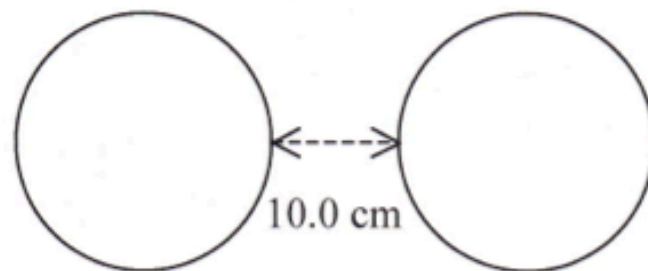PHYSICS 51W – Workshop - Week 3

These problems are based on the second half of Chapter 22

1. A sphere has a radius of 10.0 cm and a uniform charge density $\rho = \cancel{0.120}\ 0.0120\ C/m^3$.
   a. How much charge is on the sphere.
   b. A second, identical sphere is placed 10.0 cm away as shown. What is the force on either sphere?

10.0 cm

2. Two infinite plane plates are 2.0 cm apart. They have equal and opposite surface charge densities on them. If the electric field between them is 1.00×10^5 N/C, directed downward as shown.
   a. What is the surface charge density on the upper plate?
   b. How would your answer change if the separation between the plates were twice as great? If the electric field were twice as great?

σ

E

$-\sigma$

2.0 cm
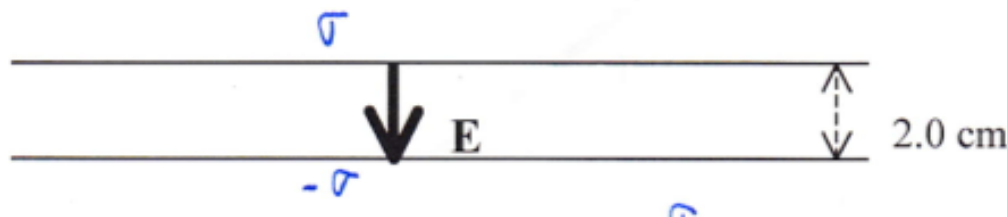
3. A metal sphere has a radius 10.0 cm. After an unknown amount of charge is placed on the sphere, it is discovered that the electric field 10.0 cm from the surface is 1.25×10^5 N/C directed toward the sphere.

      a. What is the charge on the sphere?
      b. What is the surface charge density on the sphere?
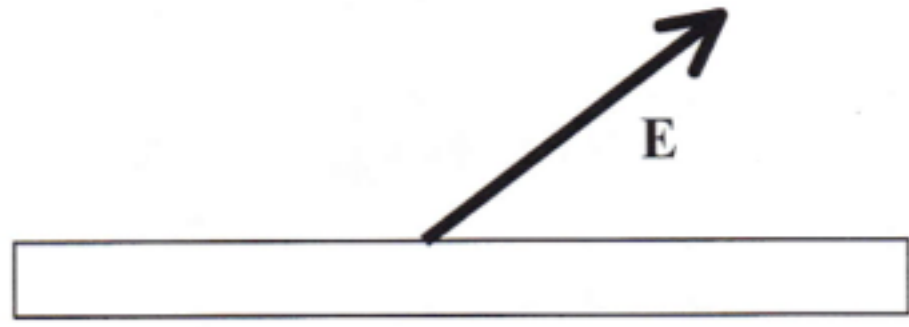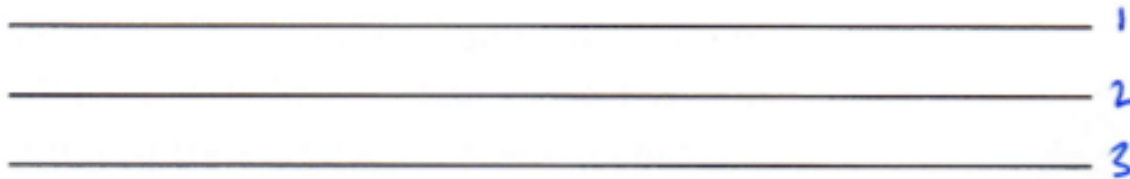   c. What is the electric field just outside the sphere?

