Physics 503 **Homework Set 3** **Fall 2016**

Zangwill 5.4 A Charged Sheet between Grounded Planes

Two infinite conducting planes are held at zero potential at $z = -d$ and $z = d$. An infinite sheet with uniform charge per unit area σ is interposed between them at an arbitrary point.

(a) Find the charge density induced on each grounded plane and the potential at the position of the sheet of charge.

(b) Find the force per unit area which acts on the sheet of charge.

Zangwill 5.15 Practice with Greens Reciprocity

The text derived Greens reciprocity theorem for a set of conductors as a special case of a more general result. For conductors with charges and potentials (q_k, ϕ_k) and the same set of conductors with charges and potentials $(\tilde{q}_k, \tilde{\phi}_k)$, the theorem reads

$$\sum_{i=1}^{N} q_i \tilde{\phi}_i = \sum_{i=1}^{N} \tilde{q}_i \phi_i$$

(a) Use the symmetry of the capacitance matrix to prove the theorem directly.

(b) Three identical conducting spheres are placed at the corners of an equilateral triangle. When the sphere potentials are $(\phi, 0, 0)$, their charges are (q, q_0, q_0). What is the charge q on each sphere when the potential of each sphere is ϕ?

(c) What is the potential on each sphere when their charges are $(q, 0, 0)$?

Zangwill 5.24 Holding a Sphere Together

A conducting shell of radius R has total charge Q. If sawed in half, the two halves of the shell will fly apart. This can be prevented by placing a point charge Q' at the center of the shell.

(a) What value of Q' just barely holds the shell together?

(b) How does the answer to part (a) change for the case of an insulating sphere with uniform charge density $\sigma = Q/4\pi R^2$?