

PHY2054 TEST III

Name _____ Panther ID _____

MULTIPLE CHOICE (8 points each). Choose the one alternative that best completes the statement or answers the question.

- 1) An RL circuit consists of a switch, an emf source ϵ_0 , a $5.0 \text{ k}\Omega$ resistor, and a 4.0 H inductor. If the potential across the resistor is 65.0 V at 2.0 ms after the switch is closed, find the source emf, ϵ_0 . 1) _____
 A) 56 V B) 71 V C) 76 V D) 36 V

- 2) A 5 H inductor carries a current of 2 amps . How can a self-induced EMF of 50 volts be made to appear across the inductor? 2) _____
 A) Change the current to 10 amps .
 B) Break the circuit instantaneously.
 C) Change the current at the rate of 10 amps/sec .
 D) Change the current uniformly to zero in 20 seconds .
 E) None of these.

- 3) An RLC circuit has a resistance of $2.0 \text{ k}\Omega$, a capacitance of $8.0 \mu\text{F}$, and an inductance of 9.0 H . If the frequency of the alternating current is $4.0/\pi \text{ kHz}$, what is the phase shift between the current and the voltage? 3) _____
 A) 36 rad B) -1.6 rad C) 3.1 rad D) 1.5 rad

- 4) A large electromagnet has a 22 T magnetic field between its poles. What is the magnetic energy density between the poles? 4) _____
 A) 190 J/cm^3 B) $30,000 \text{ J/cm}^3$ C) 240 J/cm^3 D) 88 J/cm^3

- 5) The current flowing through a circuit is changing at a rate of 6.00 A/s . If the circuit contains a 190.0 H inductor, what is the emf across the inductor? 5) _____
 A) 1140 V B) $\frac{3}{95} \text{ V}$ C) $\frac{1}{190} \text{ V}$ D) $31\frac{2}{3} \text{ V}$

- 6) When light travels from air into water, 6) _____
 A) its velocity, wavelength and frequency all change.
 B) its velocity and wavelength change, but its frequency does not change.
 C) its velocity changes, but its frequency and wavelength do not change.
 D) its wavelength changes, but its velocity and frequency do not change.
 E) its frequency changes, but its velocity and wavelength do not change.

- 7) For a series $R-L-C$ circuit with a resistance of $13.0 \text{ k}\Omega$, a capacitance of $7.0 \mu\text{F}$, and an inductance of 35.0 H , what frequency is needed to minimize the impedance? 7) _____
 A) 0.064 kHz B) 2.1 kHz C) 0.010 kHz D) 12 kHz

- 8) If the voltage amplitude across an $8.50\text{-}\mu\text{F}$ capacitor is equal to 12.0 V when the current amplitude through it is 3.33 mA , the frequency is closest to: 8) _____
 A) 32.6 kHz B) 5.20 kHz C) 5.20 Hz D) 32.6 Hz E) 32.6 MHz

- 9) In a series $L-R-C$ circuit, the resonance frequency is f_0 . If you double the resistance, the inductance, the capacitance, and the voltage amplitude of the ac source, the new resonance frequency is: 9) _____
 A) $f_0/2$ B) f_0 C) $4f_0$ D) $2f_0$ E) $f_0/4$

- 10) At a certain instant in time, an electromagnetic wave has \vec{E} in the $-z$ direction and \vec{B} in the $+y$ direction. In what direction does the wave propagate? 10) _____
- A) $-x$ direction B) $+x$ direction C) $+y$ direction D) $-z$ direction E) $+z$ direction

Regular problems (10 points each)

11)

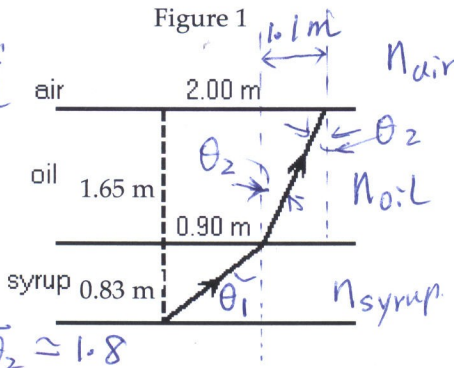
$$\theta_2 = \theta_{\text{critical}} = \sin^{-1} \frac{n_{\text{air}}}{n_{\text{oil}}}$$

$$\sin \theta_2 = \frac{1.01}{\sqrt{(1.01)^2 + (1.65)^2}}$$

$$= 0.5547$$

$$\theta_2 = 33.6^\circ$$

$$n_{\text{air}} = 1 \rightarrow n_{\text{oil}} = \frac{1}{\sin \theta_2} \approx 1.8$$



A tank holds a layer of oil, 1.65 m thick, which floats on a layer of syrup that is 0.83 m thick as shown in Figure 1. Both liquids are clear and do not intermix. A ray, which originates at the bottom of the tank on a vertical axis, crosses the oil-syrup interface at a point 0.90 m from the axis. The ray continues and arrives at the oil-air interface, 2.00 m from the axis and at the critical angle. Find the index of refraction of the syrup.

$$\sin \theta_1 = \frac{0.9}{\sqrt{(0.9)^2 + (0.83)^2}} = 0.735$$

$$n_{\text{syrup}} \sin \theta_1 = n_{\text{oil}} \sin \theta_2 \rightarrow n_{\text{syrup}} = n_{\text{oil}} \frac{\sin \theta_2}{\sin \theta_1}$$

$$= 1.36$$

- 12) A series ac circuit consists of a voltage source of frequency $f = 60$ Hz and source voltage amplitude 345 volts, a resistor of resistance $R = 393 \Omega$, a capacitor of capacitance $C = 2.7 \times 10^{-6}$ F, and an inductor of inductance L .

- (a) What must be the value of L for the phase angle Φ to be zero?
 (b) When L has the value calculated in (a), what is the current amplitude in the circuit?

$$f_0 = 60 \text{ Hz}, V = 345 \text{ (V)}, R = 393 \text{ (\Omega)}, C = 2.7 \times 10^{-6} \text{ F}$$

a) If the phase $\Phi = 0$, then $X_L - X_C = 0$, on resonance,

$$\omega_0 = 2\pi f_0 = \frac{1}{\sqrt{LC}} \rightarrow L = \frac{1}{\omega_0^2 C} = 2.6 \text{ (H)}$$

b) On resonance, $I = \frac{V}{Z} = \frac{V}{R} = 0.878 \text{ (A)}$
 $R = Z$