Problem set 10 (due May 29)

1. Consider an infinitely long cylindrical shell of radius R with uniform surface charge density σ. Use Gauss' law to find the electric field

   (a) (2pt) At a point outside of the shell

   (b) (1pt) At a point inside the shell

2. (3pt) A total charge Q is distributed uniformly throughout a spherical shell of inner and outer radii r_1 and r_2. Use Gauss' law to compute the electric field at a position $\vec{r}$ with $r_1 < |\vec{r}| < r_2$.

3. (4pt) In two dimensions, Gauss' law is given in terms of the line integral

   $$\int_{\partial M} \vec{E} \cdot \hat{n} \, d\ell = 2\pi \tilde{k} Q$$

   where the integrate is over a piecewise smooth curve ∂M (the boundary of a two-dimensional surface M), $\hat{n}$ is the vector normal to the curve, $\tilde{k}$ is the two-dimensional Coulomb's constant, and Q is the total charge enclosed by the curve ∂M.

   Compute the electric field of an infinite line with uniform linear charge density λ using Gauss' law. Compare this result with the one obtained in problem 1(b) of the previous homework.