PHYS 1021: FINAL EXAM
12 December, 2013
Instructor: Ania Harlick

Student Name: ______________________________ Total: ______ / 100

ID Number: ______________________________

INSTRUCTIONS

1. There are nine questions each worth 12.5 marks. You are responsible for **EIGHT** of the questions. Please indicate which question you don't want to be marked. You have **2 hours** to complete the test.
2. A calculator is allowed.
3. There is an formula sheet at the end of the exam which may be removed.
4. Provide all numerical answers to 3 significant figures.
5. Write answers neatly in the spaces provided. If necessary, continue onto the back of the page.
6. Do not erase or use "white out" to correct answers. Draw a line neatly through material to be replaced and continue with correction.
7. TURN OFF YOUR CELL PHONE. ACTUALLY, PLEASE HIDE IT.
8. Don't panic. If something isn't clear, ASK!

Question	Mark	Max
1		12.5
2		12.5
3		12.5
4		12.5
5		12.5
6		12.5
7		12.5
8		12.5
9		12.5

Q1a Sketch a graph showing elastic force exerted by the spring with spring constant k as a function of its displacement from $x = -A$ to $x = A$. [2.5 points]

Q1b A $m = 0.500$ kg glider is attached to an ideal spring with a force constant $k = 450\ N/m$, undergoes simple harmonic motion with an amplitude of 0.40 m.

(a) Determine the angular frequency of the motion. [2 points]

(b) Determine maximum speed and maximum acceleration of the glider. [2 points]

(c) Determine total mechanical energy of the system. [2 points]

(d) The **velocity** of the glider when it is at the position $x = -0.18$ m for the first time. [4 points]

Q2a Two strings are made of the same material and have waves of equal speed propagating along them. String I is thick and string II is thin. Is the tension in string I greater, equal or less than tension in string II. Briefly justify your answer. [2.5 points]

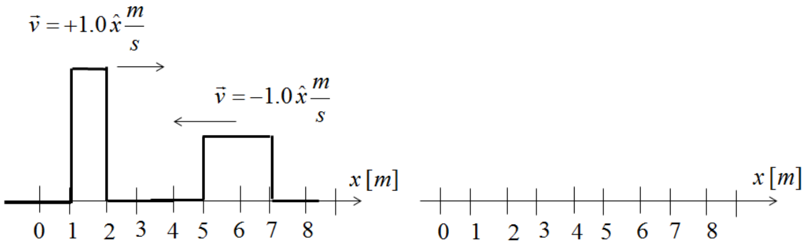
Q2b Twenty violins playing simultaneously with the same intensity combine to give an intensity level of 82.5 dB.

(a) What is the intensity of each violin? [4 points]

(b) What is the intensity level of one violin? [3 points]

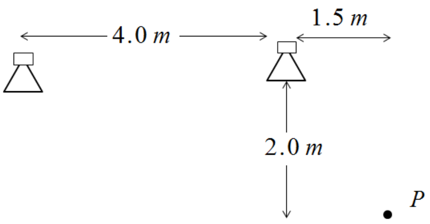
(c) If you assume that each violin is the same distance $x = 9.8$ m away from you, what is the power produced by each instrument. [3 points]

Q3a Two pulses on a string approach one another at the time $t = 0$ s as shown in the figure below (left). Each pulse moves with a speed of 1.0 m/s. On the diagram next to it, make a **CAREFUL** sketch of the resultant disturbance at time $t = 2.0$ s. [2.5 points]



Q3b Two loudspeakers A and B are emitting waves of the same frequency $f = 1021$ Hz in a room where speed of sound is measured to be $v = 342$ m/s. A listener notices that a destructive interference occurs at point P indicated in the figure.

