Homework 2 – Due September, 20

2.1. (20 pt.) Point charges Q_1 and Q_2 are, respectively, located at (4,0,-3) and (2,0,1). If Q_2 = 4 nC, find Q_1 such that:

a) The E vector at (5,0,6) has no z-component;

b) The force on a test charge at (5,0,6) has no x-component.

2.2. (15 pt.) The point charge Q is located at point P(0,-4,0), while a 10 nC charge is uniformly distributed along a semicircular ring as shown in Figure 1. Find the value of Q such that E(0,0,0) = 0.

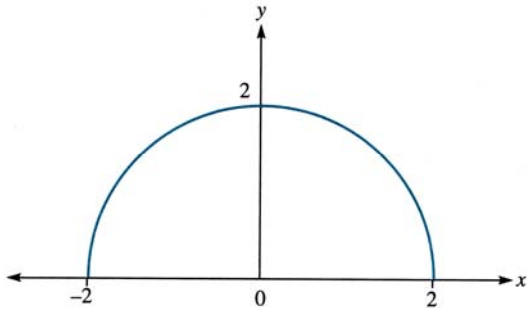

Figure 1

2.3. (15 pt.) If spherical surfaces r = 1 m and r = 2 m, respectively (see Figure 2 as a hint), carry uniform surface charge densities 8 nC/m^2 and -6 nC/m^2, find D at r = 3 m.

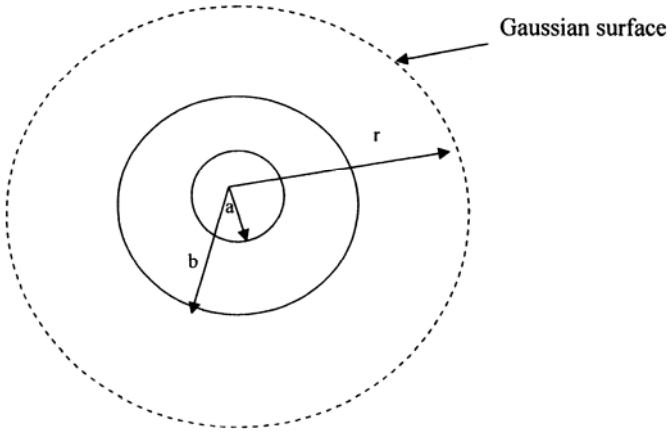

Figure 2

2.4. (20 pt.) Three point charges Q_1 = 1 mC, Q_2 = -2 mC, and Q_3 = 3 mC are, respectively, located at (0,0,4), (-2,5,1), and (3,-4,6).

a) Find the potential V_P at $P(-1,1,2)$;

b) Calculate the potential difference V_{PQ} if Q is (1,2,3).

2.5. (10 pt.) If $V = 2x^2 + 6y^2$ V in free space, find the energy stored in a volume defined by $-1 \le x \le 1$, $-1 \le y \le 1$, and $-1 \le z \le 1$.

2.6. (10 pt.) In a slab of Teflon ($\varepsilon_r = 2.1$), the electric field is $E = 6u_x + 12u_y - 20u_z \ \ V/m$. Find ***D*** and ***P***.

2.7. (10 pt.) Two point charges in free space are separated by distance d and exert a force 2.6 nN on each other. The force becomes 1.5 nN when the free space is replaced by a homogeneous dielectric material. Calculate the dielectric constant of the material.