PHYS 3033/3053 Assignment 3

Due: 25 Sep 2015 at begin of lecture at 3:00 pm

Problem 1.

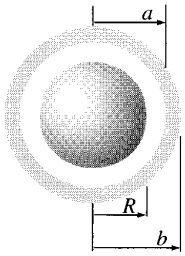
A sphere of radius *R* carries a charge density $\rho(r) = kr^2$ (where *k* is a constant). Find the energy of the configuration using

(a) $W = \frac{\varepsilon_0}{2} \int_{\text{all space}} E^2 d\tau$,

(b) $W = \frac{1}{2}\int \rho V d\tau$.

Problem 2.

A metal sphere of radius *R*, carrying charge *q*, is surrounded by a thick concentric metal shell (inner radius *a*, outer radius *b*, as in the figure below). The shell carries no net charge.



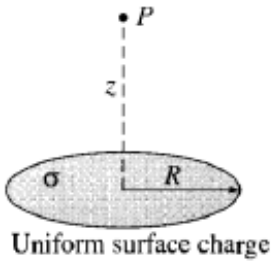
(a) Find the surface charge density σ at *R*, at *a*, and at *b*.

(b) Find the potential at the center, using infinity as the reference point.

(c) Now the outer surface is touched to a grounding wire, which lowers its potential to zero (same as at infinity). How do your answers to (a) and (b) change?

Problem 3.

Using $W = \frac{1}{4\pi\varepsilon_0}\int \frac{\sigma(r')}{r} da'$, find the potential at a distance *z* above the center of the charge distribution in the figure shown below. Compute the *z*-component of the **E** field by $\mathbf{E} = -\nabla V$.



Uniform surface charge

Problem 4.

A conical surface (an empty ice-cream cone) carries a uniform surface charge σ. The height of the cone is h and the radius on the top is also h. Find the potential difference between points **a** (the vertex) and **b** (the center of the top).