

Physics 7B, Fall 2007, Section 2, Instructor: Prof. Adrian Lee
Second Midterm Examination, Tuesday November 6, 2007

Please do work on these pages. You can use the backs and there is extra paper at the end. You may use one double-sided 3.5" x 5" index card of notes and a calculator. Test duration is 110 minutes. Please be explicit in your derivations and show your work.

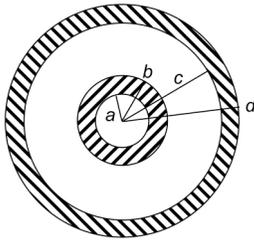
NAME:

SECTION:

(Giancoli Ch 24, problem 8)

- 1) **Connecting Capacitors.** A capacitor with $C = C_1$ is charged to V_1 and a second capacitor with $C = C_2$ is charged to V_2 . (20 points total)
 - a) These capacitors are then disconnected from their batteries, and the positive plates are now connected to each other and the negative plates are connected to each other. What will be the potential difference across each capacitor and the charge on each? (10 pts)
 - b) What is the voltage and charge for each capacitor if plates of opposite sign are connected? (10 pts)

2) **Spherical Capacitor.**



Consider a capacitor consisting of two concentric conducting spherical shells. Both shells have a finite thickness. The inside shell has inner radius a and outer radius b . The outside shell has inner radius c and outer radius d . Initially, neither sphere is charged. A battery is hooked up between the two spheres. The inside shell now has a charge $+Q$ and the outside shell has a charge $-Q$. (40 pts total)

a) What is the capacitance of the system? (10 pts)

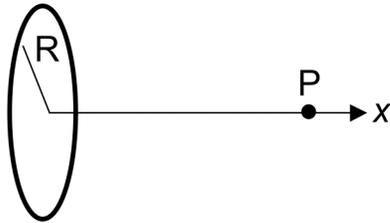
b) What is the surface charge density on all four surfaces, that is, the inside and outside of both shells? Do not use qualitative arguments based on forces, but calculate the surface charge densities explicitly. (10 pts)

c) How much work is needed to move a test charge of value q from infinity to the center of the shells (assume there is a small hole in the shells to allow the charge to pass). (10 pts)

d) (harder, perhaps save for last) Now, fill half the distance between the shells with a dielectric of dielectric constant k . The dielectric extends from $r = b$ to $r = (c - b)/2$. The battery remains connected. What is the new capacitance of the shells, and what is the effective field inside the dielectric, that is, the total field that you would measure with a test charge? (Imagine there is a tiny hole in the dielectric so you could measure the field). (10 pts)

Extra work page (number your problems)

3) **Fields and Potentials of Rings and Disks.**



A thin circular ring of radius R carries a uniformly distributed charge Q . Set the symmetry axis to be the x -axis. (30 pts total)

a) Determine the potential at a point P on x -axis as a function of x . (10 pts)

b) Starting with the potential from (a), determine the x , y , and z components of the electric field at the same point (10 pts)

c) Now, consider a full round disk of radius R with a non-uniform surface charge density $\sigma = ar^2$, where r is measured from the center of the disk. Again, the x -axis is along the symmetry axis. Find the potential $V(x)$. The needed integral can be done “by parts.” (10 pts)