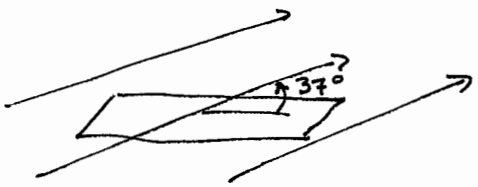
Practice Exam #3 **PS250**
June 23, 2006 Dr. Darrel Smith

Show your work !!

Answer Key
Name

10 points

1. A rectangular copper loop 5.00 cm by 20.0 cm is located in a region of changing magnetic field. The direction of the magnetic field makes an angle of 37° with the plane of the loop. The time-changing field has the following time dependence: $B(t) = 0.10\ T + (1.00 \times 10^{-3}\ T/s)\ t$. Find the induced emf in the copper loop for times $t>0$.



$$\Phi = \vec{B}\cdot\vec{A} = BA\cos 53^\circ$$

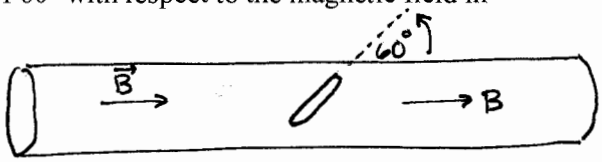
$$\frac{d\Phi}{dt} = \left(\frac{dB}{dt}\right) A\cos 53^\circ = 1.00\times10^{-3}\left(100\times10^{-4}\ m^2\right)\cos 53^\circ$$

$$|\mathcal{E}| = \frac{d\Phi}{dt} = 6.02\times10^{-6}$$

emf = 6.02×10^{-6} volts

10 points

2. A long, narrow solenoid with radius 2.50 cm and 1000 turns/meter has a thin circular copper wire of radius 1.50 cm centered on the axis of the solenoid. The time rate of change of the current in the solenoid is 60 A/m. If the plane of the thin copper wire makes an angle of 60° with respect to the magnetic field in the solenoid, calculate the following:



a. The induced emf in the thin circular copper wire.

$$\Phi = \vec{B}\cdot\vec{A} = BA\cos\theta = BA\cos 30^\circ$$

$$|\mathcal{E}| = \frac{d\Phi}{dt} = \left(\frac{dB}{dt}\right) A\cos 30^\circ = \left(n\mu_0\frac{dI}{dt}\right) A\cos 30^\circ = 1{,}000\left(4\pi\times10^{-7}\right) 60\,\frac{A}{m}\,\pi\left(1.5\times10^{-2}\ m\right)^2 \cos 30^\circ$$

$$|\mathcal{E}| = 4.62\times10^{-5}\ \text{volts}$$

$$= 46.2\times10^{-6}\ \text{volts}$$

emf = 46.2 μV

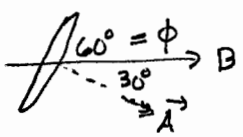
b. The current induced in the thin circular copper wire if the resistance of the wire is 0.020 Ω.

$$I = \frac{|\mathcal{E}|}{R} = \frac{46.2\times10^{-6}\ V}{.02\ \Omega} = 2.31\times10^{-3}\ A$$

$$= 2.31\ mA$$

I = 2.31 mA

c. If you want to reduce the emf by a factor 2, what angle should you position the plane of the copper wire with respect to the magnetic field?



$$\frac{\cos\theta}{\cos 30^\circ} = \frac{1}{2} \qquad \cos\theta = \frac{1}{2}\cos 30^\circ$$

$$\theta = \cos^{-1}\left(\frac{1}{2}\cos 30^\circ\right)$$

$$\theta = 64.3^\circ \qquad \phi = 90 - 64.3^\circ = 25.66^\circ$$

ϕ = 25.66° degrees