AP PHYSICS 2 • EXERCISE SHEET

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, $B = \dfrac{\mu_0 I}{2\pi r}$
- calculate the force on a current-carrying wire in a field, $F = BI\ell\sin\theta$
- 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**

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

■ **Force on a wire**

$F = BI\ell\sin\theta$ — 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** $\dfrac{\mu_0 I}{2\pi r}$
- **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]

Solutions

2.1 $F = BI\ell = 0.50 \times 3.0 \times 0.20 = 0.30$ N.

2.2 they attract each other.

2.3 $B = \dfrac{\mu_0 I}{2\pi r} = \dfrac{(4\pi \times 10^{-7})(5.0)}{2\pi(0.10)} = 1.0 \times 10^{-5}$ T.

3.1 **B**.

3.2 **B**.

3.3 (a) $F = BI\ell = 0.25 \times 4.0 \times 0.50 = 0.50$ N. (b) it doubles to 1.0 N ($F \propto I$).