PHYS 3033/3053 Assignment 4

Due: 2 Oct 2015 at begin of lecture at 3:00 pm

Problem 1.

Show that in general the average potential over a spherical surface of radius R is

$$V_{ave} = V_{center} + \frac{Q_{enc}}{4\pi\varepsilon_0 R},$$

where V_{center} is the potential at the center due to all the *external* charges, and Q_{enc} is the total enclosed charge.

Problem 2.

In one sentence, justify **Earnshaw's theorem**: *A charged particle cannot be held in a stable equilibrium by electrostatic forces alone*.

Problem 3.

Two infinite grounded metal plates lie parallel to the xz plane, one at $y = 0$, the other at $y = a$. The left end, at $x = 0$, is closed off with two infinite strips insulated from each other and from the two infinite plates. One of the strips is from $y = 0$ to $y = a/2$ and is held at a constant potential $-V_0$, and the other, from $y = a/2$ to $y = a$, is at potential V_0.

(a) Find the potential inside this "slot."

(b) Determine the surface charge density $\sigma(y)$ on the two strips at $x = 0$.

Problem 4.

A rectangular pipe, running parallel to the z-axis (from $-\infty$ to ∞), has three grounded metal sides, at $x = 0$, $x = a$, and $y = 0$. The fourth side, at $y = b$, is maintained at a specified potential $V_0(x)$.

(a) Develop a general formula for the potential within the pipe.

(b) Find the potential explicitly, for the case $V_0(x) = V_0$ (a constant).

Problem 5

An amount of charge Q has been deposited on an isolated conducting sphere of radius R, and the sphere has been placed in a uniform electric field $\mathbf{E_0}$ in the z direction. What is the potential outside the sphere?