(a) Determine the wavelength of the sound wave. [2 points]



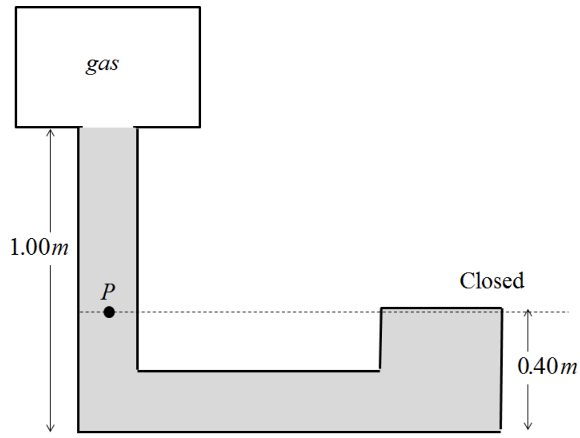
(b) Determine whether the speakers are in phase or out of phase. Support your answer with calculations. [4 points]

(c) Determine the frequency closest to 1021 Hz that would cause the listener to hear a constructive interference at point P. [4 points]

Q4a Why is it possible for people to float without any effort in Dead Sea ($\rho = 1240\ kg/m^3$)? [2.5 points]

Q4b The container, consisting of two cylinders connected at the bottom (shown in the figure below) is filled with oil ($\rho_{oil} = 790\ kg/m^3$). The left hand side of the cylinder has a radius of 0.050 m while the right hand side has a radius of 0.15 m. The pressure of th gas in the chamber above the left arm of the container is equal to $P_{atm} = 101.3 \cdot 10^3$ Pa.

(a) Determine the pressure at point P. [3 points]



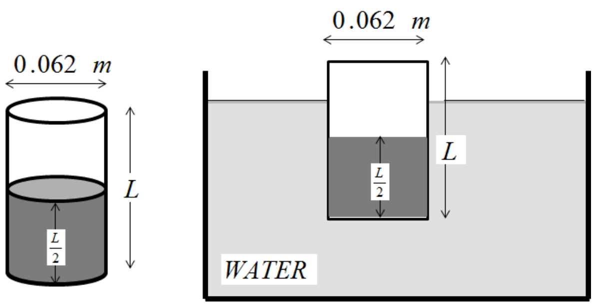
(b) What is the force exerted by the fluid on the top of the container on the right hand side [3 points].

(c) How would the pressure of the gas in the chamber have to change for the pressure at point P to be equal to exactly 1 atm. [4 points]

Q5a A small ranger vehicle has a soft, ragtop roof. When the car is at rest, the roof is flat. What happens to the roof when the car is cruising at highway with the windows rolled up? Briefly explain your reasoning. [2.5 points]

Q5b A can of soda with volume of $3.55 \cdot 10^{-4}\ m^3$ with $0.031\ m$ radius has a mass of $0.020\ kg$. Such a can, half full of water, is floating upright in water, as shown in the figure. (*NOTE: The cylindrical shape of the can is drawn on the side for a reference*)

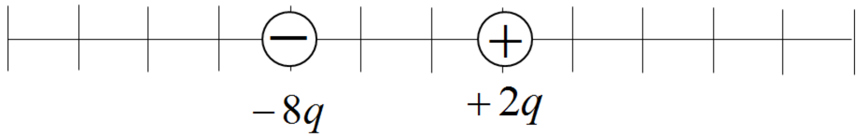
(a) Draw a free body diagram of the soda can floating in the water. [3 points]



(b) Determine the height of the can that is below the water surface. [4 points]

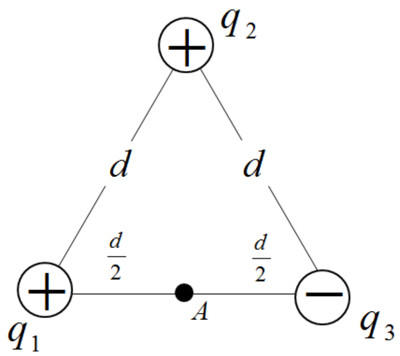
(c) Determine mass of aluminum ($\rho_{Al} = 2800\ kg/m^3$) that needs to be dropped into the can to make it totally submerged in the water. [4 points]

Q6a Indicate a point (or points) where electric field along the horizontal line is equal to zero. [2.5 points]



Q6b Figure below shows a system consisting of three charges $q_1 = +5.00\ \mu C$, $q_2 = +5.00\ \mu C$ and $q_3 = -5.00\ \mu C$ at the vertices of an equilateral triangle of side $d = 0.0275\ m$.

