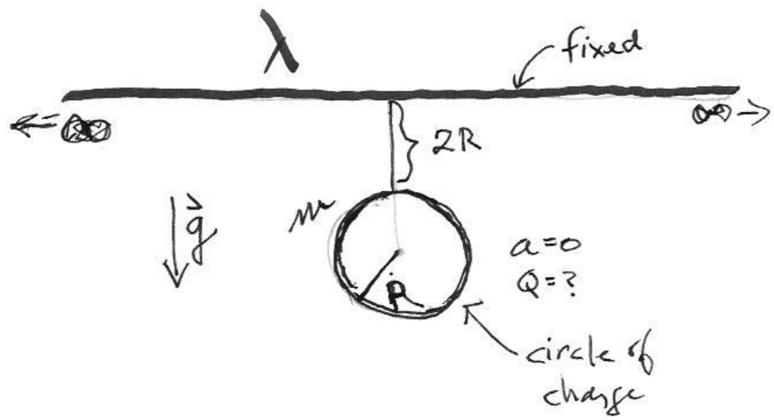
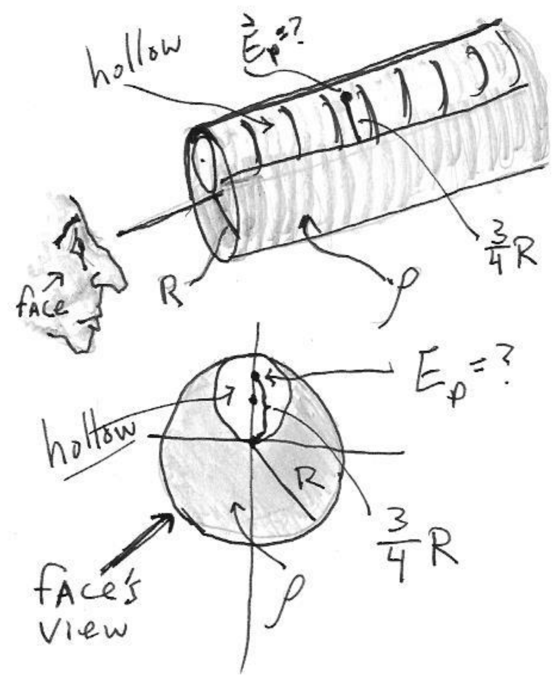
Physics 4B Exam 1 Spring 2014 Name________________________

1. (25 points) Starting at the surface of a dielectric sphere, a charge +q is fired with an initial velocity radially inward toward the center of the sphere. The sphere has a uniform charge density with the radius R and total charge on the sphere Q. **What minimum initial speed of the charge is necessary so that the charge could penetrate just to the center of the sphere?** To imagine this, pretend that there is a small hole, a tunnel, that the charge travels through to get to the center, but the tunnel is so small that its existence does not influence any electrical effects.

2. (25 points) There is gravity in this problem. A circular ring of mass m, radius, R, and unknown negative charge -Q is suspended below an infinitely long charged wire of given charge density λ by a distance of 2R from circle's top point. The plane of the circle is parallel to the length of wire. **Find the magnitude of charge Q on the ring such that it would not accelerate in the given position.**



3. (25 points) An infinitely long dielectric cylinder has a radius R and a charge density ρ. Along its length is an offset cylindrical hollow of charge as shown in the diagram. **Find the electric field vector at the point indicated in the diagram, within the hollow, ¾ of the way radially outward from the center axis.**



4. (25 points) A bead of mass *m* and charge -*q* is constrained to move along the x axis by a frictionless wire in the presence of a fixed charge distribution as shown in the diagram. **Find the period of the bead's oscillation** about the origin (for small displacements from equilibrium only). Treat the ring as a point mass. Recall that if a restoring force is linear in a Hooke's Law style form (i. e., $F = k\Delta x$) then its oscillation's period is given by $T= 2\pi[m/k]^{1/2}$. You can use symmetry arguments if you want. There is no gravity in this problem.