Physics 7b
Fall 2006
Midterm Exam 2
R. Packard

Work all five problems. The first four are weighted equally and the fifth is worth half as much. Introduce and clearly define algebraic symbols. Do not perform numerical work until you have a final algebraic answer within a box. Check the dimensions of your answer before inserting numbers. Work the easiest problem first, and the next hardest, etc. If you do not understand the question, ask the proctor for assistance.

Name_____

SID_____

Section Number or Day and Time_____

GSI name (if known) _____

1. _____

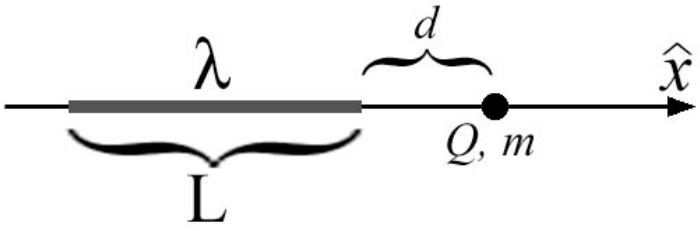
2. _____

3. _____

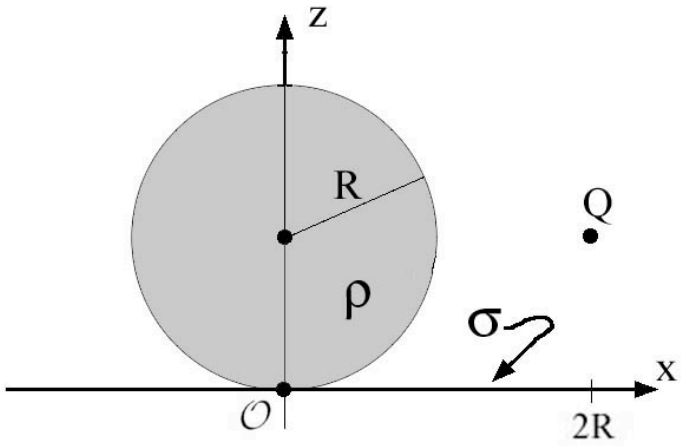
4. _____

5. _____

Total _____



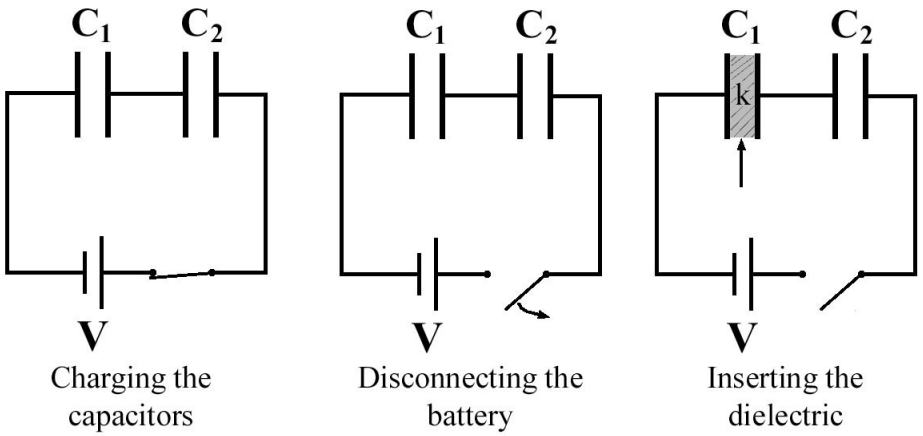
1. (20pts) A line charge of length L and lineal positive charge density λ rests along the x axis, as shown above. A point positive charge Q with mass m is released from a point on the x axis a distance d away from one end. Find the speed of the charge when it reaches a distance 2d away from the end.



Charge Distribution for Problem 2, in the xz plane.

2. (20pts) As shown above, a sphere of radius R and uniform charge density ρ rests on an infinite plane of surface charge density σ. Let the origin of the coordinate system be placed at the contact point between the sphere and the plane. The charged plane lies in the xy plane, z=0. Find the magnitude of the force on a particle of charge Q located at position x=2R, y=0, z=R .

3. (20pts) Two equal capacitors of capacitance $C_1 = C_2 = C_o$ are connected in series with their ends connected to a battery of voltage V, as shown in the first part of the figure below. After initial charging, the battery is disconnected from the capacitors, as shown in the second part of the figure below. Subsequently, Capacitor 1 gets filled with a dielectric medium of dielectric constant k, as shown in the third part of the figure below.



a. After the initial charging and before the dielectric is inserted, what is the total energy stored in the capacitors?

b. After the dielectric is inserted, what is the charge, Q_1 and Q_2, on each capacitor?

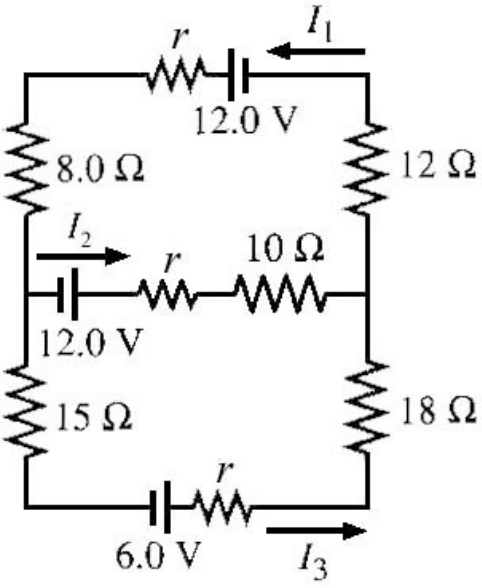
c. After the dielectric is inserted, what is the voltage, V_1 and V_2, across each capacitor?

d. Has the energy stored gone up or down and by how much?

4. (20pts) (Taken from Chapter 26, Problem 34).

   a. Determine the currents I_1, I_2, and I_3, as labeled in the figure below. Assume the internal resistance of the battery is $r = 1\Omega$.

   b. Determine the terminal voltage of the 6.0V battery.
   (Hint: If the same current flows through multiple resistors, they are in series.)



5. (10pts) In a certain region of space, the electric potential is given by $V = y^2 + 2xy - 4xyz$. Determine the magnitude of the electric field at the point $x = y = z = 1$.