Physics 7B
Spring 2008
Midterm 2
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Work all problems. Introduce and clearly define algebraic symbols to represent all physical quantities. **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 parts first, and the next hardest, etc. If you do not understand the question ask the proctor for assistance. All problems are weighted equally.

Name_____

SID_____

Sect. # or day and time _____

Name of GSI (if known)_____

1._____

2._____

3._____

4._____

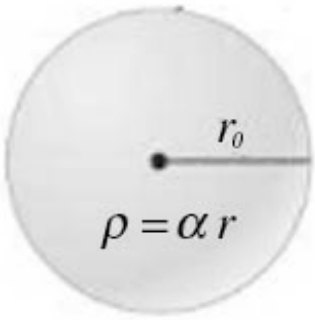
5._____

Total_____

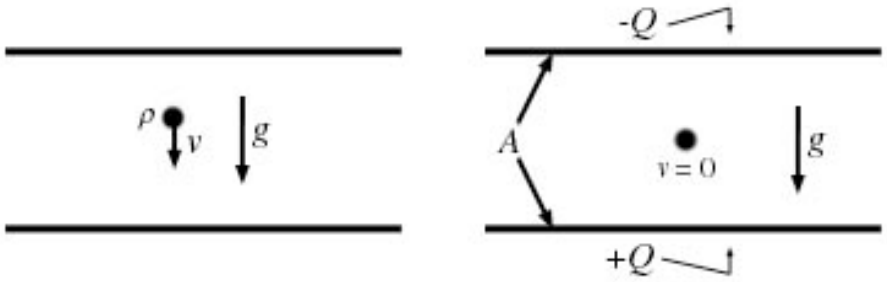
1. A sphere of radius r_0 carries a spherically symmetric charge density $\rho = \alpha r$, as shown below.

a) Compute the potential (relative to $V = 0$ at $r = \infty$) at a point at radius $r = r_0 / 2$.

b) Compute the total energy stored in the electric field in the space outside the sphere.



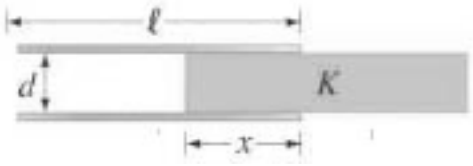
2. The drag force on a sphere of radius r and moving with a velocity v through a fluid is given by $F_v = B\,r\,v$, where B is a constant characterizing the fluid. Suppose a small, spherical charged particle, of mass density ρ, is found to fall vertically (in gravity g) at a constant, measured speed v_0 between two large, horizontal, uncharged metal plates of area A. *After the measurement*, the plates are charged with $-Q$ on the top plate and $+Q$ on the bottom. The charge is adjusted until the particle comes to rest and no longer moves up or down. Find the charge of the sphere, q, in terms of v_0, B, Q, ρ, g, and A. Assume the electric field between the plates is uniform.



3. A slab of width d and dielectric constant K is inserted a distance x into the space between the square, parallel plates (with side length ℓ and plate separateion d) of a capacitor as shown below. Determine, as a function of x:

a) The capacitance, $C(x)$.

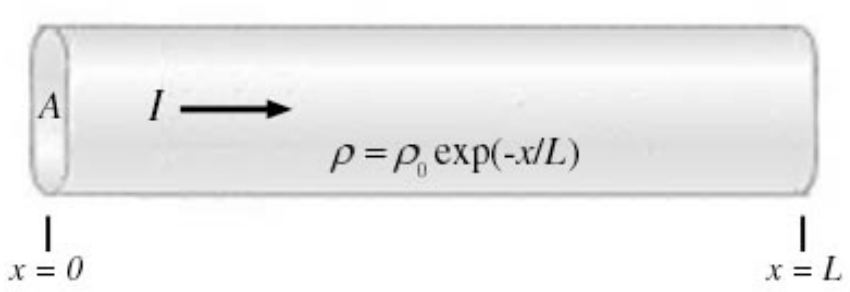
b) The energy stored by the capacitor, $U(x)$, if the potential difference of the capacitor is V_0.



4. A wire of length L and cross sectional area A is oriented along the x-direction and is made of a material whose resistivity varies along the length of the wire as $\rho = \rho_o e^{\frac{-x}{L}}$.

a) Compute the resistance across the ends of the wire.

b) A current I flows along the wire from one end to the other. Find the electric field, $\boldsymbol{E}$, inside the wire as a function of the distance along the wire, x. Let the start of the wire be placed at $x = 0$.



5. (*Homework Problem, Chapter 26, Problem 36)*

a) Determine the currents I_1, I_2, and I_3 in the circuit shown below. Assume that the internal resistance of each battery (shown as the resistors next to the batteries labeled with resistance r) is $r = 1.0\ \Omega$.

b) What is the *terminal voltage* of the 6.0-V battery?