

Magnetic fields of wires and forces on moving charges

AP Physics 2 (algebra-based) · Lab answers

The sample readings give a straight line through the origin with gradient about 0.49 g/A. The answers below turn that gradient into a field strength and discuss how reliable it is.

Level: AP Physics 2 (algebra-based) · **Curriculum:** AP P2 Unit 12

Question 1 Force from the readings

$F = \Delta m g = (1.46 \times 10^{-3} \text{ kg})(9.81) = \mathbf{1.43 \times 10^{-2} \text{ N}}$. The wire pushes up on the magnets (Newton's third law), so the balance reads a different mass.

Question 2 Graph

The graph is a **straight line through the origin**, so Δm is proportional to I . This matches $F = BIL$, where B and L are constant.

Question 3 Slope of the line

Slope = $(2.44 - 0.50) / (5.0 - 1.0) = 1.94 / 4.0 = \mathbf{0.485 \text{ g/A}}$, which is $4.85 \times 10^{-4} \text{ kg/A}$.

Question 4 Magnetic field

$F = \Delta m g = BIL$ gives $B = (\text{gradient} \times g) / L = (4.85 \times 10^{-4})(9.81) / 0.040 = \mathbf{0.12 \text{ T}}$.

Question 5 Uncertainty

For L : $1/40 = \mathbf{2.5 \%}$. For Δm at 1.0 A: $0.01 / 0.50 = \mathbf{2 \%}$. At 1.0 A the two are similar. At larger currents the balance uncertainty shrinks as a percentage, so the length L becomes the main limit.

Question 6 Changing the angle

$F = BIL \sin \theta$, so the force is multiplied by $\sin 30^\circ = 0.5$. At 4.0 A the reading was 1.95 g, so it becomes about $\mathbf{0.98 \text{ g}}$.

Question 7 Improving the method

(1) Use a larger range of currents and take readings on the way up and down to average out heating. (2) Measure the length of wire in the field more carefully with a longer pole gap, or use a Hall probe to compare the field value. **$B \approx 0.12 \text{ T}$** is the result to quote.