Suggested Problems 4

1. What is the capacitance of the two metal spheres shown in Figure 1 if a potential difference of 100 V is generated between the spheres when one is charged with 20 nC and the other with -20 nC?

![Figure 1](image1)

2. A parallel-plate capacitor consists of two circular conducting plates of area 0.04 m², separated by a distance of 0.2 mm. The plates are connected to the terminals of a 12 V battery.

   a) What is the charge on each plate? What is the electric field between the plates?

   b) If you move the plates apart so that their separation becomes 0.3 mm, how much charge will flow from each plate to the terminals of the battery? What will be the new electric field?

   c) Due to the increase in the plate separation as in part (b), do you observe the following quantities to increase, decrease, or remain the same: i) capacitance, and ii) potential difference across the capacitor?

3. Two infinitely long parallel conducting wires, each of radius a, are separated by a distance d. Figure 2 shows a part of the infinitely long wires. Assuming d >> a, derive the capacitance per unit length.

![Figure 2](image2)

4. Given a hydrogen atom, calculate the following:
a) The electric potential established by the nucleus of a hydrogen atom at the average distance of the circulating electron \((r = 5.29 \times 10^{-11} \text{m})\),

b) The electric potential energy of the atom when the electron is at this radius,

c) The kinetic energy of the electron, assuming it to be moving in a circular orbit of this radius centered at the nucleus, and

d) The energy required to ionize the hydrogen atom.

Note: Express all energy values in electron-volts (eV).