Physics 1021 - Fall 2011. Final Exam.

NAME ____________________________

STUDENT NUMBER __________________

December 13^{th},2011

Time: 2 Hours

Instructor: Dr. Ania Harlick

INSTRUCTIONS

1. There are eight questions, each consisting of short theory part and a problem solving part. **Answer all the questions**.
2. The amount of points awarded for each question is in the bracket next to it. Budget your time accordingly.
3. Do not erase or "whiteout" your answers. Draw a line through what you think is wrong and continue your calculations
4. Please use THREE significant figures in all calculations.
5. RELAX. GOOD LUCK. DON'T PANIC.

Q	Q I	Q II	Q III	Q IV	Q V	Q VI	Q VII	Q VIII	**T**
Score									
Max	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	100

Question I

1. Sketch a graph showing restoring force $\overrightarrow{F}$ of an ideal spring as a function of displacement $\overrightarrow{x}$ of the unstrained spring form equilibrium. [2.5 points]

2. A mass m is attached to the spring of spring constant $k = 632$ N/m. The string is then stretched 4.85 cm and released from the rest. The period of oscillation is measured to be $T = 0.125$ s.

a) Determine amplitude and angular frequency of this motion? [3 points]

b) Determine the mass of the particle. [2 points]

c) Determine the maximum speed of the mass. [2 points]

c) Determine the speed of the mass when it's at the position $x = 3.45$ cm. [3 points]

Question II

1. Why don't two carol singers sound twice as loud as one carol singer? [2.5 points]

2. You are flying an ultra-light aircraft at a speed of 39.0 m/s. An eagle, whose speed is 18.0 m/s is flying directly towards you. The eagle emits a shrill cry, and you hear the sound of frequency 4020 Hz. The speed of sound is 330 m/s.

a) What is the frequency of the shrill cry emitted by the eagle? [4 points]

b) After a while you realize the eagle is flying behind you in the same direction as you. If it emits the same shrill cry, what frequency will you hear? [4 points]

c) If the power of the sound emitted by the eagle is $6.43 \cdot 10^{-3}$ W, what is the sound intensity at distance 4.00 m away from it? [3 points]

Question III

1) Sketch first three standing waves which are possible in a tube opened at one end and closed at the other. [2.5 points]

2. Two strings of equal length $L = 0.750$ m are clamped at each end and vibrate with the same harmonic and under the same tension. The first string has mass $m = 45.0$ g and vibrates at frequency $f = 400$ Hz. The second string is slightly lighter, so that when both strings are vibrating together beats with frequency of 5.00 Hz are heard.

a) What is the linear mass density of the first string? [2 points]

b) If the strings vibrate in fundamental harmonics, what is the speed of the wave in the first string? [3 points]

c) What is the tension on the strings? [3 points]

d) What is the vibrational frequency of the second string? [2 points]

Question IV

1. A tank is closed completely and filled with water. A valve is opened in the bottom of the tank and the water begins to flow out. When the water stops flowing, will the tank be completely empty or would there still be a noticeable amount of water in it? Justify your answer. [2.5 points]

2. Robinson Crusoe makes an attempt to escape from a deserted Pacific Island on a raft made from coconut timber ($\rho = 600$ kg/m^3) of dimensions 1.00 m by 2.00 m by 0.200 m. The draft is built to hold Robinson Crusoe ($m_{RC} = 60.0$ kg) and some of his possessions. ($\rho_{seawater} = 1025$ kg/m^3)

a) What is the mass of the raft? [3 points]

b) Draw the free body diagram of the raft and its cargo, clearly indicating all the forces. [3 points]

c) Determine the maximum mass of the cargo that causes the draft to be completely immersed. [4 points]

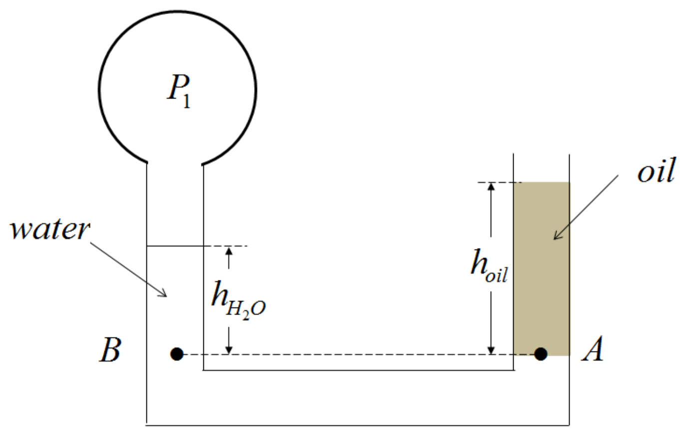
Question V

1. State Pascal's Principle. [2.5 points]

2. A U-tube shown in the diagram contains water and olive oil ($\rho_{oil} = 913$ kg/m^3). The cross sectional area of the tube $A = 7.00 \cdot 10^{-4}$ m^2. The pressure in the bulb is 1% higher than the atmospheric pressure. The height of the column of oil is measured to be $h_{oil} = 0.168$ m.

