Name:_____

SID: _____

Physics 7B Midterm 2 – Fall 2020
Professor A. Lanzara

TOTAL POINTS: 100

Show all work, and take particular care to explain what you are doing. Partial credit is given. Please use the symbols described in the problems, define any new symbol that you introduce and label any drawings that you make. All answers should be in terms of given variables or numbers. If you get stuck, skip to the next problem and return to the difficult section later in the exam period.

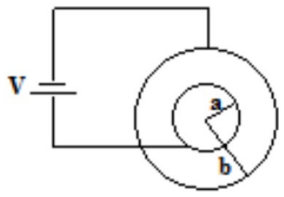
Problem 1 (20 pts):

Consider the spherical capacitor in the figure below. The capacitor is made out of an inner spherical shell of radius *a* and an outer spherical shell of radius *b*. The space between the two shells is empty.

a) Find the capacitance C.

The two shells are kept at a constant potential difference *V* by an emf, as shown in the figure below:

b) Find the total energy stored in the capacitor.
c) What is the surface charge density on the inner shell?
d) If we now fill the space in between the two shells with a material of conductivity σ. Find the total current flowing between the two spherical shells.



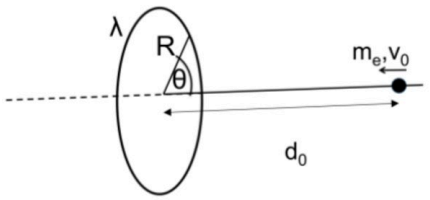
Problem 2 (20 pts):

A charge is distributed on a ring of radius R such that the ring has linear density charge density λ. If $\lambda = + A_0 \cos^2 \theta$, find:

a) The electric potential at a point a distance d_0 from the center of the ring (see figure below). If a charge +q is placed at that point, find the electric potential energy of the charge.
b) The direction and magnitude of the force that the ring exerts on a charge +q at a distance d_0 from the center of the ring (see figure below).

If the charge q has initial velocity v_0 moving toward the center of the ring, find:

c) the minimum value of v_0 so that the charge can exit on the other side of the ring.

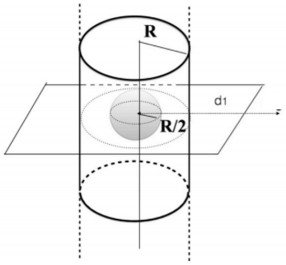


Problem 3 (20pts)

Consider an infinite cylinder with radius R made of an insulating material. A sphere of radius R/2 is scooped out of the cylinder. The center of the sphere lies on the axis of the cylinder (see figure below). The cylinder has a uniform charge density ρ.

Find the electric field as a function of distance from the cylinder's main axis in the plane (as shown below) for

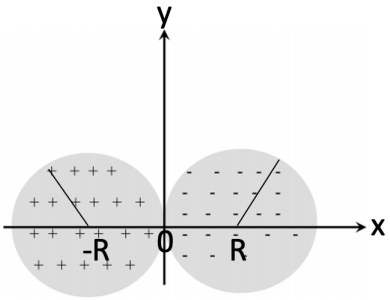
i. Points inside the sphere
ii. Points outside the sphere and inside the cylinder
iii. Points outside the cylinder



Problem 4 (20pts)

Two full spheres of radius R and uniform charge density ρ and - ρ are placed next to each other, as shown in the figure below. Find:

a) The magnitude of the electric field in the point of contact (x=0)
b) The electric field at the center of the right sphere (x=R)
c) The electric dipole moment



Problem 5 (20pts)

Consider a resistor that has the shape of a truncated and partially hollowed out right circular cone, as pictured below, and carries a steady current *I*. From the left to the right side of the resistor, the outer diameter of the resistor varies uniformly from *a* to *b*, with $a < b = 2a$. The inner diameter also varies uniformly, from *a/4* to *8b/9*. Assume the resistor has uniform resistivity ρ.

a) Through which end of the resistor does the most current flow?
b) Which end of the resistor has a higher electric field?