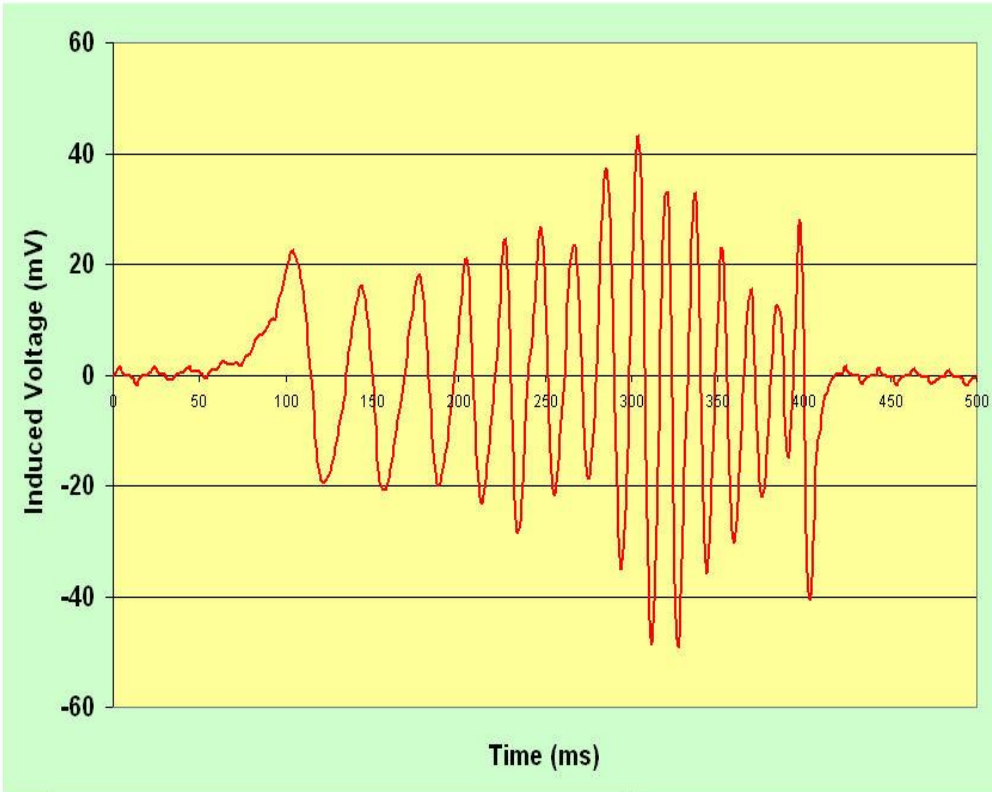
An experiment to measure the gravitational force field

In January, 2014, an interesting article was published in the Physics Education journal describing an inductive gravimeter (page 41, volume 49). By using electronic timing the free fall of an object could be investigated. Full details are given in the article but the essence of the method is that **the object is a magnet** and, as it falls through a series of coils wound on a tube, an induced voltage is generated and is recorded on an oscilloscope . The fact that the time intervals are getting shorter shows that the object must be in a force field as it is accelerating. In this experiment, therefore, a gravitational FORCE FIELD is being demonstrated before our very eyes.

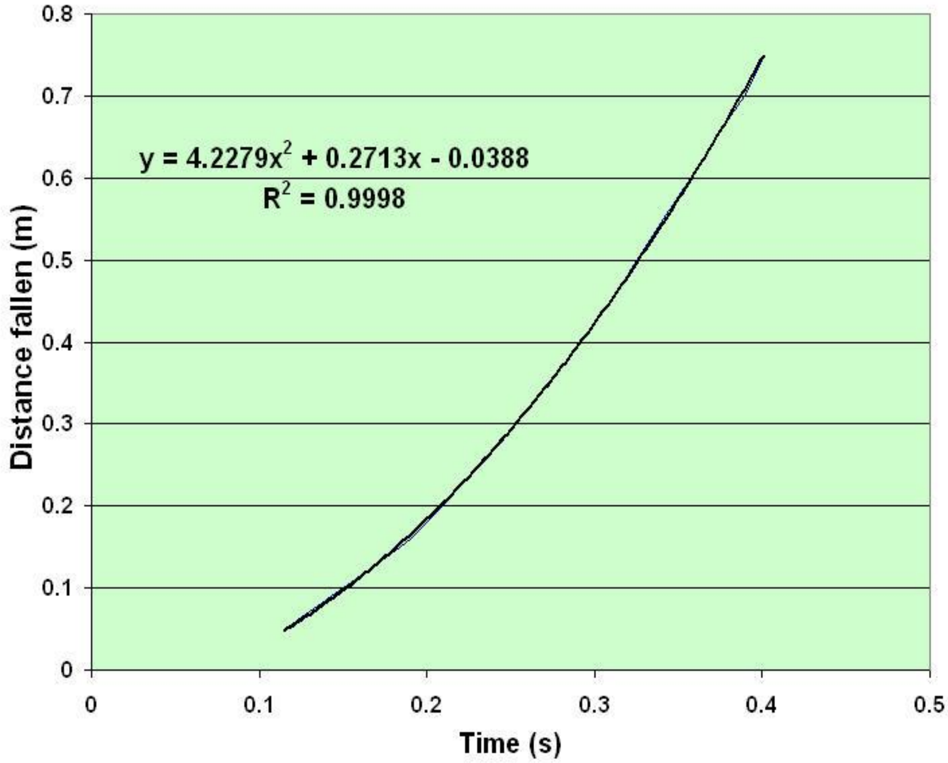
A metre long cardboard tube was used, 45 mm OD and 40 mm ID. Fifteen coils, 10 turns each, were wound on the outside and were all connected in series; the spacing was 5 cm between the centre line of the coils and an illustration of two of the coils is given. The upper coil is 7.5 cm from the top of the tube

The illustration shows that the coils are series connected with the left hand wire continuing from coil to coil. The return wire on the right hand side comes from the fifteenth coil at the lower end of the tube (note the wire is insulated copper and has a diameter of 0.052 mm).

A Picoscope ADC100 is used to record the induced voltage and a "single shot" mode is used. A dc pulse initiated the sweep and this was applied to channel A as a trigger pulse. The signal from the series connected coils were recorded on channel B. Results are presented below and it is clear that these times could never be made with a stop watch. All the peaks occur in a time interval of less than ½ second (500 ms).



The trace clearly shows that the magnet is moving faster and faster thus confirming that it is acted on by the gravitational force. The envelope of the trace cannot be explained though it may be due to the fact that the trajectory of the magnet is not precisely on the center-line of the tube



The magnet N_S poles give rise to positive and negative swings in the induced voltage and, from an EXCEL trace the times of the middle point can be determined. We know that these crossings will occur just when the magnet passes the coil so a time versus "fallen distance" of 0.05 m, 0.10 m, 0.15 m .... can be plotted. From the laws of motion we have $s = 0.5*g*t^2 + u*t$ so the data can be fitted to a polynomial of second order.

We therefore find that the falling object method gives $g = 8.4\ ms^{-2}$. One can only state that ***no allowance*** has been made for air resistance in our theoretical framework but we know that this would be quite significant as no attempt was made to streamline the magnet. The measured value is reasonably close to $9.81\ ms^{-2}$ is therefore considered acceptable.