

12.3 Magnetism and Current-Carrying Wires

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS current-carrying wire 载流导线 • magnetic field 磁场

Objective

Build the skills to answer exam questions on **magnetism and current-carrying wires**.

You must be able to:

- describe the field around a long straight **current-carrying wire** 载流导线, $B = \frac{\mu_0 I}{2\pi r}$
- calculate the force on a current-carrying wire in a field, $F = BIl \sin \theta$
- explain the attraction or repulsion between two parallel wires

1 Worked examples

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

■ Field around a wire

$B = \frac{\mu_0 I}{2\pi r}$, with $\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}$; the field circles the wire and weakens with distance.

■ Force on a wire

$F = BIl \sin \theta$ — maximum when the wire is perpendicular to the field.

■ Parallel wires

Currents in the **same** direction **attract**; in **opposite** directions they **repel**.

2 Practice

2.1 A wire of length 0.20 m carries 3.0 A perpendicular to a 0.50 T field. Find the force.[2]

2.2 State what happens to two parallel wires carrying current in the same direction. [1]

2.3 Find the magnetic field 0.10 m from a long wire carrying 5.0 A ($\mu_0 = 4\pi \times 10^{-7}$). [2]

3 Exam-style questions

3.1 The force on a current-carrying wire in a magnetic field is [1]

- | | |
|---|--------------------------|
| A | qvB |
| B | $BI\ell$ |
| C | $\frac{\mu_0 I}{2\pi r}$ |
| D | V/R |

3.2 Two parallel wires carrying current in **opposite** directions [1]

- | | |
|---|-------------|
| A | attract |
| B | repel |
| C | do nothing |
| D | always melt |

3.3 A 0.50 m wire carries 4.0 A at 90° to a 0.25 T field.

(a) Find the force on the wire. [2]

(b) State what happens to the force if the current is doubled. [1]