Electrodynamics, spring 2008
Exercise 2 (31.1., 1.2.; Friday group in English)

1. There are no charges inside a sphere of radius R. Show that

$$\int_{r<R} \mathbf{E}\, dV = \frac{4\pi R^3}{3}\, \mathbf{E}(0)$$

   where $\mathbf{E}(0)$ is the electric field at the centre of the sphere. A possibly useful result:

$$\int_{4\pi} \frac{d\Omega'}{|\mathbf{r}-\mathbf{r}'|} = \frac{4\pi}{max(r,r')}$$

2. There is an electric dipole $\mathbf{p}$ at the centre of a sphere. What kind of charge distribution should be placed at the surface of the sphere so that there is no field outside of the sphere?

3. A box $0 \leq x \leq a, 0 \leq y \leq b$ is very long into the z-direction.
   a) Solve the potential $\varphi(x, y)$ inside the box with the boundary conditions $\varphi(y = b) = V =$ constant and $\varphi = 0$ at other edges.
   b) Based on this result, how would you easily handle a situation in which all edges of the box are held at different constant potentials?

4. A conducting cylinder of radius a is kept at potential V_a and a surrounding cylinder of radius b is at potential V_b. The cylinders have a common axis. Calculate the electric field between the cylinders as well as the surface charge densities.

5. An infinitely long grounded conducting cylinder has a radius of R. Outside of the cylinder at the distance of d from its axis, there is an infinitely long line charge parallel to the cylinder. The line charge density is λ. Determine the potential outside of the cylinder. Tip: method of images.

6. Extra problem (one extra point available): How can you separate pepper from a mixture of salt and pepper by using a plastic spoon and a piece of wool?

Return the answers until Tuesday 29.1. 12 o'clock.