Final Report

Faraday's Law

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Phys 102 - Section 11 - Group 9

6/05/19

Spring - 2019

Objective:

The main aim of this experiment is to find out the relation between the amplitude of generated AC current with the velocity of the magnet that passes through the coil and number of turns in the coil through the magnet is passed upon.

Theory:

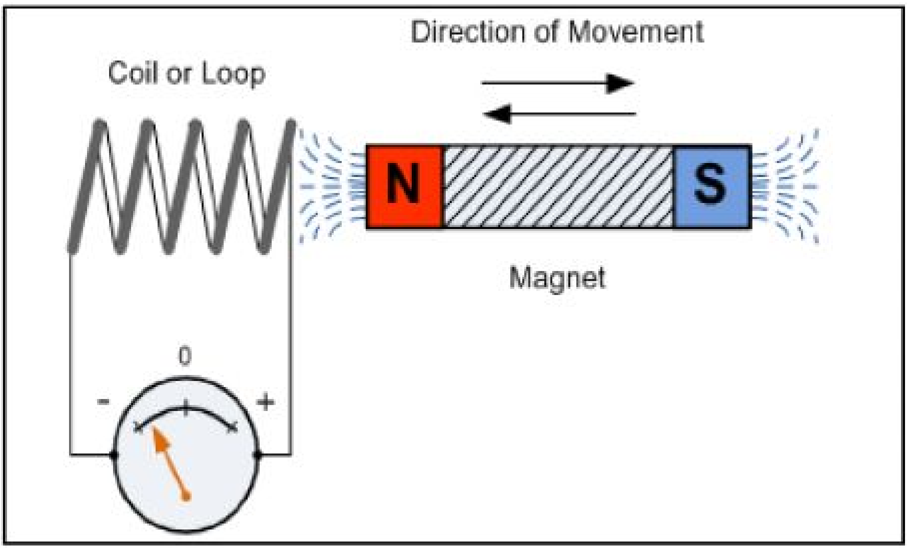
Faraday's law states that emf induced is proportional to the rate of change of the magnetic flux. The emf induced can be increased by increasing the number of turns of the coils.[3]

The concept we'll be experimenting upon is called Faraday's Law. We would be performing the experiment twice, once for to find the relation between increasing velocity and the amplitude of the current generated, while keeping the number of turns in coil constant, and the second time, keeping the velocity at which the magnet cuts through the magnetic flux constant, while variating the number of turns per coil. Given below is a list of apparatus we will be required to set up the experiment.

Formula 1: $\varepsilon = -N\Delta\Phi\Delta t$

Formula 2: $\varepsilon = IR$

Procedure:



Apparatus:

1. Rod-shaped magnet
2. Copper wire (10m)
3. Ammeter
4. Inextensible string
5. Video camera

We setup the coil in the shape of a cylinder and then we attach a magnet to a rod to provide movement to our magnet and then we connect both ends of the coil with an ammeter and then begin pulling up the magnet through a coil with a number of turns that would be connected to an Ammeter to calculate the change in current generated through the rate of change of magnetic flux due to the movement of the magnet.

To observe the ammeter reading and avoid possibility of human errors, we record slow-motion videos of the ammeter to record the readings and later on record them in the tables mentioned below.

For part one of the experiment since the speed of the magnet needs to be varied for data sets, so we move the magnet through the coil with different velocities and record any changes in the EMF generated.[2]

For the second experiment which will require us to find the relation between the generated current, and number of turns of the coil, would be done with the same method, but the speed with which the magnet is moved is constant, only the number of turns of coil, will be changed. Hence this will provide us with the related between the two.

We first record the reading of the ammeter by varying the number of turns of coil and keeping velocity roughly constant.

After that, we record the values of the Ammeter reading by keeping the number of turns constant and varying the velocity of magnets approach.

This way, we are able to plot the dependency of the x-axis independent (number of turns or velocity) with the y-axis dependent (ammeter reading) in the scenario.

Data and Results:

The Table for Experiment 1 (varying approach velocity of magnet with constant number of turns)

Number of turns (N)	Approach velocity of Magnet	Ammeter Reading (μA)
400	Very Slow	100
400	Slow	100
400	Moderate	100
400	Fast	100
400	Very Fast	100

Table for Experiment 2 (varying number of turns with constant velocity ie: moderate)

Number of Turns (N)	Ammeter Reading (A)
400	100
600	150
800	210
1000	260
1200	300
1400	340
1600	390

From the above tables we observe that a change in approach velocity of the magnet has not effect on the current induced in the coil and this can also be supported by the formula:

$$\varepsilon = \ -N\Delta\Phi\Delta t$$

Where the speed of approach is not a factor.

