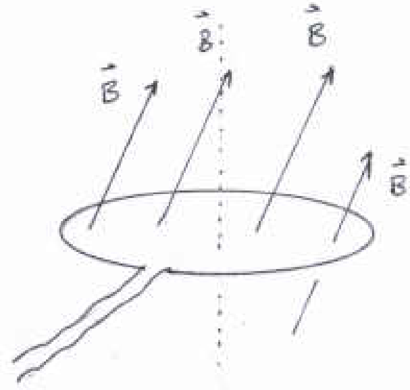
Name________________________________

Phys 2120, Section 3
Quiz #5 — Spring 2003



1. A planar circular loop of wire with a radius of 6.00 cm lies within a uniform magnetic field whose direction is at 35.0° from the normal to the plane of the loop.

The magnitude of the magnetic field changes linearly from 0.300 T to 0.100 T in 0.200 s.

What is the magnitude of the emf induced in the loop during this time interval?

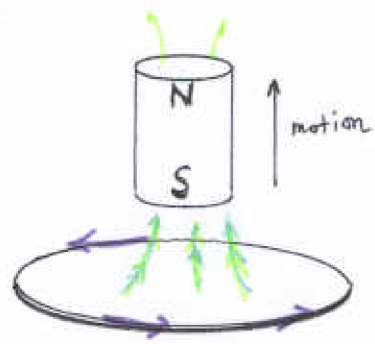
change in flux is

$$\Delta\Phi_B = \Delta(BA\cos\phi) = (\Delta B)A\cos\phi \quad w/ \quad A = \pi r^2 = \pi(6.00\times10^{-2}\,m)^2 = 1.13\times10^{-2}\,m^2$$

mag. of induced emf is

$$\mathcal{E} = N\frac{\Delta\Phi_B}{\Delta t} = 1\cdot\frac{(\Delta B)A\cos\phi}{\Delta t} = \frac{(0.200\,T)(1.13\times10^{-2}\,m^2)\cos 35^\circ}{(0.200\,s)}$$

$$= \boxed{9.3\times10^{-3}\,V}$$



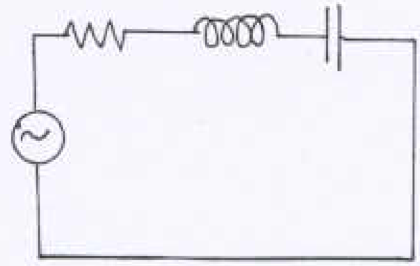
2. A permanent magnet with its South pole pointing downward pulled upward, away from a loop of wire as shown. (The loop of wire comes "out of the page" as I have tried to show.)

Indicate the direction of the induced current and using Lenz's Law, *carefully explain* why you made this choice.

Induced current goes as shown: counter-clockwise as seen from the top.

Since $\vec{B}$ field lines go toward the S pole of a magnet, the flux thru the loop is upward but decreasing (since the magnet is moving away). To oppose this change the induced current should make an upward flux. By the second Right-Hand-Rule, the indicated current does this.

3. An AC generator has a maximum voltage of 150. V and a frequency of 60.0 Hz. It is connected in series to a 200. Ω resistor, a 300. mH inductor and a 7.50 μF capacitor.



Find the amplitude of the current in the circuit.

Reactances of the elements are:

$$L: \quad X_L = \omega L = 2\pi f L = 2\pi (60\, s^{-1})(300\times 10^{-3}\, H)$$

$$= 113.1\, \Omega$$

$$C: \quad X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C} = \frac{1}{2\pi (60\, s^{-1})(7.50\times 10^{-6}\, F)} = 353.7\, \Omega$$

Impedance of circuit is:

$$Z = \sqrt{R^2 + (X_L - X_C)^2} = 313\, \Omega$$

Amplitude of current is:

$$I = \mathcal{E}_m / Z = \frac{(150\, V)}{(313\, \Omega)} = \boxed{0.479\, A}$$

You must show all your work and include the right units with your answers!

$$\Phi_B = BA\cos\phi \qquad \mathcal{E} = -N\frac{d\Phi_B}{dt} \qquad L = \frac{N\Phi_B}{i} \qquad L_{\text{sol}} = \mu_0 n^2 A l \qquad \mathcal{E} = -L\frac{di}{dt}$$

$$i = \frac{\mathcal{E}}{R}\left(1 - e^{-t/\tau_L}\right) \qquad \tau_L = \frac{L}{R} \qquad i = i_0 e^{-t/\tau_L}$$

$$f = \frac{\omega}{2\pi} \qquad X_L = \omega L \qquad X_C = \frac{1}{\omega C} \qquad V_R = IR \qquad V_L = IX_L \qquad V_C = IX_C$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2} \qquad \mathcal{E}_m = IZ$$

$$I_{rms} = \frac{I}{\sqrt{2}} \qquad \tan\phi = \frac{X_L - X_C}{R} \qquad P_{\text{avg}} = I_{\text{rms}}^2 R = \mathcal{E}_{\text{rms}} I_{\text{rms}}\cos\phi \qquad \omega = \frac{1}{\sqrt{LC}}$$