INDOSAW
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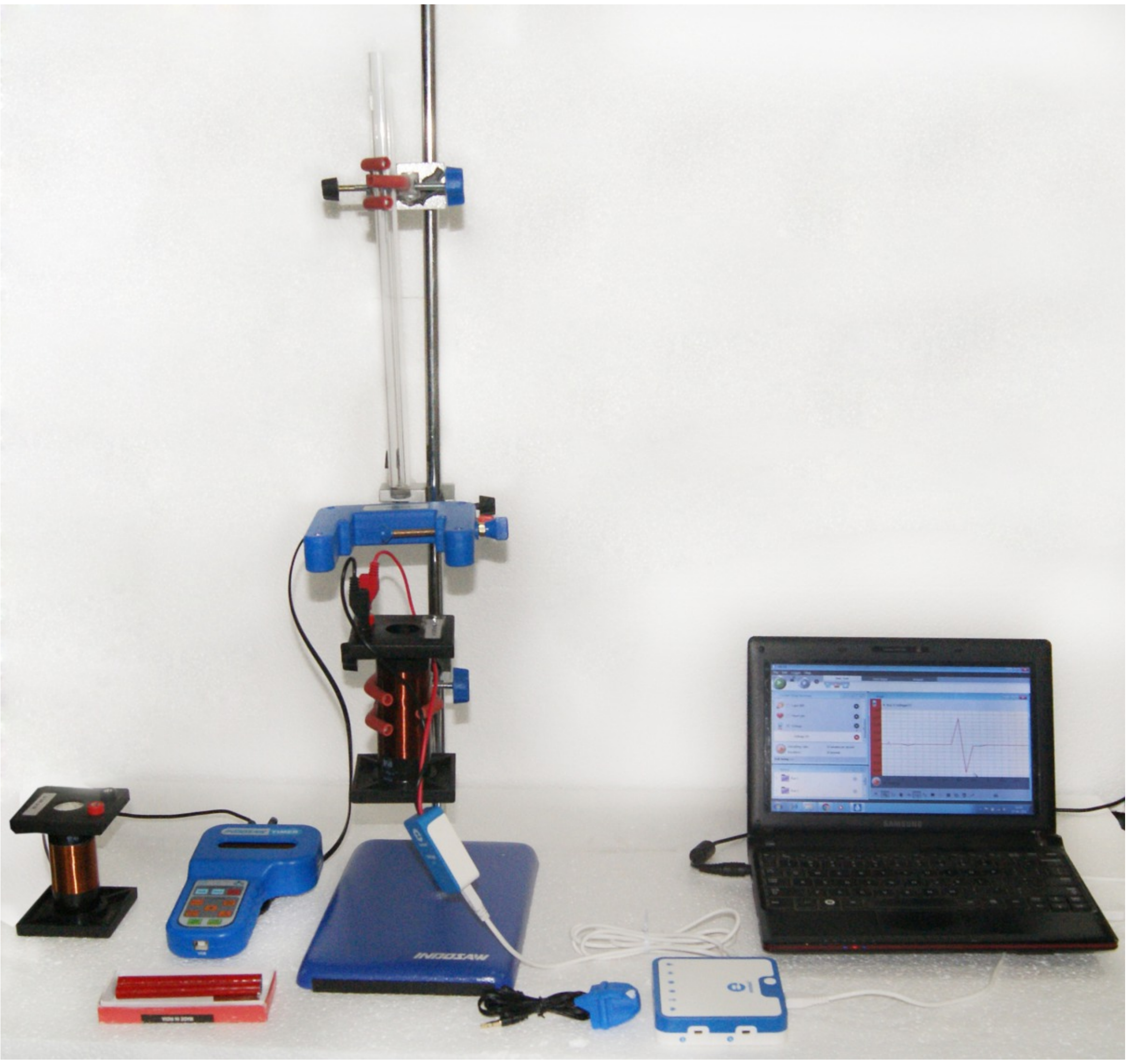
VERIFICATION OF FARADAY & LENZ'S LAW

Instruction Manual



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OBJECTIVE:

Verification of Faraday and Lenz's law of induction by measuring the induced voltage as function of time.

1. Measurement of the induced voltage impulse Up-p and the velocity of the falling magnet.
2. Evaluation of the induced voltage impulse Up-p as a function of the velocity of the magnet.
3. Calculation of the magnetic flux induced by the falling magnet as a function of the velocity of the magnet.