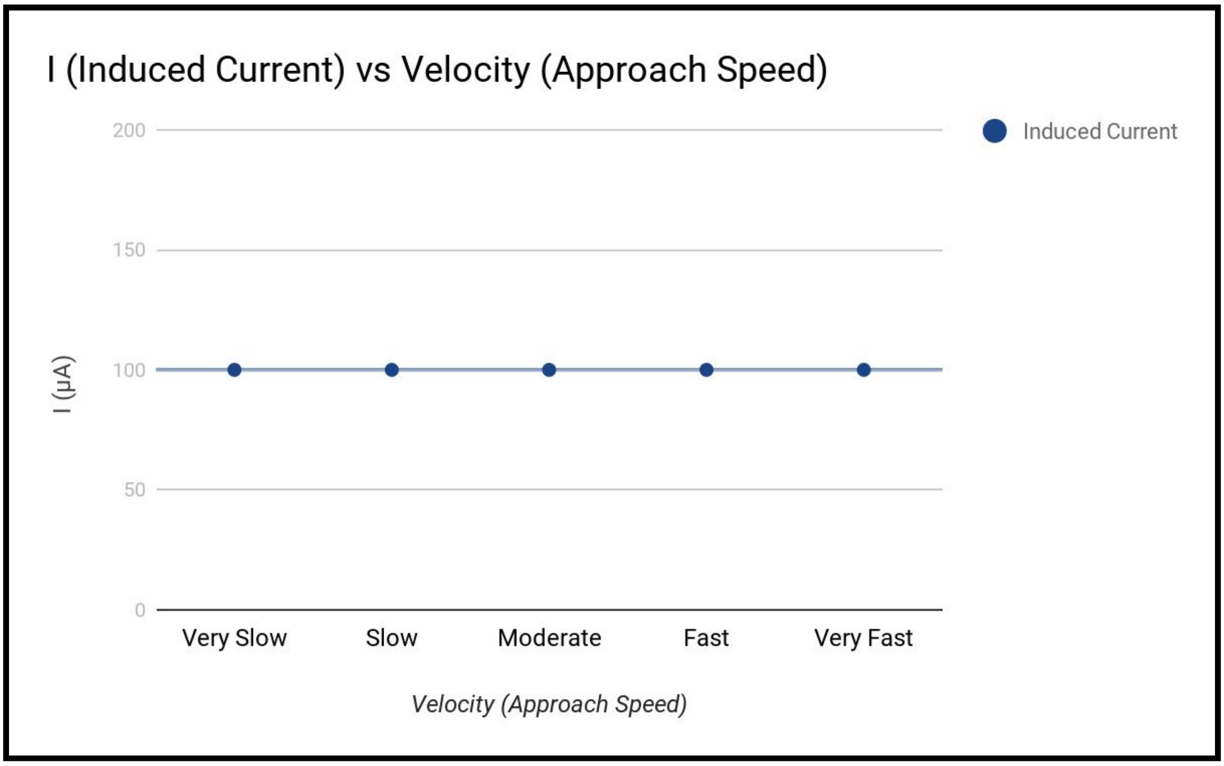
Furthermore, from Experiment 2, it is observed that the EMF induced increases linearly with increase in the number of turns in the coil.[3] This observation can also be supplemented by the above mentioned formula where the EMF induced is directly dependent on the number of turns of coil. Now, using the formula:

