

Magnetic fields of wires and forces on moving charges

AP Physics 2 (algebra-based) · Test answers (mark scheme)

The marking guide gives one mark for the correct relationship, one for the substitution and one for the answer with its unit. Direction questions require the rule to be named or applied, not just a final word.

Level: AP Physics 2 (algebra-based) · **Curriculum:** AP P2 Unit 12

Question 1 Field near a cable (2 marks)

(a) $B = \mu_0 I / 2\pi r = (4\pi \times 10^{-7})(25) / (2\pi \times 0.040) = \mathbf{1.3 \times 10^{-4} \text{ T}}$.

(b) Current doubles and distance doubles, so B is unchanged: $\mathbf{1.3 \times 10^{-4} \text{ T}}$.

Marking: 1 mark each part.

Question 2 Direction of force (2 marks)

(a) With north as the direction of v and east as B , the right-hand rule gives **downward** for a proton.

(b) The electron is negative, so the force is **upward**.

Marking: 1 mark each part.

Question 3 Proton in a uniform field (4 marks)

(a) $F = qvB = (1.6 \times 10^{-19})(1.2 \times 10^6)(0.80) = \mathbf{1.5 \times 10^{-13} \text{ N}}$.

(b) $qvB = mv^2/r$, so $r = mv/(qB) = (1.67 \times 10^{-27})(1.2 \times 10^6) / (1.6 \times 10^{-19} \times 0.80) = \mathbf{1.6 \text{ cm}}$.

(c) r is proportional to v , so the radius **doubles**.

Marking: (a) 1; (b) 1 for the relationship, 1 for the answer; (c) 1.

Question 4 Force on a wire (3 marks)

(a) $F = BIL = 0.15 \times 6.0 \times 0.80 = \mathbf{0.72 \text{ N}}$.

(b) $F = 0.72 \times \sin 40^\circ = 0.72 \times 0.643 = \mathbf{0.46 \text{ N}}$.

(c) The force on the moving charges depends on the component of the velocity perpendicular to B . Along the field there is no such component, so $\mathbf{F = 0}$.

Marking: 1 mark each part.

Question 5 Parallel wires (3 marks)

(a) $F/L = \mu_0 I_1 I_2 / 2\pi d = (4\pi \times 10^{-7})(12)(8.0) / (2\pi \times 0.030) = \mathbf{6.4 \times 10^{-4} \text{ N/m}}$.

(b) Currents in the same direction **attract**.

Marking: (a) 1 for substitution, 1 for the answer; (b) 1.

Question 6 Work done (2 marks)

The magnetic force is always perpendicular to the velocity, so it has no component along the displacement and does zero work. With no work done, the kinetic energy and the speed stay constant, and only the direction changes.

Marking: 1 for perpendicular force; 1 for zero work so no change of speed.

Question 7 Sign of the charge (2 marks)

For a positive charge moving right in a field out of the page, the right-hand rule gives a downward force. The path curves **upward**, the opposite way, so the charge is **negative**.

Marking: 1 for correct application of the rule; 1 for stating negative.

Question 8 Undeflected beam (2 marks)

(a) $qE = qvB$, so $v = E/B = 6.0 \times 10^3 / 0.030 = \mathbf{2.0 \times 10^5 \text{ m/s}}$.

(b) For a faster particle the magnetic force qvB is larger than the electric force qE , so it is **deflected** in the direction of the magnetic force.

Marking: 1 mark each part.