AP PHYSICS C: ELECTRICITY AND MAGNETISM • EXERCISE SHEET

12.2 Magnetism and Moving Charges

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

KEY WORDS magnetic force 磁力 • perpendicular 垂直 • right-hand rule 右手定则 • centripetal force 向心力 • magnetic field 磁场

Objective

Build the skills to answer exam questions on **magnetism and moving charges**.

You must be able to:

- calculate the **magnetic force** 磁力 on a moving charge, $\vec{F} = q\vec{v} \times \vec{B}$
- use the **right-hand rule** 右手定则 for the direction of $\vec{v} \times \vec{B}$
- explain why the magnetic force does **no work**
- analyse the **circular motion** of a charge in a uniform field, $r = \dfrac{mv}{qB}$

1 Worked examples

Study these first. Each one shows the method for a question type used later.

■ **Force on a moving charge**

$\vec{F} = q\vec{v} \times \vec{B}$, with magnitude $F = qvB\sin\theta$ and direction from the right-hand rule.

■ **No work**

Because $\vec{F} \perp \vec{v}$, the magnetic force does **no work** — it changes only the **direction** of the velocity, not the speed.

■ **Circular motion**

For $\vec{v} \perp \vec{B}$, the force provides the centripetal force: $qvB = \dfrac{mv^2}{r}$, so $r = \dfrac{mv}{qB}$.

2 Practice

2.1 A charge of 3.0×10^{-6} C moves at 2.0×10^{4} m s^{-1} perpendicular to a 0.40 T field. Find the force. [2]

2.2 Explain why the magnetic force does no work on a moving charge. [2]

2.3 Write the formula for the radius of a charge's circular path in a magnetic field. [1]

3 Exam-style questions

3.1 The magnetic force on a moving charge is [1]

- **A** $q\vec{E}$
- **B** $q\vec{v} \times \vec{B}$
- **C** $I\vec{L}$
- **D** $m\vec{a}$

3.2 The magnetic force on a moving charge does [1]

- **A** positive work
- **B** negative work
- **C** no work
- **D** maximum work

3.3 A proton ($q = 1.6 \times 10^{-19}$ C, $m = 1.67 \times 10^{-27}$ kg) moves at 4.0×10^{6} m s^{-1} perpendicular to a 0.50 T field.

(a) Find the magnetic force on it. [2]

(b) Find the radius of its circular path. [2]

Solutions

2.1 $F = qvB = (3.0 \times 10^{-6})(2.0 \times 10^{4})(0.40) = 2.4 \times 10^{-2}$ N.

2.2 the force is perpendicular to the velocity, so $\vec{F} \cdot \vec{v} = 0$ and no work is done — only the direction changes.

2.3 $r = \dfrac{mv}{qB}$.

3.1 B.

3.2 C.

3.3 (a) $F = qvB = (1.6 \times 10^{-19})(4.0 \times 10^{6})(0.50) = 3.2 \times 10^{-13}$ N. (b) $r = \dfrac{mv}{qB} = \dfrac{(1.67 \times 10^{-27})(4.0 \times 10^{6})}{(1.6 \times 10^{-19})(0.50)} = 0.084$ m.