

Faraday's law, inductors and LR circuits

AP Physics C (Mechanics and E&M, calculus-based) · Lab

Name: _____ Date: _____ Class: _____

A falling magnet induces a short pulse of emf in a coil. In this lab you test whether the peak emf grows in proportion to the speed of the magnet, a direct consequence of Faraday's law.

Level: AP Physics C (Mechanics and E&M, calculus-based) · **Curriculum:** AP PC:E&M Unit 13

Aim

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

Equipment

- Coil of 400 turns
- Small cylindrical magnet
- Plastic guide tube, clamp stand and ruler
- Voltage sensor or data logger
- Foam pad

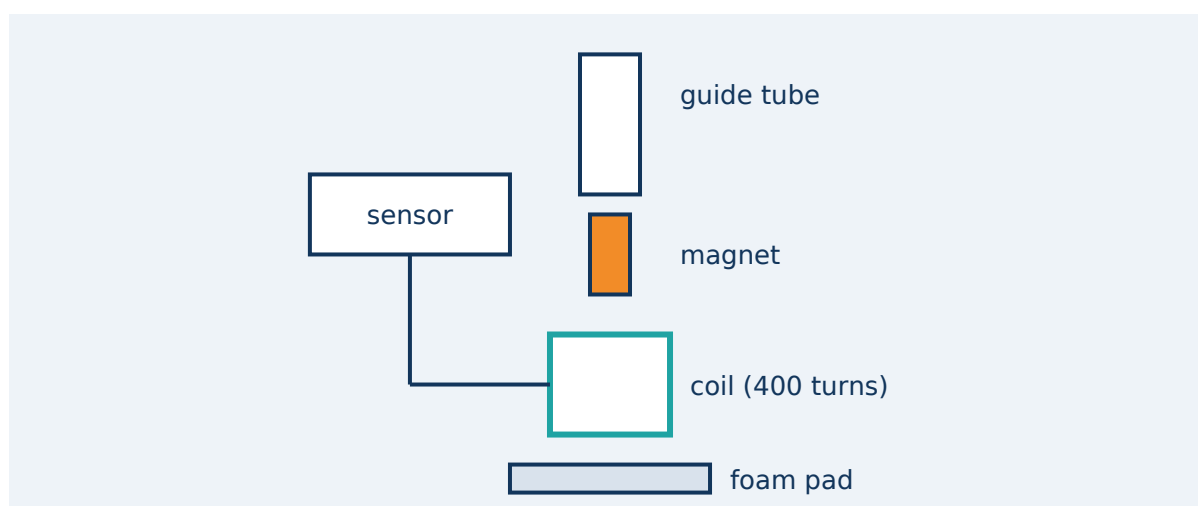
Safety

Safety

Keep the magnet away from phones and cards, and hold the magnet by its sides to avoid trapped fingers. Clamp the stand firmly so it cannot topple.

Method

1. Clamp the tube vertically with its lower end about 2 cm above the coil.
2. Release the magnet from rest at height h above the middle of the coil.
3. Record the peak emf from the logger trace.
4. Repeat three times for each height and take the mean.
5. Use five heights from 5 cm to 40 cm.



Set-up: the magnet falls through the coil and the voltage sensor records the peak emf.

Results

Height h (cm)	Mean peak emf (mV)
5	37
10	54
20	74
30	93
40	108

Analysis questions

Question 1 Speed at the coil

Use $v = \sqrt{2gh}$ with $g = 9.81 \text{ m/s}^2$ to find the speed for each height. Tabulate your answers to 2 decimal places.

Question 2 Graph

Plot peak emf (y) against v (x) and describe the shape.

Question 3 Gradient

Find the gradient of the best-fit line and state its unit.

Question 4 Link to Faraday's law

Explain why the peak emf should be roughly proportional to the speed of the magnet.

Question 5 Sources of error

Suggest two reasons the real speed at the coil differs from $\sqrt{2gh}$.

Question 6 Uncertainty

The emf readings vary by ± 3 mV between repeats. Calculate the percentage uncertainty in the reading at 5 cm and at 40 cm and comment.

Question 7 Improvement

Suggest a change of method that would let you check $\varepsilon = -N d\Phi/dt$ more directly.