PH 393 Physics II **Exam 2** **Fall 2010**

Name: _____ **11/10/10**

Present neat and orderly answers for each question.
Clearly indicate your method of solution for each problem, including equations used.
Include appropriate units.
Show all work.

$e = 1.6 \times 10^{-19}$ C
$\mu_0 = 1.26 \times 10^{-6}$ Tm / A

Multiple Choice (2 pts each)

1. You are tasked with designing a circuit consisting of a voltage source and a light bulb inside of the enclosure for your optical experiment. Once connected you find that the light bulb is too bright and the intensity needs to be reduced because it is interfering with your experiment. You recall from your physics II class that you can modify the circuit to reduce the brightness by introducing an additional element into the circuit. What element would you add and how would it be connected?

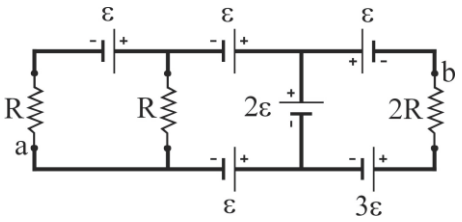
   a. A resistor in parallel;
   b. A resistor in series;
   c. A capacitor in parallel;
   d. A capacitor in series. Ans. _____

2. In chemistry you use a mass spectrometer to measure the charge to mass ratio of two different elements. You find that the charge to mass ratio of the first element is ¾ the charge to mass ratio of the second element. Determine the ratio of the path lengths if all the atoms are deflected $\pi/6$ radians and they are initially projected into the chamber at the same speed.

   a. $\frac{L_1}{L_2} = \frac{3}{4}$;
   b. $\frac{L_1}{L_2} = \frac{4}{3}$;
   c. $\frac{L_1}{L_2} = \frac{9}{16}$;
   d. $\frac{L_1}{L_2} = \frac{16}{9}$. Ans. _____

3. In class we looked at a demonstration of an electron beam, confined to a glass dome, directed into a circular path due to an externally applied magnetic field. The presence of the external magnetic field and the field due to the electron beam both pass through the glass dome. Compare the relative magnitudes of the contributions from each of the two magnetic fields that affect the magnitude of the net magnetic field passing through the glass dome?

   a. $B_{beam} = B_{external} = 0$;
   b. $B_{beam} > B_{external}$;
   c. $B_{beam} < B_{external}$;
   d. Need more information. Ans. _____



4. Given the circuit shown what is the potential at point a compared to point b if R = 10 Ω and ε = 10 V?

   a. 20 V;
   b. 10 V;
   c. -10 V;
   d. -20 V. Ans. _____

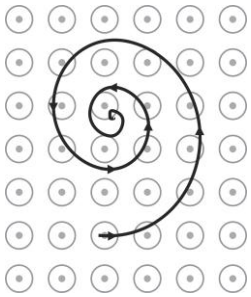
5. To discharge a capacitor in a series RC circuit very quickly, what should the values of the resistance and capacitance be?

   a. Both should be as large as possible;
   b. Make the resistance as large as possible and the capacitance as small as possible;
   c. Make the resistance as small as possible and the capacitance as large as possible;
   d. Both should be as small as possible. Ans. _____

6. A positive charge is fired perpendicular to a long straight wire, but parallel to the plane containing the wire. How does the magnitude of the magnetic force on the charge change as it approaches the wire?

   a. Zero force;
   b. Constant force;
   c. Increases as 1/r;
   d. Increases as $1/r^2$. Ans. _____

7. A particle enters a uniform magnetic field and follows the path shown. Based on this diagram what can you say about the charge and velocity of the particle?



   a. Positive Charge and speeding up;
   b. Positive charge and slowing down;
   c. Negative charge and speeding up;
   d. Negative charge and slowing down. Ans. _____

8. In order to determine the electrical properties of a liquid you can use the following experimental setup. A glass tube sealed at both ends is oriented horizontally. There are several holes drilled into the side of the tube and the tube is oriented so the holes are at the top of the horizontal tube. The tube is filled with the liquid to be studied and specifically chosen metal rods are placed in two of the holes. A comparison of measured voltages due to the same applied current to each situation can be made. Consider the two situations where the rods are placed at one end and halfway down the length of the tube, and the situation where one rod is placed ¼ the way down the tube and the second at 2/3 the way down the tube. What would the ratio of the voltages be?

   a. $\frac{V_1}{V_2} = \frac{3}{4}$;
   b. $\frac{V_1}{V_2} = \frac{4}{3}$;
   c. $\frac{V_1}{V_2} = \frac{5}{6}$;
   d. $\frac{V_1}{V_2} = \frac{6}{5}$.

   Ans. _____

9. A resistor, a capacitor and a power supply are connected in series. What is the current in the circuit after 2 time constants?

   a. 0;
   b. $0.135\frac{\varepsilon}{R}$;
   c. $0.607\frac{\varepsilon}{R}$;
   d. $\frac{\varepsilon}{R}$.

   Ans. _____

10. An airplane flies through a storm cloud that has a high potential relative to the ground. The plane picks up an extremely high surface charge density by the time it leaves the cloud. How should the pilot compensate for the presence of the charge as he flies the plane parallel to the equator, from west to east?

