B8R07848 gravimeter NFU 609

Purpose:

The Inductive Gravimeter is an exciting extension to the normal methods of determining g by freefall. When a magnet is dropped through the vertically mounted pipe it induces small alternating voltages into small coils of wire which are accurately placed at 5cm intervals. These small signals are captured using a Digital Storage Oscilloscope. Knowing the geometrical dimensions of the gravimeter and calculating the time intervals between peaks of the captured signal, it is possible to calculate the acceleration due to gravity. The Inductive Gravimeter has been developed from an original idea from John Nunn of the National Physics Laboratory.

Equipment required:

Digital Storage Oscilloscope
2 x 4mm leads and BNC to 4mm socket adaptor (B8R05704) or, BNC Plug to stackable 4mm plug (B8RO6754). This will normally give better results.

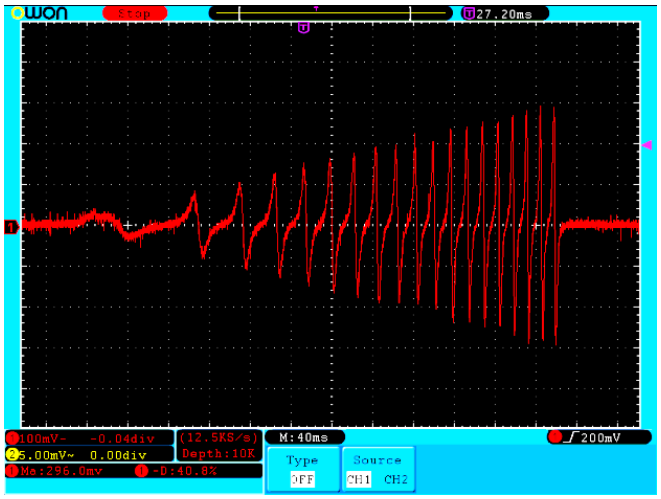
Theory:

As the magnet passes each coil, the magnet induces an EMF into the coil. The north pole of the magnet will induce a positive EMF and the south pole of the magnet will induce a negative EMF. The magnet passes each coil in turn, leading to a series of peaks and troughs getting larger and closer together as the magnet accelerates down the tube.

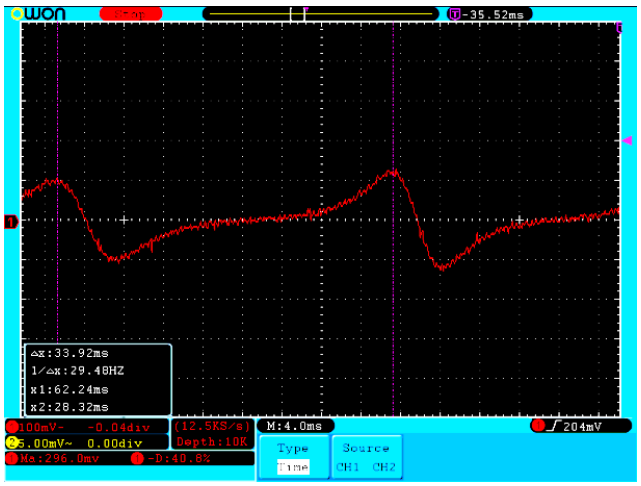
Measuring the time between successive peaks allows the student to calculate the average velocity and the acceleration due to gravity.