PRINCIPLE:

When a permanent magnet falls with different velocities through a coil, the change in the magnetic flux (4) generates an induced voltage impulse U. The induced voltage impulse Up-p is recorded with voltage probe through a computer interface system Einstein Labmate. Depending on the polarity of the permanent magnet the induced voltage impulse is negative or positive.

SCOPE OF SUPPLY:

S. No	Item Name	Qty
1	Einstein Labmat	1
2	Voltage Sensor ±25V	1
3	Support Base	1
4	Support Rod	1
5	Universal Clamp	2
6	Bosshead	3
7	Coil N=700, L=75mm, Dia=32mm	1
8	Coil N=1150, L=75mm, Dia=32mm	1
9	Cylindrical Magnet 100mm & 50mm	1
10	Tube 300mm	1
11	Digital Timer	1
12	Photogates	1
13	MiLAB Software	1
14	USB computer interface cable	1
15	Micro USB sensor interface cable	1

INFORMATION ABOUT COILS

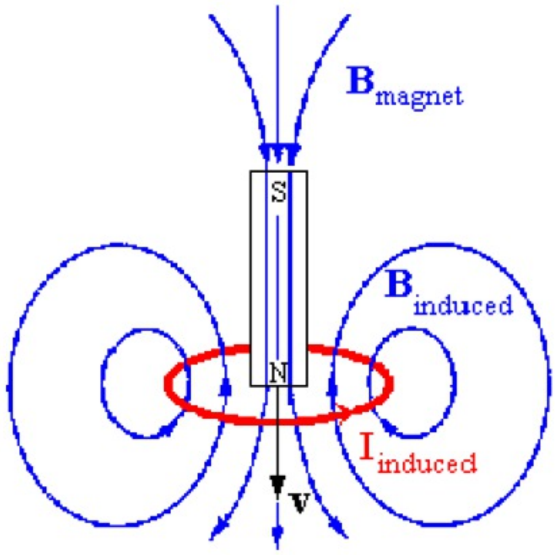
Dimension (mm)	OD mm	SWG	Length mm	Coil R mm	N	R ohm	L mH	I max Amp
32x25x75	32	30	75	16.457	700	19	13.8	0.3A
32x25x100	32	26	100	16.457	1150	13.5	8.8	0.7A

THEORY:

The changing magnetic field can give rise to an electrical current, a phenomenon we call electromagnetic induction. The mathematical law that relates the changing magnetic field to the induced current (or, more accurately, the induced voltage or emf) is called Faraday's Law.

The magnetic flux through a surface in a magnetic field B is

$$\Phi = B\,A\cos$$



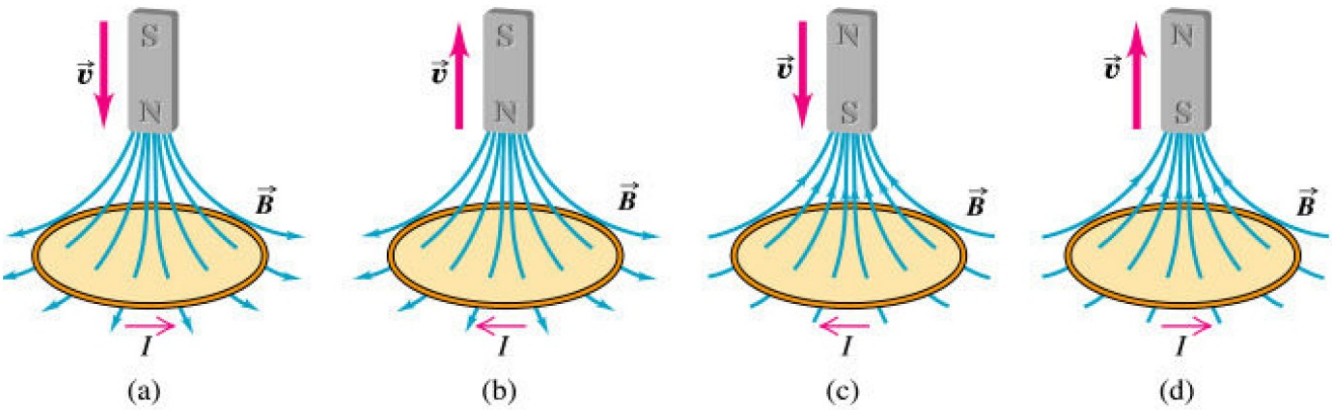
A conducting loop which has voltage or Current probe attached to it will register a Voltage or current if the magnetic flux through the loop changes in time. The change may arise from motion of a magnet.

