Mississippi State University
Department of Physics and Astronomy
PH 2223 Lab

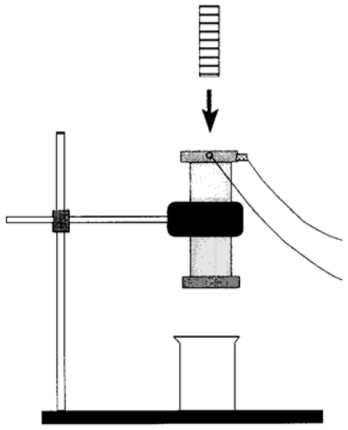
Faraday's Law of Induction

What is the law that determines the direction of flow of current in a wire loop when subjected to time varying magnetic flux? What does this law state? Write down the form of Faraday's Law of Electromagnetic induction (EMI) and indicate what each term means.

In this lab session, we shall measure the EMF created by EMI caused by a falling magnetic dipole. Data studio shall be used to measure the induced EMF accurately, but let us understand the theoretical structure here (roughly at least). Familiarize yourself with *Section 29.2* (P.996 - 997; Sears and Zemansky's University Physics, Ed.12). Magnetic field along the axis of a dipole is given by;

$B = \frac{\mu_o}{4\pi}\frac{2m}{z^3}$; where, **m** is the dipole magnetic moment, $\mu_o / 4\pi$ is the magnetic coupling constant and **z** is the distance (along the axis of the dipole) from the center of the dipole to the point of measurement Here we shall just consider the center point of the coil as the point of measurement. Also it will be assumed that the dipole can produce a uniform magnetic field (The spherical chicken strikes again!).

Fig.1: Schematic diagram of the experimental setup to demonstrate EMI (Assume N to be on the bottom side of the magnet).



1. Let the radius of coil be 2cm. Calculate its area **A**. Find the magnetic flux ϕ_B.
2. Differentiate ϕ_B w.r.t time. Express $d\phi_B / dt$ in terms of velocity (***v***) of the falling dipole.

(Hint: Chain rule; first differentiate ϕ_B w.r.t **z** and then **z** w.r.t **t**. $dz/dt = v$) $|V| = \frac{\mu_o}{4\pi}\frac{6mAv}{z^4}$

3. So you got the EMF! Now let us put in some numbers. If the coil had 1000 turnings, **m** = ½Am^{-2}, assuming the bar magnet was dropped from a height of 1m calculate the value of ***v***, and with the optimum proximity value of **z** as 2cm calculate the maximum EMF that could be got out of this setup.

Challenge

Fix the values of number of turnings **N** of the coil, area of the coil, optimum proximity value of **z** and the value of value of **m** if we assumed our model of calculation is prefect using your experimental data. As you might see, our calculation doesn't match. What could we have done wrong?