E

10.0 cm

4.

The picture above represents a piece of metal. There is charge on the piece of metal.

      a. Explain why the electric field inside the piece of metal is zero.
      b. Explain why the electric field outside the piece of metal cannot be in the direction indicated in the picture below.

E

5.

_____ 1
_____ 2
_____ 3

Three large parallel insulating sheets are 1.00 cm apart.
    The upper one has a surface charge density $\sigma_1 = 6.0\ \mu C/m^2$.
    The middle one has a surface charge density $\sigma_2 = -6.0\ \mu C/m^2$.
    The lowest one has a surface charge density $\sigma_3 = 2.0\ \mu C/m^2$.
Find the magnitude and direction of the electric field in the following regions
    a. Above the upper plate
    b Between the two upper plates
    c. Between the two lowest plates
    d. Below the lowest plate.

6. A thick metal sphere has an inner radius of 10.0 cm
and an outer radius of 20.0 cm. A charge of 6.0 μC is
placed at the center of the metal sphere, and a charge
of –4.0 μC is placed on the metal sphere. The distances
in the questions below are measured from the center.
    a. What is the electric field at r = 30.0 cm?
    b. What is the electric field at r = 15.0 cm?
    c. What is the electric field at r = 7.5cm?
    d. Determine the surface charge density of the charge
located at r = 10.0 cm and at r = 20.0 cm.
    e. Sketch a graph of the electric field as a function of r.

7. The electric field in a certain region of space is 1.25×10^5 N/C.

    a. If you are 10.0 cm from a point charge, what is the charge?

    b. If you are 10.0 cm from a metal sphere of radius 5.0 cm, what is the charge on the sphere?

    c. If you are 10.0 cm from an infinitely long iniform line charge, what is its charge per unit length?

    d. if you are 10.0 cm from a uniform infinite plane of charge, what is the surface charge density?

    e. If you are 10.0 cm from a uniformly charged sphere of radius 5.0 cm, what is the volume charge density of the sphere?

8. 10 µC of charge is uniformly distributed on a sphere whose radius is 10.0 cm.

    a. Find and graph the electric field outside the sphere.

    b. The dashed line represents an imaginary spherical surface concentric with the sphere. The radius of this dashed sphere is 5.0 cm. How much charge is inside this new sphere?

    c. What is the flux of the electric field through this dashed sphere?

    d. Find and graph the electric field inside the charged sphere.
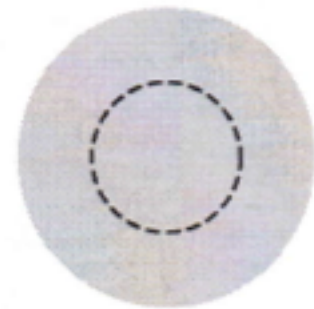
9. Three concentric thin metal shells have radii of 5.0 cm, 10.0 cm, and 15.0 cm. The inner shell has a charge of 2.0 µC. The middle shell has a charge of – 6.0 µC. The outer shell has an unknown amount of charge.

    a. It is observed that there is no electric field outside the outer shell. How much charge is on this shell?

      b. Graph the electric field as a function of r.

      c. Where is the electric field the greatest?
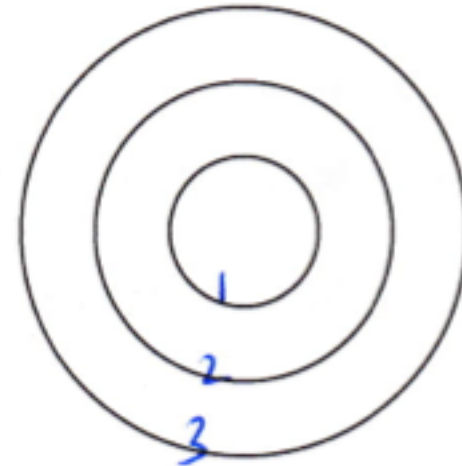
10. A solid sphere has a volume charge density $\rho = 2.0$ ~~~ C/m^3. The radius of the sphere is 20.0 cm.

      a. What is the total charge on the sphere?

      b. Use Gauss' Law to determine the electric field outside the sphere.