

12.2 Magnetism and Moving Charges

Name: _____ Class: _____ Date: _____

Total: 9 marks

KEY WORDS magnetic force 磁力 • right-hand rule 右手定则 • 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, $F = qvB \sin \theta$
- use the **right-hand rule** 右手定则 to find the direction of the force
- describe the circular path of a charge moving perpendicular to a uniform field

1 Worked examples

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

■ Force on a moving charge

$F = qvB \sin \theta$, where θ is the angle between $\vec{v}$ and $\vec{B}$. The force is **maximum** when $v \perp B$ and **zero** when they are parallel.

■ Direction

The force is perpendicular to **both** $\vec{v}$ and $\vec{B}$ — use the right-hand rule (for a positive charge).

■ Circular motion

A charge moving perpendicular to a uniform field is pushed sideways continuously, so it travels in a **circle**.

2 Practice

2.1 A charge of 2.0×10^{-6} C moves at 3.0×10^4 m s⁻¹ perpendicular to a 0.20 T field. Find the force. [2]

2.2 State the angle between $\vec{v}$ and $\vec{B}$ that gives the maximum force. [1]

2.3 State the shape of the path of a charge moving perpendicular to a uniform magnetic field. [1]

3 Exam-style questions

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

- A** qE
- B** $qvB \sin \theta$
- C** $BI\ell$
- D** $\frac{1}{2}mv^2$

3.2 A charge moving parallel to a magnetic field feels a force of [1]

- A** maximum size
- B** zero
- C** qvB
- D** qE

3.3 A proton ($q = 1.6 \times 10^{-19}$ C) moves at 5.0×10^6 m s⁻¹ perpendicular to a 0.30 T field.

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

(b) Describe the shape of its path. [1]

Solutions

2.1 $F = qvB = (2.0 \times 10^{-6})(3.0 \times 10^4)(0.20) = 1.2 \times 10^{-2} \text{ N}.$

2.2 90° (perpendicular).

2.3 a circle.

3.1 B.

3.2 B.

3.3 (a) $F = qvB = (1.6 \times 10^{-19})(5.0 \times 10^6)(0.30) = 2.4 \times 10^{-13} \text{ N}.$ (b) a circular path.