

Forces on currents and moving charges in magnetic fields

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

Name: _____ Date: _____ Class: _____

How strong is the field between two magnet poles? You will not need a magnetic probe: the force on a wire carrying a known current pushes back on the magnet, and a top-pan balance turns that push into a mass reading you can analyse.

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

Aim

To measure the flux density between two magnet poles by weighing the reaction force of a current-carrying wire on the magnet.

Equipment

- top-pan balance reading to 0.01 g
- pair of ceramic magnets on an iron yoke, with a 4.0 cm length of gap
- stiff copper wire held in a clamp stand, not touching the magnet
- variable low-voltage dc supply (0–3 A), ammeter, switch and leads
- metre rule

Safety

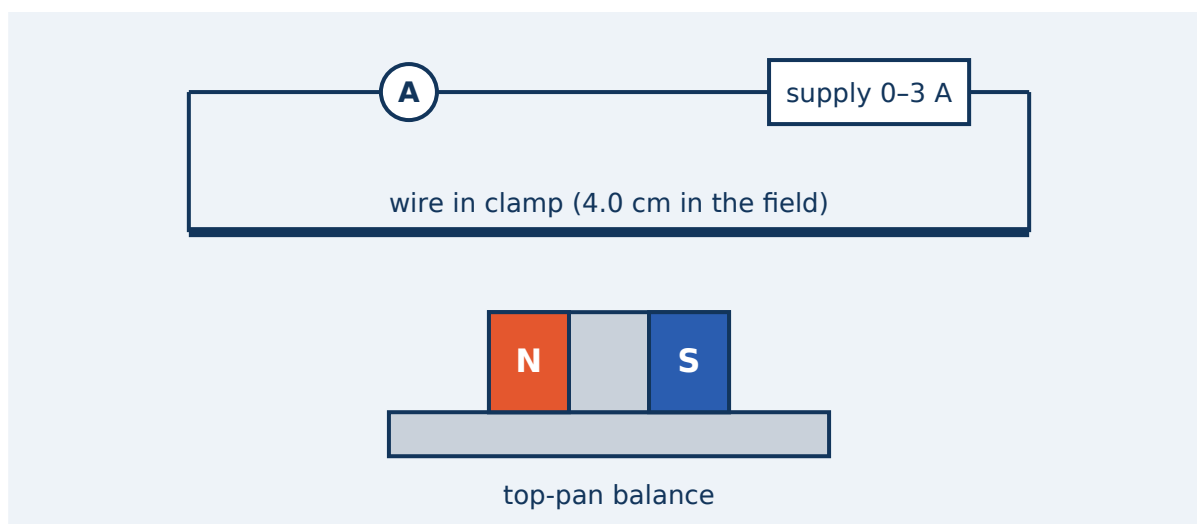
Safety

Keep the current below 3 A and switch off between readings because the wire warms up. Keep phones, bank cards and pacemakers away from the magnets. Do not touch the wire when it is hot.

Method

1. Place the magnet assembly on the balance and fix the wire in the clamp so that it passes horizontally through the gap without touching.
2. Switch the circuit off and press tare so the balance reads 0.00 g.
3. Set the current to 0.5 A, switch on, and record the new balance reading at once.
4. Switch off. Repeat for 1.0, 1.5, 2.0 and 2.5 A, taring each time.
5. Reverse the current once and note the sign of the reading.

6. Measure the length of wire inside the field with the rule.



The wire is fixed, so the magnet is pushed down (or up) by the equal and opposite force, which the balance records as an apparent change of mass.

Results

The wire length in the field is $L = 0.040$ m. Apparent mass change Δm :

Current I / A	Δm / g	Δm / kg	$F = \Delta m \text{ g} / \text{N}$
0.5	0.17	1.7×10^{-4}	1.7×10^{-3}
1.0	0.36	3.6×10^{-4}	3.5×10^{-3}
1.5	0.52	5.2×10^{-4}	5.1×10^{-3}
2.0	0.70	7.0×10^{-4}	6.9×10^{-3}
2.5	0.86	8.6×10^{-4}	8.4×10^{-3}

Analysis questions

Question 1 Plotting

Using your table, draw a force-current graph with F on the y-axis and a straight best-fit line through the origin.

Question 2 Gradient

Find the gradient of your line in N/A.

Question 3 Flux density

Use the gradient to calculate B . State the formula you use.

Question 4 Direction

Explain why the balance reading changed sign when the current was reversed.

Question 5 Uncertainty

The balance reads to 0.01 g. Calculate the percentage uncertainty in the smallest Δm and comment.

Question 6 Improvement

Suggest two improvements that would make B more accurate.