Faraday noted that the emf induced in a loop is proportional to the rate of change of magnetic flux though it

$$\varepsilon = -N\,\frac{d\Phi}{dt}$$

where ε is the electromotive force induced (measured in volts) and N is the number of turns of the coil. Provided each turn of the coil is sized and oriented like the others, its contribution is simply additive; hence the coefficient N in front of the flux derivative. Notice the negative sign.

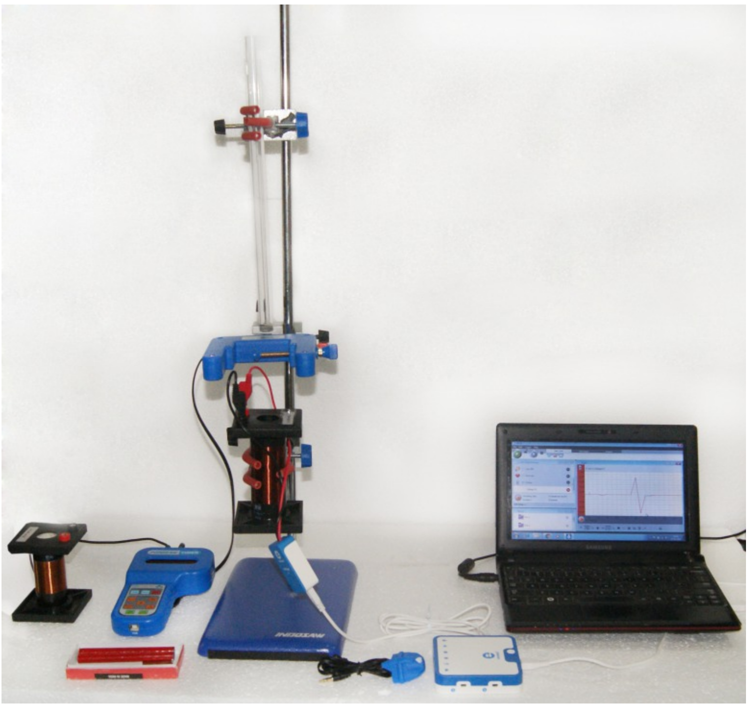
Lenz's Law states that the induced emf (and current) will be in a direction such that the induced magnetic field opposes the original magnetic flux change. Keep in mind that the induced current will now produce an induced magnetic field. The direction of that magnetic field will be opposite to the direction the flux is changing.



In the figure above, we see that the direction of the current changes. Lenz's Law helps us determine the DIRECTION of that current.

EXPERIMENTAL SETUPS:

1. Set up the experiment according to Figure on right.
2. Adjust the Photogate in such a manner that it is located directly above the coil the magnet must interrupt the light beam during its fall. Connect the Photogate to GATE-1 of the digital timer.
3. Connect the coil to voltage probe and Labmate to record the voltage pulse through PC.
4. The acrylic tube provides the magnet with reliable guidance and also insures a stable spinless fall even at larger fall heights.
5. Install the MiLAB Software.



PROCEDURE

1. Switch ON the digital timer and set MODE>SPEED>SELECT MASK>PRESS START/STOP KEY.
Set the length via UP arrow key and press START/STOP KEY to record the speed of falling object directly.
2. Start the software and set the Measuring time 0.5 Second and Sampling rate 1000 sample/sec. Set the Triggering point at 0.015 Volt.
3. Initially set the voltage ZERO and collect the data.
4. Introduce the tip of the magnet in the glass tube, let it fall; catch it with one hand under the coil. Read the velocity of falling magnet in timer.
5. Measure the total amplitude Up-p (peak to peak) of the induction voltage (Fig. below);

