

How changing flux creates an emf

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

Name: _____ Date: _____ Class: _____

Does a faster magnet induce a bigger emf? You will drop a small magnet through a coil from several heights and record the peak emf. The heights give the speeds, so you can test Faraday's law directly with simple equipment.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB D.4

Aim

To find how the peak emf induced in a coil depends on the speed of a magnet falling through it.

Equipment

- coil of about 500 turns of enamelled copper wire wound on a short plastic former
- small neodymium or ceramic magnet that fits freely in a clear plastic tube
- voltmeter with a peak-hold function, or a data logger, with leads
- clear plastic tube 60 cm long, clamp stand and metre rule
- soft cloth or foam pad to catch the magnet

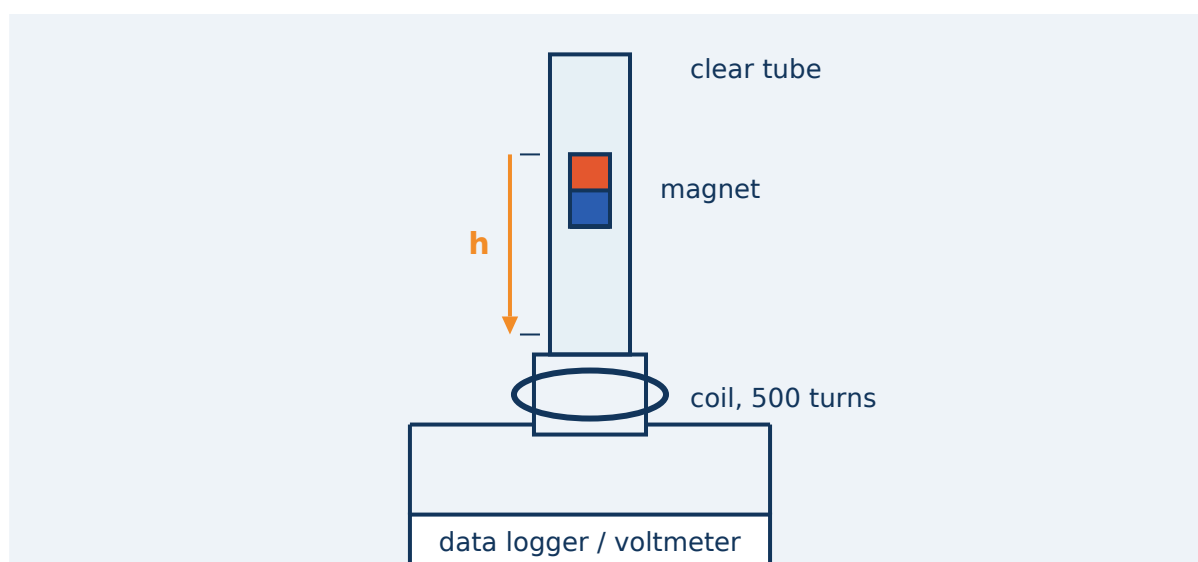
Safety

Safety

Strong magnets can pinch skin and wipe bank cards, so keep them apart and handle one at a time. Place the foam pad under the tube so that the falling magnet cannot chip the floor or the coil. Clear away any magnet that falls on the floor.

Method

1. Clamp the tube vertically so that it passes through the middle of the coil, and place the foam pad below it.
2. Connect the coil to the voltmeter or data logger.
3. Hold the magnet in the tube with its lower end 5 cm above the top of the coil and release it. Record the peak emf.
4. Repeat from 10, 20, 30 and 40 cm, taking three readings each time and using the mean.
5. Calculate the speed at the coil for each height from $v = \sqrt{2gh}$, ignoring air resistance.



The magnet falls from height h above the coil, and the logger records the emf pulse as the flux changes.

Results

Each emf value is the mean of three drops:

Height h / cm	Peak emf / mV	Speed v / m/s (calculated)
5	34	0.99
10	48	1.40
20	67	1.98
30	84	2.43
40	95	2.80

Analysis questions

Question 1 Plotting

Plot peak emf (vertical) against speed v (horizontal) and draw the best-fit line through the origin.

Question 2 Pattern

Describe the relationship between emf and speed shown by the graph.

Question 3 Gradient

Find the gradient of your line, with units.

Question 4 Explanation

Use Faraday's law to explain why a faster magnet induces a larger emf.

Question 5 Sign of the pulse

With a data logger you see a positive pulse followed by a negative pulse. Explain why.

Question 6 Evaluation

Suggest two reasons why the real speed at the coil is smaller than $\sqrt{2gh}$, and one way to improve the experiment.