PHYS 222 Examination 3

Name (print): _____

Signature _____

Problem 1 _____

Problem 2 _____

Problem 3 _____

Problem 4 _____

Problem 5 _____

Problem 6 _____

Total _____

Directions: Time allowed: 2 hours. There are six problems worth 20 points each. You may work all six problems for 120/100 possible points. Materials allowed: CRC or other approved math handbook (highly recommended), any math reference book you wish to use, an 8.5" x 11" sheet of paper for formulas, your calculator. Feel free to ask for help. You may leave the room at any time provided you are not gone for more than a couple of minutes, and do not take anything with you. Good Luck!

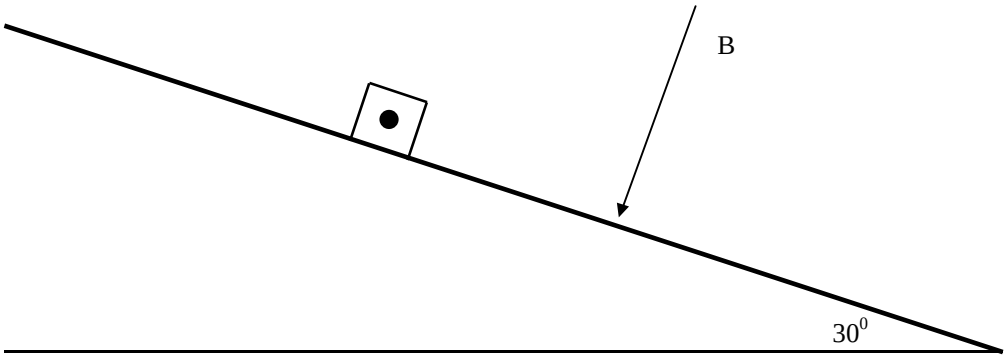
Problem 1. Short Answer

- Explain how the pickups of an electric guitar convert the oscillations of a vibrating string to an amplified musical sound.

- Explain the relationship between the current and the voltage in the transient phase of a capacitive DC circuit.

- How did Maxwell “adjust” Ampere’s Law and why did he do it?

Problem 2. A 0.5 kg metal rod lies across twin metal rails 1 meter apart as shown below (side view). The rails are inclined at an angle of 30^0 to the horizontal. The coefficient of static friction between the rails and the metal rod is 0.6. If a magnetic field of 10 Tesla is directed *downward* at an angle of 60^0 to the horizontal, the current flows through the bar out of the plane of the page, what must the magnitude of the current be in order to get the rod to move? In what direction does the bar move?



Problem 3. A series RLC circuit has the following values:

$R = 350\Omega$
$L = 1.8$ H
$C = 5.5$ *m*F
$w = 377\ s^{-1}$
$V_m = 150$ VAC

(a) What is the impedance of this circuit?

(b) What is the maximum current in this circuit?

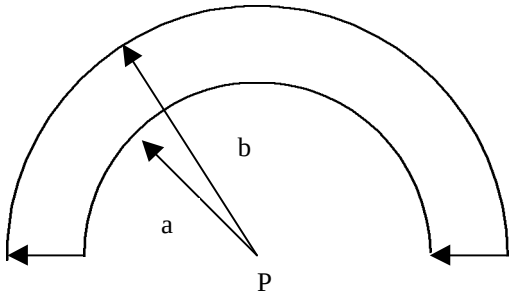
(c) What is the phase relationship between the voltage and the current in this circuit? Is the circuit inductive or capacitive? Draw a phasor diagram showing $\mathbf{V}_R$, $\mathbf{V}_L$, $\mathbf{V}_C$, $\mathbf{V}_{total}$, and $\mathbf{I}_{max}$, and the instantaneous values of these quantities when $wt = \pi/4$ radians (45^0).

(d) Find the peak voltage across each element. What is the relationship between the sum of the peak voltages with the peak applied voltage? Explain.

(e) Find the instantaneous voltage across each element at t = 0.002083 seconds. What is the relationship between the sum of the instantaneous voltages across each element, and the applied voltage? Explain.

(f) What is the resonant frequency of this circuit?

4. Use Biot Savart to determine the magnetic field at point ***P*** of the configuration below.



Problem 5. A circular loop of radius R consists of N turns of wire. This loop is penetrated by a magnetic field perpendicular to the plane of the loop of magnitude $B = B_0\left(1-\frac{r}{2R}\right)\cos wt$, where R is the radius of the loop and r is measured from the center of the loop.

a) Sketch this arrangement
b) Determine the induced emf in the loop.

Problem 6. Derive an expression for the induced emf due to the rotating loop shown at the right in terms of *wt*. The ***B*** field is directed upward along the *z* axis. Which direction does the induced current flow? At what value of *q* does the does the induced emf have its maximum value?