PH 393 Physics II **Exam 1** **Fall 2010**

Name: _____ **9/29/10**

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.

$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2 / (N\ m^2)$
$k_e = 8.99 \times 10^{9}\ (N\ m^2) / C^2$

Multiple Choice (2 pts each)

1. An electron is fired through the center of a positively charged ring. The electron is fired along the central axis of the ring. If half of the ring is removed, what happens to the electron as it passes through the half-ring and moves away along the central axis?
    a. The electron's speed increases and the electron continues in a straight line;
    b. The electron's speed decreases and the electron continues in a straight line;
    c. The electron's speed increases and the electron moves along a curved path directed away from the central axis;
    d. The electron's speed decreases and the electron moves along a curved path directed away from the central axis.

    Ans. _____

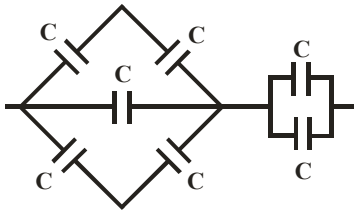
2. A charge Q is uniformly distributed inside a sphere (with diameter L), a cube (with length dimensions L) and a cylinder (length L and diameter L). Which combination of shapes would give a ratio of electric fluxes that is ½ for a Gaussian surface that is half of all the dimensions of the original shape?
    a. Sphere and cube;
    b. Sphere and cylinder;
    c. Cube and cylinder;
    d. No combination of these shapes will give this ratio. Ans. _____

3. The electrostatic potential is given by $V(x,y,z) = 4.0|x| + V_0$, where V_0 is a constant, x is measured in meters and V is measured in volts. Which of the following charge distributions is most likely responsible for this potential?
    a. A point charge at the origin;
    b. A negatively charged flat sheet in the x = 0 plane;
    c. A positively charged flat sheet in the x = 0 plane;
    d. A uniformly charged sphere centered at the origin. Ans. _____

4. Two identical capacitors that have been discharged are connected in series across the terminals of a 100 V battery. When only one of the capacitors is connected across the battery the energy stored is U_0. What is the energy stored when the two capacitors in series are connected to the battery?
    a. $4U_0$;
    b. $2U_0$;
    c. $½U_0$;
    d. $¼U_0$. Ans. _____

5. Consider a solid charged conductor in electrostatic equilibrium. The potential difference between a point on the surface of the conductor and a point inside the conductor is:
    a. > 0 if the charge is positive and < 0 if the charge is negative;
    b. < 0 if the charge is positive and > 0 if the charge is negative;
    c. always = 0, independent of the sign of the charge;
    d. always > 0, independent of the sign on the charge. Ans. _____

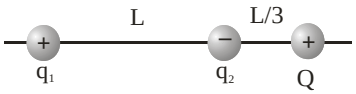
6. What is the equivalent capacitance for the combination of identical capacitors shown?



a. C;
b. 2C;
c. 4C;
d. ½C. Ans. _____

7. A hollow cone 10 cm tall with a 5 cm base diameter made of a non-conducting material is placed in a 11,000 N/C uniform electric field. The long axis of the cone is parallel to the electric field, with the electric field entering the base of the cone. What is the magnitude of the electric flux leaving the cone?
   a. 0.022 Nm^2/C;
   b. 0.086 Nm^2/C;
   c. 22 Nm^2/C;
   d. 86 Nm^2/C. Ans. _____

8. Two charges $+q_1$ and $-q_2$ are separated by a distance L. A third charge $+Q$ is located a distance $L/3$ to the right of q_2, as shown. If the net electrostatic force on the third charge is zero, then the magnitudes of the first two charges must be related according to:

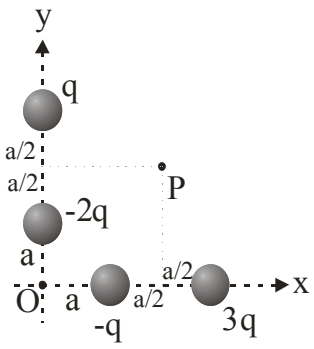


   a. $q_1 = 4q_2$;
   b. $q_1 = 9q_2$;
   c. $q_1 = 16q_2$;
   d. $q_1 = 27q_2$. Ans. _____

9. An electron is pushed into an electric field where it acquires a 2 V electrical potential. Suppose instead that two electrons are pushed the same distance into the same electric field. The electrical potential of the two electrons is
   a. 0.5 V;
   b. 1 V;
   c. 2 V;
   d. 4 V. Ans. _____

10. Two charges, a positive charge q_1 and an unknown charge q_2, are placed halfway between two oppositely charged parallel plates. It takes q_1 5 μs to reach the right plate and q_2 6 μs to reach the left plate. Both charges have the same magnitude of charge. Which of the following must be true about q_2 based on this information? (Ignore any interaction between charges).
    a. q_2 is positively charged;
    b. q_2 has a smaller force on it due to the electric field between the plates;
    c. q_2 undergoes the same acceleration as q_1;
    d. q_2 is more massive than q_1. Ans. _____

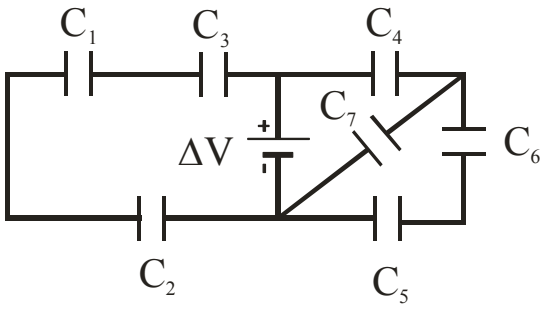
Problem 1 (20 pts)



Four charges are arranged in the configuration shown above.

a) Determine the net electric field at point P. (8 pts)
b) Determine the force on a negative charge q placed at point P. (4 pts)
c) Where must a 4q charge be placed in order for the net electric field to be zero at the origin? (8 pts)

Problem 2 (20 pts)



$C_1 = 6\ \mu F$
$C_2 = 8\ \mu F$
$C_3 = 2\ \mu F$
$C_4 = 1\ \mu F$
$C_5 = 12\ \mu F$
$C_6 = 10\ \mu F$
$C_7 = 4\ \mu F$
$\Delta V = 12\ V$

Consider the circuit shown above with four fully charged capacitors.

a) Find the equivalent capacitance for this circuit. (6 pts)
b) Find the charge on and potential difference across C_1 and C_7. (10 pts)
c) Find the total energy stored by capacitors C_1 and C_7 in this circuit. (4 pts)