Method:

Connect the gravimeter to a Digital Storage Oscilloscope. For best results, use a BNC to 4mm plug lead such as B8RO6754. Set the trigger threshold to approximately 0.2V, the Vertical sensitivity to 100mV per division and the time-base to 40ms/division. Set the trigger to “Single” and drop the magnet down thee tube. The Oscilloscope will trigger and you will see a waveform similar to the one below:

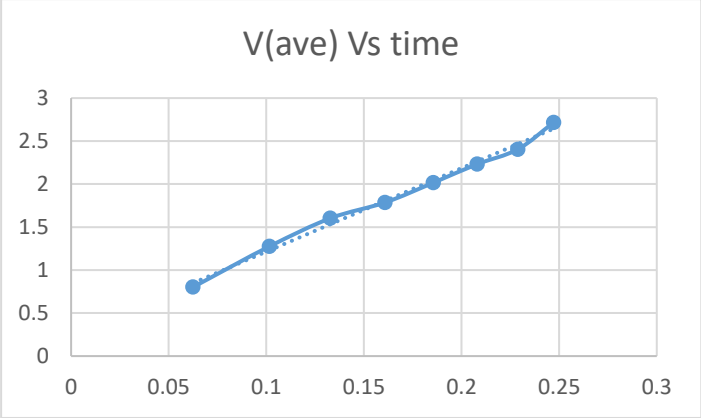


It is apparent that the time between adjacent peaks becomes smaller as the magnet accelerates down the tube. Decreasing the time base allows us to zoom in so that more accurate measurements can be made. Use the oscilloscope cursors to measure the time between successive peaks, then use the horizontal position control to move the next two peaks into view and repeat the process until the time between all the peaks has been recorded. Change the time-base as necessary to achieve the best results.



Position	Time (ms)	Total Time (s)	Ave Velocity (m/s)
Coil 1-2	70.4	0.0704	0.7102
Coil 2-3	41.6	0.112	1.2019
Coil 3-4	32.4	0.1444	1.5432
Coil 4-5	29.92	0.17232	1.7908

The average velocity is calculated by dividing the distance between the coils, which is 5cm, by the time taken for the magnet to travel between the two coils. Now plot the average velocity against total time to produce a graph of this form:



Draw a line of best fit and calculate the gradient to give an approximation for the acceleration due to gravity.

Extension activities

The result calculated above is unlikely to be the accepted value of 9.7 ms^{-2}. Why is this? There are a number of factors that could contribute to an error, the spacing of the coils and identifying the same point on the waveform when measuring the time using an oscilloscope. There are physical aspects that can also affect the outcome. Has the magnet touched the side wall of the tube and been slowed down? Is the current induced in the coils slowing the magnet due to Lenz's law? (this effect is actually very small as the oscilloscope input impedance is 1MΩ, so the currents induced are very small).

Compare the results achieved by plotting the average velocity of the first 10 coils and the last 10 coils. What is happening to the acceleration? You will find that the acceleration reduces as the velocity of the magnet increases. This is due to the fact that the magnet is falling through a confined space. As the magnet's velocity increases, the drag caused by the air resistance also increases, slowing the magnet's acceleration.

Warnings

For your safety, this product should be used in accordance with these instructions, otherwise the protection provided may be impaired.

Disposal of Waste Electrical and Electronic Equipment (WEEE)

Do not dispose of this product with household waste

- For the proper treatment, recovery and recycling please take this product to an appropriate collection point.
- If you are unsure where this is, contact your Local Authority
- By disposing of this product correctly you will be providing positive help to the environment.

Warranty, repairs and spare parts

The gravimeter is guaranteed for a period of one year from the date of delivery to the customer. This warranty does not apply to defects resulting from the action of a user such as misuse, improper wiring, any operations outside of its specification, improper maintenance or repair, or unauthorized modification.

Our liability is limited to repair or replacement of the product. Any failure during the warranty period should be referred to Customer Services or techsupport@unilab.co.uk

Instructions for authorized service technicians

Please refer to the detailed service procedures, safe servicing and continued safety – contact techsupport@unilab.co.uk for advice.

Please refer to product specific risks that may affect service personnel, the protective measures and verification of the safe state after repair.

Supplier details

Philip Harris Education, 2 Gregory Street, Hyde, Cheshire, SK14 4TH

Orders and Information:
Tel: 0345 120 4521
Fax: 0800 138 8881

Repairs:
Tel: 01978 853555
E-mail : sales@techlabltd.co.uk

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