2049H Exam #1

Name:
Problem 1 [44 pts]

**Uniformly Charged Solid Sphere** (note it is not metallic) has radius $R$ and volume charge density $\rho$.

Calculate electric field (its dependence on $r$)

(a) for outside the sphere [8 pts]
(b) for inside the sphere [8 pts]

Calculate potential (its dependence on $r$)

(c) for outside the sphere [12 pts]
(d) for inside the sphere [12 pts]

(e) Does potential vary inside the sphere? [4 pts]
Problem 2 [44 pts]

Parallel plate capacitor is charged to area charge density as depicted. You can assume that the area of the capacitor is $A$ and the distance between capacitor is $d$.

(a) What is the electric field between the plates? [4 pts]

(b) What is the voltage difference between plates? Which plate has the positive voltage? [4 pts]

(c) What is the force between the plates? [proceed carefully. Ask what is the electric field by one plate first before doing the superposition] [12 pts]

(d) How much work does it take to move the plate on the left further away from the other plate by distance $d$? [12 pts]

(e) What is the energy stored in the original configuration? You can assume that you need to move the plate from distance 0 to $d$. Answer in terms of $Q$ ($\sigma \times A$), and $C$ (capacitance) [12 pts]
Problem 3 [True or False Questions] [12pts]
Dielectric strength (maximum electric field) of air is $3 \times 10^6$ V/m.

(a) Given a parallel plate capacitor, maximum charge per unit area you can store depends on the separation between two plates. [3 pts]

(b) If you have large spherical metallic shell and small spherical shell, you can store more charge on larger shell. [3 pts]

(c) If you have two capacitors (with equal capacitance) in series, the total capacitance is larger than that of each capacitor. [3 pts]

(d) Energy of 500 eV is equivalent to an electron being accelerated through a potential difference of 500 volts. It does not matter how the potential is being applied. [3 pts]