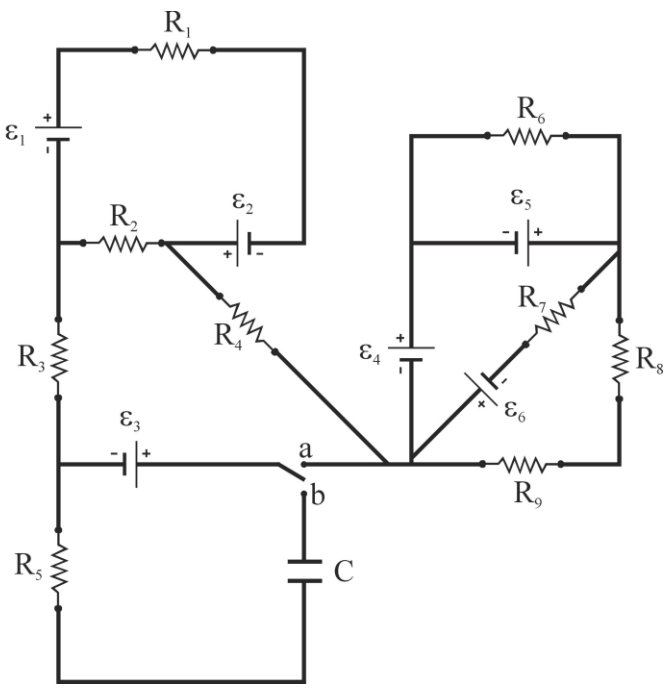
    a. Turn left;
    b. Turn right;
    c. Speed up;
    d. Descend.

    Ans. _____

Problem 1 (20 pts)

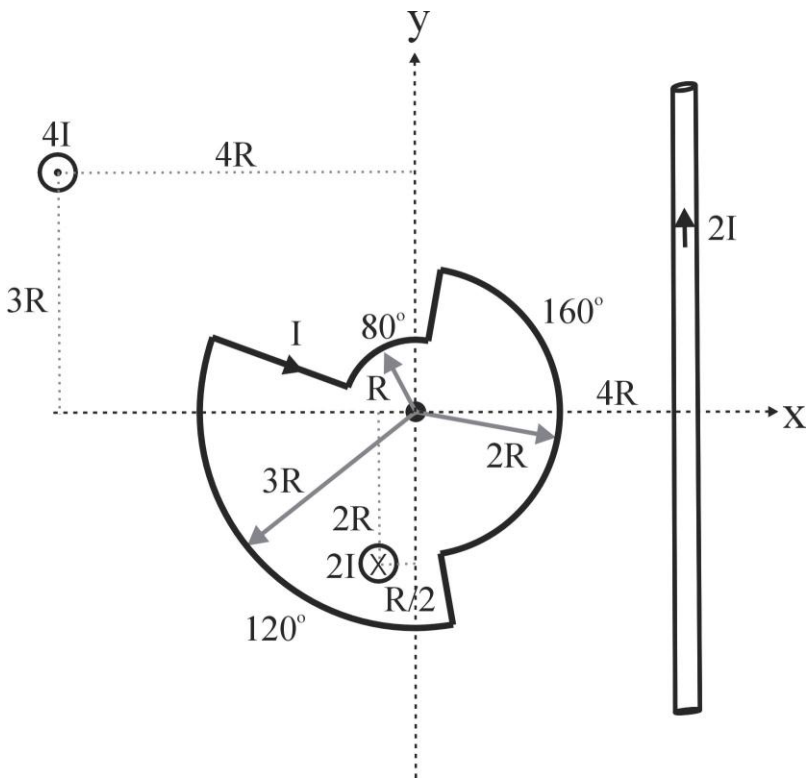
Consider the following circuit:

$R_1 = 2\ k\Omega$
$R_2 = 4\ k\Omega$
$R_3 = 1\ k\Omega$
$R_4 = 5\ k\Omega$
$R_5 = 50\ k\Omega$
$R_6 = 10\ k\Omega$
$R_7 = 8\ k\Omega$
$R_8 = 6\ k\Omega$
$R_9 = 4\ k\Omega$
$C = 100\ \mu F$
$\varepsilon_1 = 50\ V$
$\varepsilon_2 = 20\ V$
$\varepsilon_3 = 100\ V$
$\varepsilon_4 = 25\ V$
$\varepsilon_5 = 60\ V$
$\varepsilon_6 = 30\ V$



a) When the switch is at position a, write all of Kirchhoff's loop rules for the circuit. (10 pts)
b) When the switch is at position a, determine the rate at which energy appears in resistor R_7. (4 pts)
c) When the switch is at position b, determine the maximum voltage that can be across the capacitor. (2 pts)
d) When the switch is at position b, determine the voltage across the capacitor after 8s. (4 pts)

Problem 2 (20 pts)



The figure shows a region of space containing several different wires. For the configuration of wires shown determine the following. Point P is the point the radii are measured from.

a) Determine an expression for the net magnetic field at point P. (10 pts)
b) A proton is fired along the x-axis with a speed of 200 m/s. What is the net force acting on this charge when it reaches point P? Use R = 10 cm and I = 2 A. (6 pts)
c) A beam of electrons is fired along a line passing through P and perpendicular to the plane of the page. Describe how the path of the beam is modified and why. (4 pts)