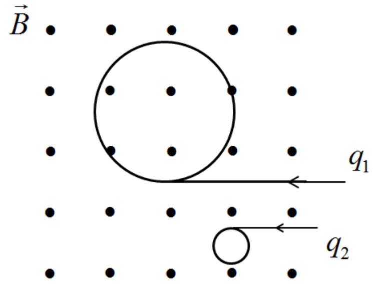
a) Calculate pressure due to the column of oil at point A. [4 points]

b) Determine the height h_{H_2O} of the water column in the left hand side of the tube. [6 points]



Question VI

1. Two equally massive particles, q_1 and q_2, enter magnetic field as shown. Identify the sign of charge on each particle and determine which particle has charge of higher magnitude. [2.5 points]

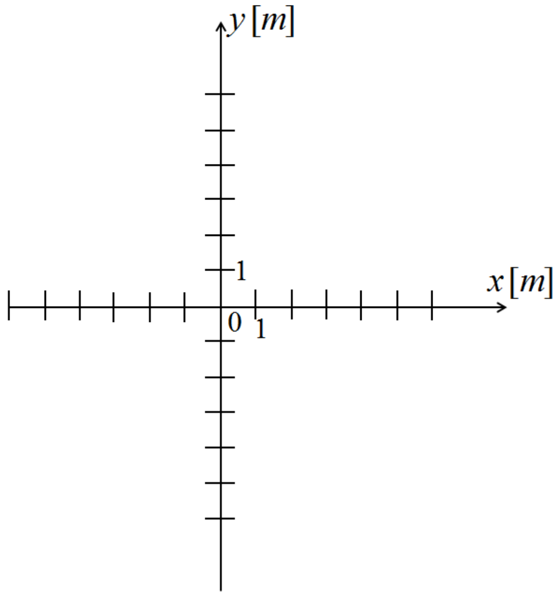


2. The uniform electric field in certain region of the space is $\overrightarrow{E} = -20.0$ N/C $\hat{y}$.

a) Draw the electric field. [2 points]

b) If electric potential at $y = 1.00$ m is -100 V, where the electric potential is zero? Draw both equipotential lines on the diagram. [4 points]

c) What is the work done by the field when moving a proton from $y_A = -2.00$ m to $y_B = 3.00$ m? [4 points]



Question VII

1. Three charges q_1, q_2 and q_3 are located in space as shown on the diagram.

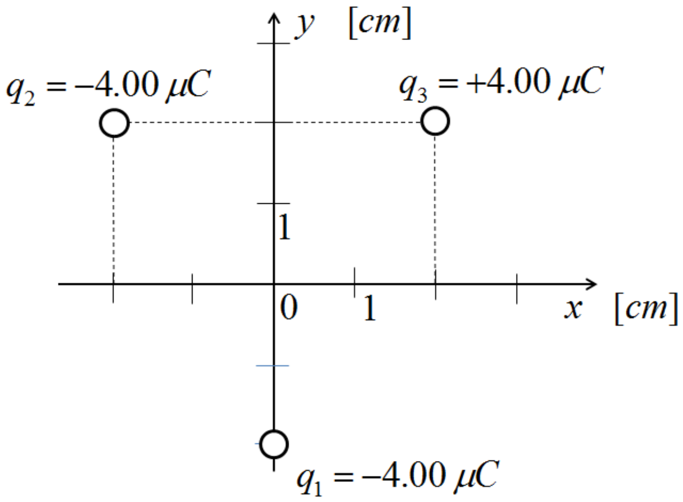
a) Draw and calculate the electric field vector $\overrightarrow{E_1}$ **at the origin** due to charge q_1 [2.5 points]

b) Draw and calculate the electric field vector $\overrightarrow{E_2}$ **at the origin** due to charge q_2 [2.5 points]

c) Draw and calculate the electric field vector $\overrightarrow{E_3}$ **at the origin** due to charge q_3 [2.5 points]

d) Determine the total electric field at the origin [2.5 points]

e) Determine a vector of electric force acting on the proton placed in the origin. [2.5 points]