$$\varepsilon = IR$$

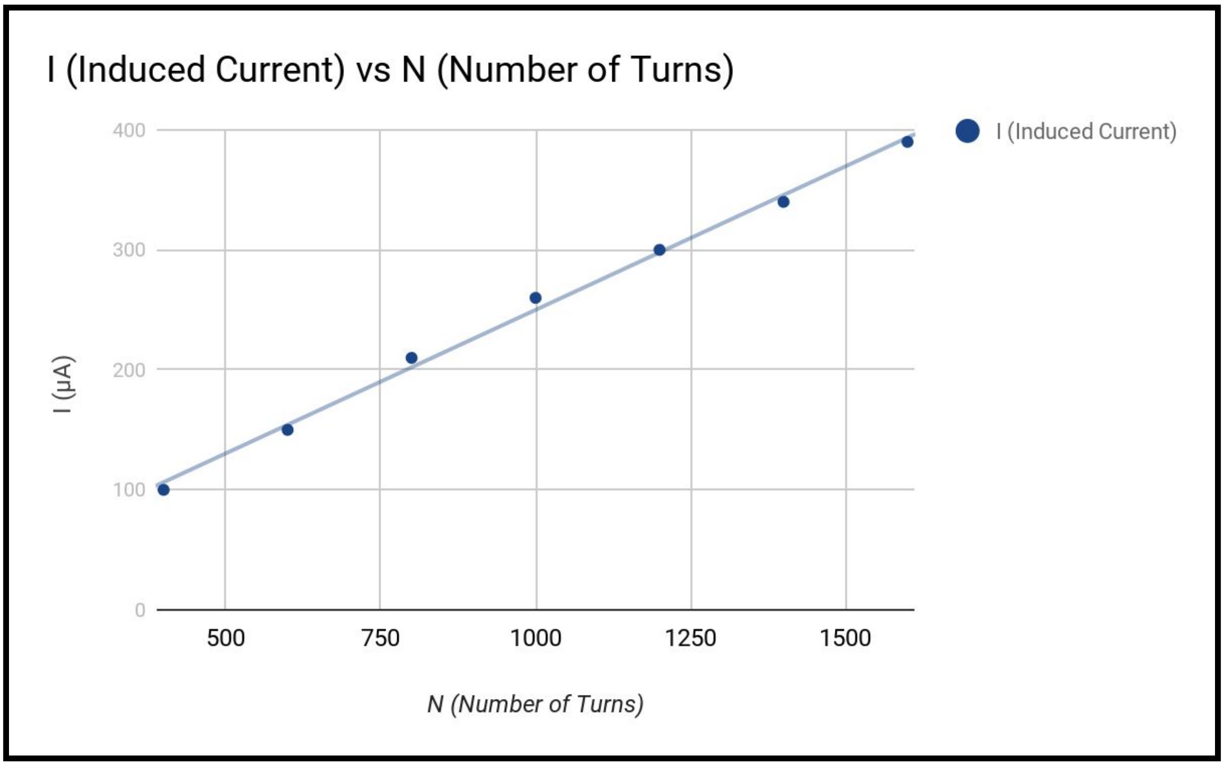
We can observe that the current induced in the coil is directly dependent on the EMF induced and since the EMF induced increases, the current induced does as well with increasing turns of coil.

$$IR = -N\Delta\Phi\Delta t$$

Plotting these graphs for our data provided with graph for 'Experiment 1' showing trend between current and approach velocity of magnet and the second graph for 'Experiment 2' showing trend between current induced and number of turns of coil.



Plot 1: I vs. approach velocity



Plot 2: I vs. N

From the above plots it is evident that there is not liable relation between the approach velocity of the magnet and the current induced. Furthermore, from Plot 2, it is shown that the current induced (I) in the coil is linearly dependent on the number of turns of coil (N).

Conclusion:

Since we can see that the Faraday's Law states that the EMF Induced is dependant upon the rate of change of magnetic flux and the number of turns in the coil (Formula 1 and 2 equated together to be used as an already derived relation between induced current and number of turns of coil). Meanwhile because EMF is directly proportional (as shown in plot of Experiment 2) to the N (number of turns in the coil), it will be produced greater Current upon greater number of coils, hence the relation between them is linear. Also, it was observed that the current induced is not dependent on the approach velocity of the magnet and hence, the graph is a constant line in plot of Experiment 1.

To account for the errors in readings and outlying points in the plots, the many possible errors may include: Inability to keep the velocity of approach constant in Experiment 1, Chance of inaccuracies in the analog ammeter used, Effects of external magnetic interference, unequal density of copper wire used, the unstable connection between the wire and the ammeter terminals (Needed to be scratched before connecting).

References:

1. http://demoweb.physics.ucla.edu/content/experiment-1-magnetic-fields-coils-and-faradays-law (used to identify the apparatus and arrangement)
2. https://byjus.com/physics/faradays-law/ (used to find relevant formulas and laws in the experiment)
3. Giancoli, 6th edition, Physics for Scientists and Engineers with Modern Physics, Person. (used for definition of Faraday's law and consultation in expected results and plotting of data)