

Magnetic flux, Faraday's law and Lenz's law

AP Physics 2 (algebra-based) · Lab answers

The sample data show a nearly proportional link between peak emf and speed, with a slope of about 0.21 V·s/m. The answers below link the pattern to Faraday's law and mention the main limitations.

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

Question 1 Entry speed

$v = \sqrt{2 \times 9.81 \times 0.30} = \mathbf{2.43 \text{ m/s}}$. This assumes free fall, so air resistance and friction with the tube are neglected.

Question 2 Graph

The graph is close to a **straight line through the origin**: the emf rises in proportion to the speed.

Question 3 Slope of the graph

Slope = $(0.59 - 0.21) / (2.80 - 0.99) = 0.38 / 1.81 = \mathbf{0.21 \text{ V}\cdot\text{s/m}}$ (volts per metre per second).

Question 4 Meaning of the result

The flux linkage changes by about the same amount as the magnet passes the coil, but a faster magnet does it in less time. $\epsilon = N\Delta\Phi/\Delta t$ is therefore **proportional to the speed**.

Question 5 Area under a pulse

The area under the emf-time graph equals $N\Delta\Phi$, so $\Delta\Phi = 2.1 \times 10^{-3} / 500 = \mathbf{4.2 \times 10^{-6} \text{ Wb}}$. Notice that this does not depend on the speed.

Question 6 Two pulses

As the magnet enters, the flux through the coil increases, and as it leaves the flux decreases. By Lenz's law the induced currents are in **opposite directions**, so the emf changes sign.

Question 7 Limitations

Air resistance and friction with the tube wall slow the magnet, and eddy currents in any metal nearby also oppose the fall. Use a wider plastic tube, a smoother inner surface, and measure the speed directly by timing between two light gates. **The true speed is below $\sqrt{2gh}$.**