

Physics 106b: Electrodynamics

Problem Set 2

Due: Friday 4:00 pm, February 24, 2012

deposit in box in 149 Bridge Annex

Remember: Late homework will be granted 50% credit up to one week late, unless you have a note from the Dean or a health official.

Reading: Griffiths Chapter 3

Problems:

1. A point charge q is located outside a conducting sphere of radius a which is held at zero potential. Show that the potential outside the sphere can be found by the method of images. You need to show that an image charge q' can be positioned in such a way that the potential it and the original charge q create is zero on the surface of a sphere coinciding with the metal sphere in the original problem. Determine the value of q' and its precise position. Find the force on the charge q and show that in the limit that it is very close to the sphere the force becomes the same as that of a point charge above an infinite plane conductor.

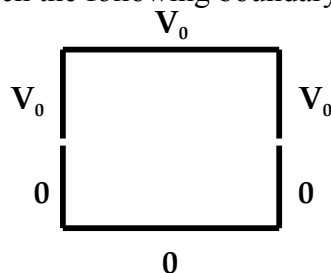
2. An infinite plane surface carries an oscillatory charge density, $\sigma = \sigma_0 \sin(kx)$.

a) Find the electrostatic potential everywhere. Roughly how far from the plane must you be in order that the potential becomes “small”?

b) Find the electric field everywhere and sketch the field vector on both sides of the plane. Demonstrate that all appropriate boundary conditions are met.

c) Determine the stored electrostatic energy in this system, per unit area of plane surface.

3. Find the electric potential everywhere inside a long conducting pipe of square cross-section (with side a) on which the following boundary conditions are imposed:



In other words, the pipe has been split down the middle lengthwise. One half is held at zero potential and the other at potential V_0 . Assume the gap between the halves is infinitesimal. *Hint:* The potentials in the top and bottom halves are related by symmetry. *Also:* I assign this problem most every year, so you can surely find a solution from a previous 106b student. But do it yourself; it's interesting and instructive and will be useful later on.

4. Griffiths 3.15