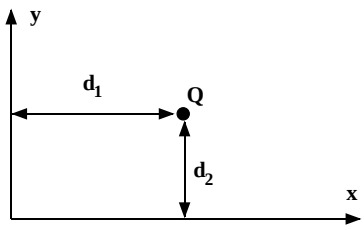
Electrodynamics, spring 2003

Exercise 2 (Thu 6.2., Fri 7.2.)

1. Consider a static charge q in a cavity inside a non-grounded neutral conductor.
   a) Describe qualitatively the electric field in the cavity, in the conductor and outside of the conductor. What are the total charges on the surface of the cavity and on the outer surface of the conductor?
   b) How the situation changes when the conductor is grounded?
2. In plasma physics, you will get familiar with the screened Coulomb potential

$$\varphi(\mathbf{r}) = \frac{q}{4\pi\epsilon_0}\frac{e^{-\alpha r}}{r}, \ \alpha > 0$$

   a) Show without cumbersome calculations that the total charge of the system is zero.
   b) Calculate the charge density and interpret physically. Tip: calculate first $\nabla \cdot \nabla(fg) = ...$
   c) Check the result by integrating the charge density.
3. Consider a box $0 \leq x \leq a, 0 \leq y \leq b$ which is very long in the z direction.
   a) Solve the potential $\varphi(x, y)$ inside the box with boundary conditions $\varphi(y = b) = V =$ constant and $\varphi = 0$ at other boundaries.
   b) Explain briefly how to deal with a case that each boundary has a different non-zero constant potential.
4. Two semi-infinite conducting planes are defined in cylindrical coordinates by the azimuth angle: $\phi = 0$ and $\phi = \phi_0$. The planes have potentials 0 and V, respectively.
   a) Solve the potential everywhere.
   b) Calculate surface charge densities on the planes.
5. A point charge Q is placed close to two perpendicular grounded conducting planes as shown in the figure. Calculate the force experienced by the charge Q due to induced charges on the planes.



Return answers until Tuesday 4.2. at 14 o'clock.