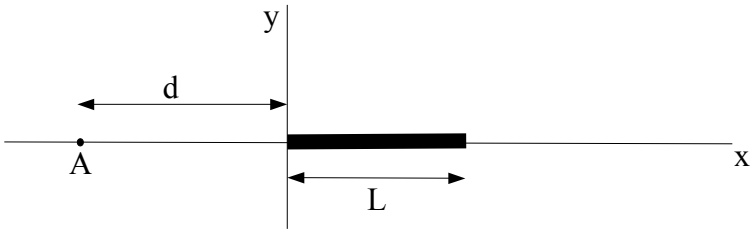
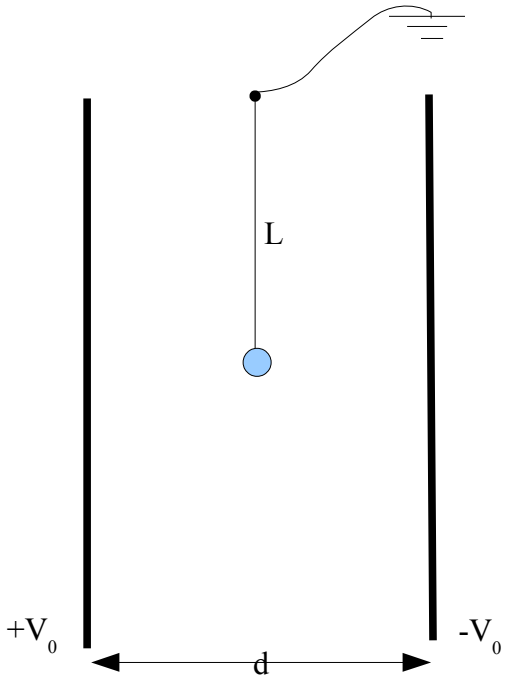
PHYS 2201 Electricity and Magnetism
Homework #7 – Due Nov. 12, 2015 by 3pm
(hand in to drop box outside 3L24)

1. A rod of length L lies along the x-axis with its left end at the origin, as shown in the figure below. It has a non-uniform charge density $\lambda(x)=\alpha x$, where α is a positive constant. Calculate the electric potential at a point A, to the left of the bar.

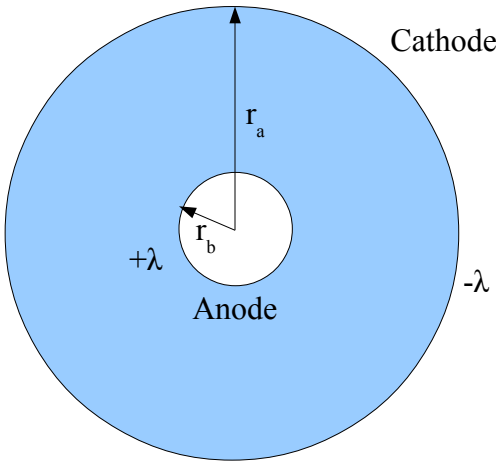


2. A point charge -q sits at the origin, and a charge +q/2 sits at the point (a,0,0). Show that the equipotential surface V=0 is spherical in shape. Determine the radius and location of the V=0 equipotential surface.

3. Two large vertical conducting plates, separated by a distance d, are charged so that their potentials are $+V_0$ and $-V_0$, as shown in the figure below. A small conducting ball of mass m and radius R (where R<<d) is hung midway between the plates. The length of conducting thread holding the conducting ball is L, and is connected to ground, so that the potential of the ball is fixed at V=0. Show that the equilibrium of the ball is unstable if V_0 exceeds the critical value $\sqrt{k_e d^2 mg/(4\mathrm{RL})}$. (Hint: consider the forces on the ball when it is displaced a distance x<<L).



4. A Geiger tube is a radiation detector that consists of a closed, hollow metal cylinder (the cathode) of inner radius r_a and a coaxial cylindrical wire (the anode) of radius r_b, as shown in the figure below. The charge per unit length on the anode is λ, while the charge per unit length on the cathode is -λ. A gas fills the space between the electrodes. When a high-energy elementary particle passes through this space, it ionizes atoms of the gas along its trajectory. The strong electric field makes the resulting ions and electrons accelerate in opposite directions. They strike other molecules of the gas to ionize them, producing an avalanche of electrical discharge. The pulse of electric current between the wire and cylinder is counted by an external circuit. Show that the magnitude of the potential difference between the wire and cylinder is $\Delta V = 2k_i \lambda \ln \frac{r_a}{r_b}$.



5. A uniformly charged cylindrical shell (a thin walled pipe) has a total charge Q, radius R, and height h. Determine the electric potential at a point a distance d from the right end of the cylinder, as shown in the figure. (Hint: Treat the cylinder as a collection of ring charges).