Practice Exam #4

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Name: _____

Problem	Grade	Points Possible
1		5
2		5
3		5
4		15
5		15
6		15
Total		60

$$x(t) = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$$
$$v_x(t) = v_{0x} + a_x t$$
$$v_{fx}^2 = v_{0x}^2 + 2a_x\Delta x$$
$$a_c = \frac{v^2}{r}$$
$$\sum_i \vec{F}_i = m\vec{a} = \frac{d\vec{p}}{dt}$$
$$\vec{p} = m\vec{v}$$

$$\epsilon_0 = 8.85 \times 10^{-12}$$

$$V_b - V_a = -\int_a^b \vec{E}\cdot d\vec{s}$$
$$V = \frac{1}{4\pi\epsilon_0}\frac{q}{r}$$
$$\vec{E} = -\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$$
$$\vec{F}_B = q\vec{v}\times\vec{B}$$
$$F_B = qvB\sin(\theta)$$
$$\vec{F}_B = i\vec{L}\times\vec{B}$$
$$\vec{\tau} = \vec{\mu}\times\vec{B}$$
$$\vec{\mu} = Ni\vec{A}$$
$$v = E/B$$

$$U_E = \frac{q^2}{2C} = \frac{1}{2}CV^2$$
$$U_B - \frac{1}{2}Li^2$$
$$\tan(\phi) = \frac{X_L - X_C}{R}$$

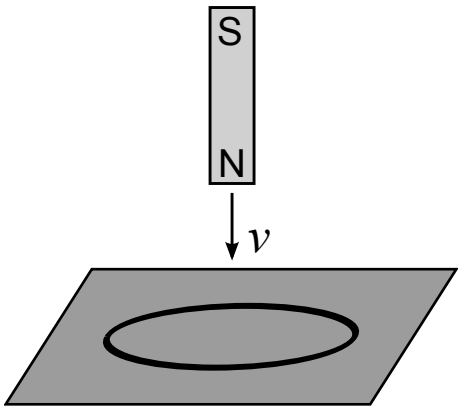
$$\vec{F}_q = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2}\hat{r}$$
$$\vec{E}_q = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r}$$
$$\vec{F}_q = q\vec{E}$$
$$\vec{p} = q\vec{d}$$
$$\vec{\tau}_p = \vec{p}\times\vec{E}$$
$$U_p = -\vec{p}\cdot\vec{E}$$
$$E_p(z) = \frac{1}{2\pi\epsilon_0}\frac{p}{z^3}$$
$$\Phi_E = q_{enc}/\epsilon_0$$
$$\Phi_E = \oint \vec{E}\cdot d\vec{A}$$
$$\Phi_B = \oint \vec{B}\cdot d\vec{A}$$

$$i = \frac{dq}{dt}$$
$$i = \int J dA$$
$$V = iR$$
$$V = q/C \text{ or } C = q/V$$
$$\tau_C = RC$$
$$\tau_L = L/R$$
$$C = \frac{\epsilon_0 A}{d}$$
$$C_{eq} = C_1 + C_2 + ...$$
$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + ...$$
$$R_{eq} = R_1 + R_2 + ...$$
$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + ...$$

$$\vec{B} = \frac{\mu_0 i}{4\pi}\int \frac{d\vec{s}\times\hat{r}}{r^2}$$
$$\oint \vec{B}\cdot d\vec{s} = \mu_0 i_{enc}$$
$$B = \frac{\mu_0 i}{2\pi R}$$
$$B = \frac{\mu_0 i\phi}{4\pi R}$$
$$B = \mu_0 ni$$
$$B = \frac{\mu_0 Ni}{2\pi}\frac{1}{r}$$
$$B(z) = \frac{\mu_0 i R^2}{2(R^2+z^2)^{3/2}}$$
$$\vec{B}(z) = \frac{\mu_0}{2\pi}\frac{\vec{\mu}}{z^3}$$
$$n = N/L$$

$$\mathcal{E} = -\frac{d\Phi_B}{dt}$$
$$L = \frac{N\Phi_B}{i}$$
$$\mathcal{E} = -L\frac{di}{dt}$$
$$\mathcal{E}_{\{1,2\}} = -M\frac{di_{\{2,1\}}}{dt}$$
$$q(t) = Q\cos(\omega t + \phi)$$
$$q(t) = Qe^{-t/2\tau_L}\cos(\omega' t + \phi)$$
$$\omega = \sqrt{1/LC}$$
$$\omega' = \sqrt{\omega^2 - (R/2L)^2}$$
$$I = \mathcal{E}_m/Z$$
$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$
$$X_L = \omega_d L$$
$$X_C = 1/\omega_d C$$

Question 1: Find the direction of the induced emf in the following figure:



Question 2: A charged capacitor and an inductor are connected in series. At time $t = 0$ the current is zero and the capacitor is charged. If T is the period of the resulting oscillations, find the next time that the energy stored in the electric field of the capacitor is a maximum. Write your answer in terms of T.

Question 3: When the amplitude of the applied emf in a series RLC circuit is doubled,

(a) the impedance is doubled.

(b) the voltage across the capacitor is halved.

(c) the capacitive reactance is halved.

(d) the current amplitude is doubled.

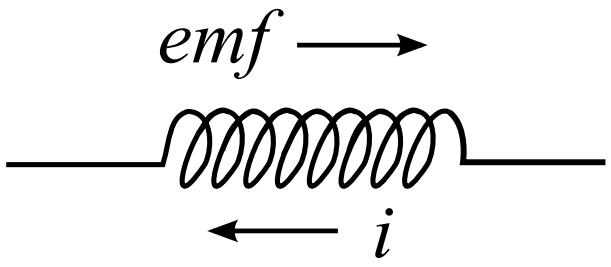
Question 4: A teeter-totter that has dimensions of 0.25 m $\times$ 3 m has a decorative metal rim along its border. Two college students are goofing around on the teeter-totter when the sun explodes; the explosion generates a roughly uniform and constant magnetic field $B = 1$ T straight toward the earth. If the angle of the teeter-totter is given by $\theta(t) = (\pi/6)\sin(2\pi t)$, measured from horizontal, what is the induced emf in the metal loop on the teeter-totter?

Question 5: At a given moment, the current through an inductor points to the left and the induced emf points to the right, as shown in the figure below.

(a) Is the current increasing, decreasing or staying the same?

(b) If the induced emf is 5 mV and the change in current is 10 A/s, find the inductance of the inductor.

(c) When paired with a capacitor of $C = 0.1\ \mu$F and a resistor of $R = 100\,\Omega$, what is the natural frequency of the resulting RLC circuit?



Question 6: In a driven RLC circuit, the maximum applied emf is 125 V and the maximum current is 3.20 A. If the current leads the applied emf by $\phi = 0.982$ rad, find

(a) the impedance, and

(b) the resistance.

(c) Is the circuit inductive ($X_L > X_C$) or capacitive ($X_C > X_L$)?