

Forces on currents and moving charges in magnetic fields

Physics grades 11-12 (A Level · IB · Class 11-12) · Lab answers

The sample data give a straight line through the origin, so the force is proportional to the current. The gradient divided by the wire length gives B. Your own data may differ, but should agree within the uncertainty of the balance.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB D.3

Question 1 Plotting

$F = \Delta m g$: 0.17 g gives 1.7×10^{-3} N, up to 0.86 g giving 8.4×10^{-3} N. The five points lie close to a straight line through the origin, so **F is proportional to I**.

Question 2 Gradient

The best-fit line through the origin has gradient $\Sigma IF / \Sigma I^2 = 3.4 \times 10^{-3}$ N/A.

Question 3 Flux density

$F = (BL) I$, so $B = \text{gradient} / L = 3.4 \times 10^{-3} / 0.040 = 0.085$ T, about 0.085 T.

Question 4 Direction

Reversing the current reverses the force on the wire. By Newton's third law the force on the magnet reverses too, so **the apparent mass change changes sign**.

Question 5 Uncertainty

$0.01 / 0.17 = 5.9\%$, while $0.01 / 0.86 = 1.2\%$. The smallest reading is therefore the least reliable; **larger currents give a smaller percentage uncertainty**.

Question 6 Improvement

Use a longer wire section or a stronger magnet to increase F; measure over a wider current range; use several turns of wire to multiply the force; measure L more precisely. **Each raises F relative to the 0.01 g resolution**.