(a) Draw the vectors of the electric field at point A due to each charge. [3 points]



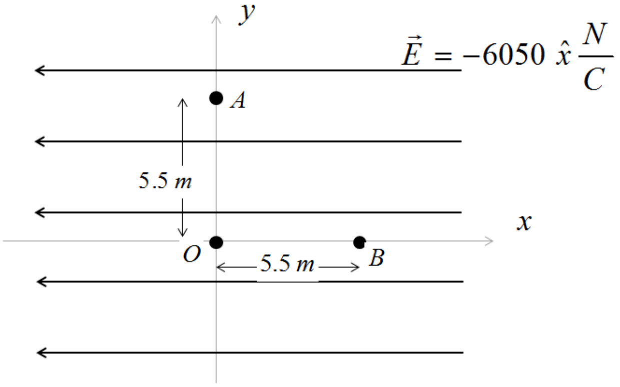
(b) Determine the magnitude and direction of the electric field at point A. [5 points]

(c) Determine the magnitude and direction of the electric force that an electron experiences at point A due to the electric field from the other charges. [2 points]

Q7a If the electric field is zero at some point in space, is the electric potential there zero as well? Briefly explain your answer. [2.5 points]

Q7b A uniform electric field with a magnitude of 6050 N/C points in the negative x direction. A 12.5 μC charge is placed at the origin, where electric potential is measured to be -12100 V.

(a) Determine the potential at point $B = (5.5m, 0m)$ [3 points]



(b) Determine the potential energy of the charge at the origin. [2 points]

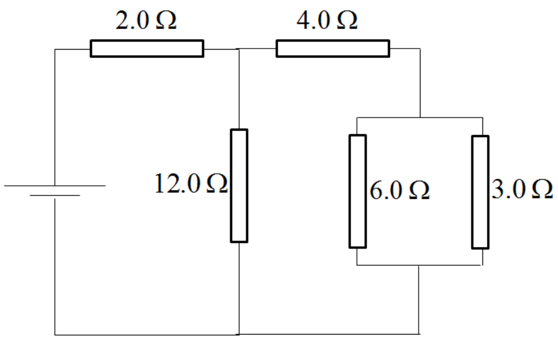
(c) Determine the work done on the charge **by the electric field** as it is moved 5.5 m in the $+x$ direction (from O to B). [3 points]

(d) Determine the the work done on the charge **by the electric field** as it is moved 5.5 m in the $+y$ direction (from O to A). [2 points]

Q8a Briefly explain the difference between resistivity and resistance. [2.5 points]

Q8b In the circuit shown in the figure below the current through the 2 Ω resistor is 3.0 A.

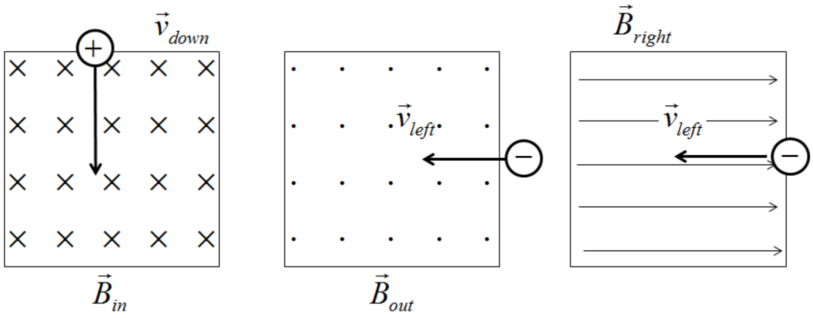
(a) Determine the equivalent resistance of the circuit. [5 points]



(b) Determine the current through the 12.0 Ω resistor. [3 points]

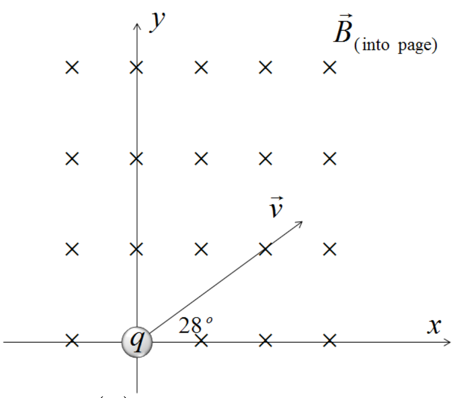
(c) Determine the power dissipated by the 12.0 Ω resistor. [2 points]