Question VIII

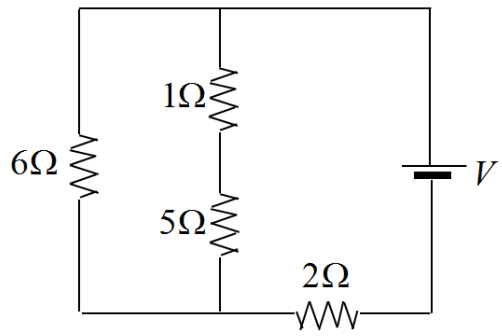
1. If you plot a graph of voltage versus current for an ohmic material, what would you expect to get for the slope and intercept? [2.5 points]

2. In the circuit shown the current through the 2.0 Ω resistor is 3.0 A.

a) The equivalent resistance R_{eq} of the circuit. [4 points]

b) The voltage of the battery. [3 points]

c) The power dissipated by the 6.0 Ω resistor. [3 points]



Useful Formulae and Constants

$F_s = -kx$	$v = \sqrt{\frac{F_T}{\mu}}$	$\rho = \frac{m}{V}$	$U = \frac{k_e q_1 q_2}{r}$
$x = A\cos\omega t$	$\mu = \frac{m}{L}$	$P = \frac{F}{A}$	$\Delta U = q\Delta V$
$v = -A\omega\sin\omega t$	$I = \frac{P}{A}$	$F_B = \rho V g$	$W_{AB} = -\Delta U$
$a = -A\omega^2\cos\omega t$	$I = \frac{P}{4\pi r^2}$	$P_2 = P_1 + \rho g h$	$E = -\frac{\Delta V}{\Delta s}$
$\omega = \frac{2\pi}{T}$	$\beta = (10db)\log(\frac{I}{I_0})$		
$\omega = \sqrt{\frac{k}{m}}$	$f_n = n\frac{v}{2L}$	$F = \frac{\eta A v}{y}$	$I = \frac{\Delta q}{\Delta t}$
$PE_{elastic} = \frac{1}{2}kx^2$	$f_n = n\frac{v}{4L}$	$Q = \frac{\pi R^4(P_2-P_1)}{8\eta L}$	$V = IR$
$KE = \frac{1}{2}mv^2$	$f_B = \lvert f_2 - f_1\rvert$	$F = \frac{k_e\lvert q_1\rvert\lvert q_2\rvert}{r^2}$	$P = IV$
$PE_{gravity} = mgh$	$\sin\theta = \frac{\lambda}{D}$	$E = \frac{k_e\lvert q\rvert}{r^2}$	$F_B = qvBsin\theta$
$\omega = \sqrt{\frac{g}{L}}$	$\sin\theta = 1.22\frac{\lambda}{D}$	$V = \frac{k_e q}{r}$	$r = \frac{mv}{qB}$

$y = A\sin(2\pi f t \mp \frac{2\pi}{\lambda}x)$

$v_{SOUND} = 331\frac{m}{s} + 0.6\frac{m}{s\cdot {}^oC}T_C$

$f' = f\frac{1\pm\frac{v_o}{v}}{1\mp\frac{v_s}{v}}$

$P + \frac{1}{2}\rho v^2 + \rho g h = constant$

$R_{eq} = R_1 + R_2 + ... + R_n$

$\frac{1}{R_eq} = \frac{1}{R_1} + \frac{1}{R_2} + ... + \frac{1}{R_n}$

Physical Constants

$k_e = \frac{1}{4\pi\epsilon_0} = 8.99\cdot 10^9\ \frac{N\ m^2}{C^2}$

$e = 1.602\cdot 10^{-19}\ C$

$g = 9.81$ m/s

$\rho_{H_2O} = 1000\ kg/m^3$

$\rho_{seawater} = 1025\ kg/m^3$

$\epsilon_0 = 8.85\cdot 10^{-12}\ \frac{C^2}{N\ m^2}$

$\mu_0 = 4\pi\cdot 10^{-7}\ \frac{T\ m}{A}$

$\rho_{oil} = 913\ kg/m^3$

Mathematical Formulae

$V = \frac{4}{3}\pi r^3$

$V = \pi r^2 l$

$A = 4\pi r^2$

$A = \pi r^2$

$A = 2\pi r l$

$C = 2\pi r$