Exercise walk-through

Magnetism and Moving Charges ▪ 12.2

eXercise

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

Method — 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.

Method — Direction

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

Method — Circular motion

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

Practice 2.1 ▪ 2 marks

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.

Solution 2.1

Worked steps

$F = qvB = (2.0 \times 10^{-6})(3.0 \times 10^{4})(0.20) = 1.2 \times 10^{-2}$ N M1 A1.

Practice 2.2 ▪ 1 mark

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

Solution 2.2

Method: Force on a moving charge

Worked steps

90° (perpendicular) B1.

Practice 2.3 ▪ 1 mark

State the shape of the path of a charge moving perpendicular to a uniform magnetic field.

Solution 2.3

Method: Circular motion

Worked steps

a circle B1.

Exam-style 3.1 ▪ 1 mark

The magnetic force on a moving charge is

A qE

B $qvB\sin\theta$

C $BI\ell$

D $\frac{1}{2}mv^2$

Solution 3.1

Method: Force on a moving charge

A qE

B $qvB\sin\theta$ ✓

C $BI\ell$

D $\frac{1}{2}mv^2$

Worked steps

B.

Exam-style 3.2 ▪ 1 mark

A charge moving parallel to a magnetic field feels a force of

A maximum size

B zero

C qvB

D qE

Solution 3.2

Method: Force on a moving charge

A maximum size

B zero ✓

C qvB

D qE

Worked steps

B.

Exam-style 3.3 ▪ 2 marks

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.
(b) Describe the shape of its path.

Solution 3.3

Worked steps

(a) $F = qvB = (1.6 \times 10^{-19})(5.0 \times 10^{6})(0.30) = 2.4 \times 10^{-13}$ N M1 A1. (b) a circular path B1.