Magnetic Fields of Currents & Ampère's Law

Magnetism · 7 questions · step-by-step answers at the end

Name: Date: Score: / 7

USEFUL EQUATIONS

$B = \mu_0 I/(2\pi r)$ $B = \mu_0 n I$ $F/L = \mu_0 I_1 I_2/(2\pi d)$ $\oint \mathbf{B}\cdot d\mathbf{L} = \mu_0 I_{\text{enc}}$ $\mu_0 = 4\pi \times 10^{-7}$ T·m/A

Questions

Show your working in the space under each question.

1. Two parallel wires 0.10 m apart each carry 10 A in the same direction. Find the force per metre and say whether it attracts or repels.

2. Find (a) the field 5.0 cm from a long wire carrying 10 A, and (b) the field inside a solenoid with 400 turns over 20 cm carrying 2.0 A.

3. A solenoid has 500 turns over 0.25 m and carries 2.0 A. Find B inside.

4. Two long parallel wires 5.0 cm apart each carry 10 A in the same direction. Find the force per metre.

5. The current in a wire doubles and you move twice as far away. What happens to B?

6. A solenoid has 1000 turns per metre and carries 3.0 A. Find B inside.

7. Find B at the centre of a semicircular arc of radius R carrying current I.

Step-by-step answers

Magnetic Fields of Currents & Ampère's Law

1. $F/L = \mu_0 I_1 I_2/(2\pi d) = (2 \times 10^{-7})(100)/0.10 =$ **2.0×10^{-4} N/m, attractive**.

2. 1. (a) $B = \mu_0 I/(2\pi r) = (4\pi \times 10^{-7})(10)/(2\pi \times 0.050) =$ **4.0×10^{-5} T** (40 μT), about the strength of Earth's field.

2. (b) $n = 400/0.20 = 2000$ turns/m.

3. $B = \mu_0 nI = (4\pi \times 10^{-7})(2000)(2.0) =$ **5.0×10^{-3} T** (5.0 mT).

4. A coil concentrates the field far more than a single wire does.

Answer: (a) 40 μT (b) 5.0 mT

3. $n = 2000$ /m, so $B = \mu_0 nI =$ **5.0 mT**.

4. $F/L = (2 \times 10^{-7})(100)/0.05 =$ **4.0×10^{-4} N/m, attractive**.

5. $B \propto I/r$, so it is **unchanged**.

6. $B = \mu_0 nI =$ **3.8 mT**.

7. Half of the full-loop value: **$\mu_0 I/(4R)$**.