\mu_0 I / 4\pi r$
- (C)  $\mu_0 I / 2r$
- (D)  $2\pi\mu_0 I / r$

4. The magnetic field at the centre of a circular coil of  $N$  turns and radius  $R$  is

- (A)  $\mu_0 NI / 2R$
- (B)  $\mu_0 NI / R$
- (C)  $\mu_0 I / 2\pi R$
- (D)  $2\mu_0 NI / R$

5. Ampere's circuital law states that

- (A)  $B \cdot dl = \mu_0 I$
- (B)  $B \cdot dl = 0$
- (C)  $E \cdot dl = -d\Phi/dt$
- (D)  $B \cdot dA = \mu_0 I$

6. Two parallel currents flowing in the same direction

- (A) attract each other
- (B) repel each other
- (C) exert no force
- (D) rotate each other

7. The current sensitivity of a moving coil galvanometer is

- (A)  $NBA/k$

- (B)  $k/NAB$   
 (C)  $NAB$   
 (D)  $k/NAB \cdot l$
8. The cyclotron frequency of a charged particle in a magnetic field  $B$  is  
 (A)  $qB/2\pi m$   
 (B)  $2\pi m/qB$   
 (C)  $qB/m$   
 (D)  $mB/q$
9. State the Biot-Savart law.  
 10. State Ampere's circuital law.

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

11. A proton moves at  $3 \times 10^6$  m/s perpendicular to a magnetic field of 0.5 T. Find the force on it.  
 12. A long straight wire carries a current of 10 A. Find the magnetic field at 0.2 m from it.  
 13. Two wires 0.1 m apart carry 5 A and 10 A in the same direction. Find the force per unit length.  
 14. Calculate the cyclotron frequency of a proton in a magnetic field of 1 T.

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

15. Show that a charged particle moving perpendicular to a uniform magnetic field undergoes circular motion, and derive  $r = mv/qB$ .  
 16. State Ampere's circuital law and use it to find the magnetic field due to a long straight current-carrying conductor.  
 17. Derive the expression for the force per unit length between two long parallel current-carrying conductors.  
 18. Explain the working of a moving coil galvanometer and derive the expression for its current sensitivity.

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

19. Define the Lorentz force. Derive the expression for the radius of the circular path of a charged particle moving perpendicular to a uniform magnetic field, and show that the time period is independent of the speed.  
 20. Explain the construction and working of a cyclotron, derive its frequency, and state its limitations. Then explain how a galvanometer can be converted into an ammeter.

### Answer Key (Marking Scheme)

- Q1 — (A)  $q(\mathbf{v} \times \mathbf{B})$ . Q2 — (A) zero. Q3 — (A)  $\mu_0 l / 2\pi r$ . Q4 — (A)  $\mu_0 NI / 2R$ .  
 Q5 — (A)  $\mathbf{B} \cdot d\mathbf{l} = \mu_0 I$ . Q6 — (A) attract each other. Q7 — (A)  $NBA/k$ . Q8 — (A)  $qB/2\pi m$ .  
 Q9 —  $d\mathbf{B} = (\mu_0/4\pi)(I d\mathbf{l} \times \hat{r})/r^2$ , the field due to a current element.  
 Q10 —  $\mathbf{B} \cdot d\mathbf{l} = \mu_0 I$ , the line integral of  $\mathbf{B}$  around a closed loop equals  $\mu_0$  times the current enclosed.  
 Q11 —  $F = qvB = 1.6 \times 10^{-19} \times 3 \times 10^6 \times 0.5 = 2.4 \times 10^{-13}$  N.  
 Q12 —  $B = \mu_0 I / 2\pi r = 1 \times 10^{-5}$  T.  
 Q13 —  $F/L = \mu_0 I_1 I_2 / 2\pi d = 1 \times 10^{-4}$  N/m, attractive.  
 Q14 —  $\nu = qB/2\pi m \approx 1.5 \times 10^7$  Hz.  
 Q15 — The magnetic force  $qvB$  provides the centripetal force  $mv^2/r$ , giving  $r = mv/qB$ ; the direction of force is always perpendicular to  $\mathbf{v}$ .

Q16 — By symmetry  $B$  is tangential and constant on a circular Amperian loop;  $B \cdot dl = B(2\pi r) = \mu_0 I$ , so  $B = \mu_0 I / 2\pi r$ .

Q17 — Each wire sits in the field of the other;  $F = B I_1 L$  with  $B = \mu_0 I_2 / 2\pi d$ , giving  $F/L = \mu_0 I_1 I_2 / 2\pi d$ .

Q18 — The coil experiences a torque  $NIA \cdot B$  balanced by the spring  $k\phi$ , so  $\phi = (NBA/k)I$ ; current sensitivity =  $NBA/k$ .

Q19 —  $F = qvB = mv^2/r$   $\Rightarrow mv/qB$ ;  $T = 2\pi r/v = 2\pi m/qB$ , independent of  $v$ .

Q20 — See notes: dees + alternating voltage;  $v = qB/2\pi m$ ; limitations at relativistic speeds; ammeter conversion with shunt  $S = I_g G / (I - I_g)$ .