Q9a In the figures below indicate the direction of the force acting on each particle.[2.5 points]



Q9b A particle of charge $+7.3\ \mu C$ and mass $3.8 \cdot 10^{-8}$ kg is traveling **perpendicular** to a 1.6 T magnetic field, as the drawing shows. The speed of the particle is 44.0 m/s

(a) Determine the magnitude and direction of the magnetic force acting on the particle. Give the direction of the force relative to the $+x$ axis. [4 points]



(b) Determine the radius of the circular path of the particle. [2 points]

(c) When the particle is moving in the $+y$ direction an electric field is turned on in the region. Determine the magnitude and direction of the $\overrightarrow{E}$ field that would allow the particle to move through this region with zero **net** force acting on it. [4 points]

Useful Formulae and Constants

$F_s = -kx$	$v = \sqrt{\frac{F_T}{\mu}}$	$\rho = \frac{m}{V}$	$\Delta U = q\Delta V$
$x = A\cos\omega t$	$\mu = \frac{m}{L}$	$P = \frac{F}{A}$	$W_{AB} = -\Delta U$
$v = -A\omega\sin\omega t$	$I = \frac{P}{A}$	$F_B = \rho V g$	$E = -\frac{\Delta V}{\Delta s}$
$a = -A\omega^2\cos\omega t$	$I = \frac{P}{4\pi r^2}$	$P_2 = P_1 + \rho g h$	
$\omega = \frac{2\pi}{T}$	$\beta = (10db)\log(\frac{I}{I_0})$		
$\omega = \sqrt{\frac{k}{m}}$	$f_n = n\frac{v}{2L}$		$I = \frac{\Delta q}{\Delta t}$
$PE_{elastic} = \frac{1}{2}kx^2$	$f_n = n\frac{v}{4L}$	$F = \frac{k_e\lvert q_1\rvert\lvert q_2\rvert}{r^2}$	$V = IR$
$KE = \frac{1}{2}mv^2$	$f_B = \lvert f_2 - f_1\rvert$	$\overrightarrow{F} = q\overrightarrow{E}$	$P = IV$
$PE_{gravity} = mgh$		$E = \frac{k_e\lvert q\rvert}{r^2}$	$F_B = qvBsin\theta$
$\omega = \sqrt{\frac{g}{L}}$		$V = \frac{k_e q}{r}$	$r = \frac{mv}{qB}$
		$U = \frac{k_e q_1 q_2}{r}$	$F_B = IBl$
		$f' = f\frac{1\pm\frac{v_o}{v}}{1\mp\frac{v_s}{v}} = f\frac{v\pm v_o}{v\mp v_s}$	

$v_{SOUND} = 331\frac{m}{s} + 0.6\frac{m}{s\cdot{}^oC}T_C$ $\qquad P+\frac{1}{2}\rho v^2+\rho gh=constant$

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

Physical Constants

$k_e = \frac{1}{4\pi\epsilon_0} = 8.99\cdot 10^9\ \frac{N\,m^2}{C^2}$ $\qquad \epsilon_0 = 8.85\cdot 10^{-12}\ \frac{C^2}{N\,m^2}$
$e = 1.602\cdot 10^{-19}\ C$ $\qquad \mu_0 = 4\pi\cdot 10^{-7}\ \frac{T\,m}{A}$
$g = 9.81\ m/s^2$
$\rho_{H_2O} = 1000\ kg/m^3$ $\qquad P_{atm} = 101.3\ kPa$
$\rho_{seawater} = 1025\ kg/m^3$ $\qquad I_0 = 1\times 10^{-12}\ W/m^2$

Mathematical Formulae

$V_S = \frac{4}{3}\pi r^3$ $\qquad V_C = \pi r^2 l$ $\qquad A = \pi r^2$
$A_S = 4\pi r^2$ $\qquad C = 2\pi r$