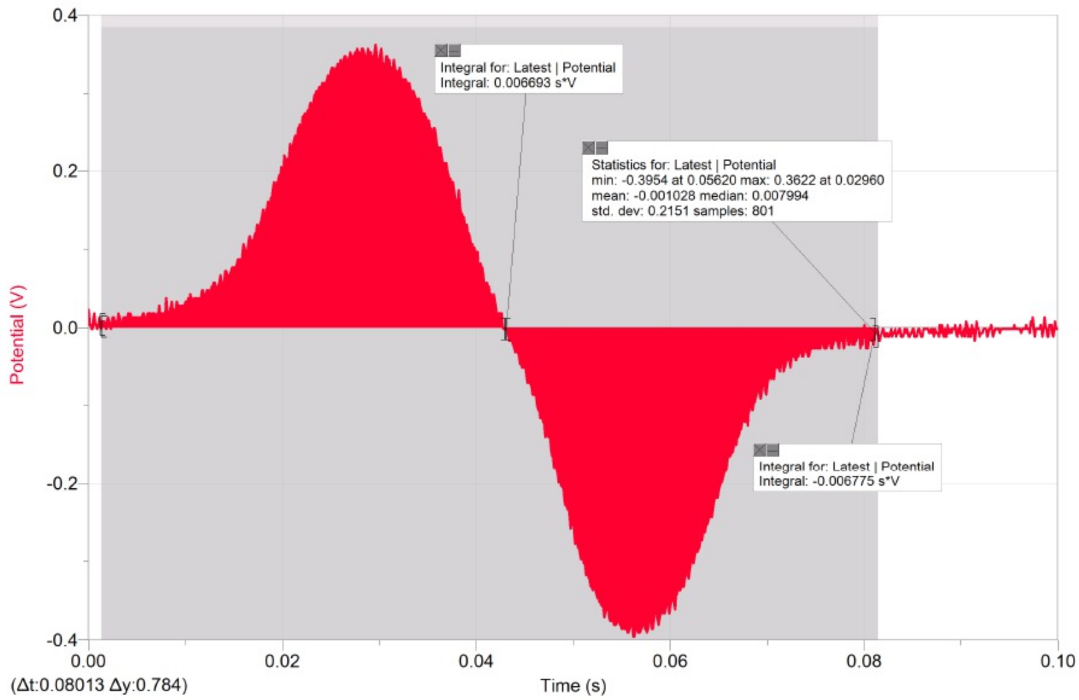
In this case: Up-p = Vmax + Vmin=0.3622+0.3954=0.7576Volt

Length of Magnet 50mm

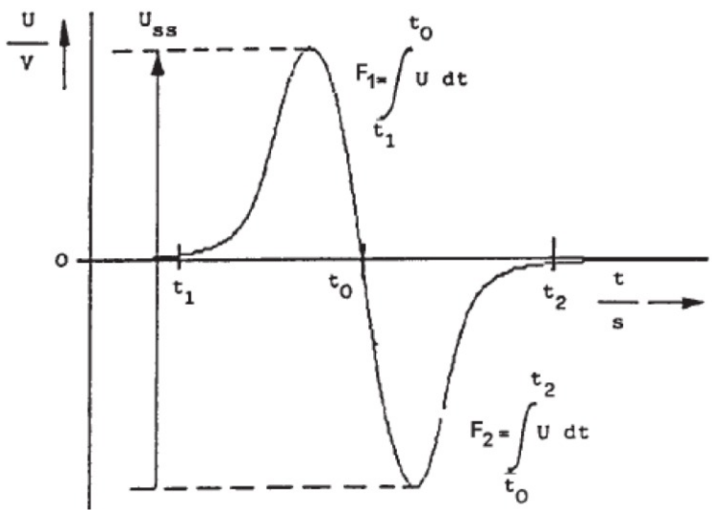
Speed of Falling Object: 2.34m/S

Area= F1+F2= 0.006693+0.006775=0.013468Vs

The area of V-T-graph represent the work done per unit induced current in the circuit.



6. Mark the positive (F1) and the negative (F2) parts of the curve separately (cf. Fig. below) Calculate the areas with the"Show integral" icon. Finally, add the values of the two partial areas.



7. Explanation of the shape- As the magnet is dropp ed the flux linked with the coil increases, and hence emf is induced in one direction. when the magnet moves when it is fully inside coil, the flux linked with coil becomes constant, so the induced emf is zero. As the magnet move out of the coil at the lower end flux decrease rapidly. The emf is induced in opposite direction. Far away from coil flux linked vanishes and induced emf become zero.

8. Negative peak is longer then the +ve peak because magnet move fastly, than when it moves into the coil.