K=9.0E9N.m$^2$ /C$^2$; $\varepsilon_0$=8.85E-12C$^2$/N.m$^2$ ; e=1.602E-19C; 1eV=1.602E-19

| P1 20 | P2 20 | P3 20 | P4 25 | P5 20 | Total 105 |
|---|---|---|---|---|---|
| | | | | | |

1. (20 points) A non-conducting sphere of radius 5 cm has a uniform charge distribution of **-5nC/cm$^3$** on it (draw a diagram). K=9.0E9N.m$^2$ /C$^2$
   a. Calculate the amount of **total charge** on it. Calculate the **total electric flux** around the sphere **at 5.1cm and 20cm from the center**.

Q=

$\Phi_{5.1cm}$=

$\Phi_{20cm}$=

   b. Calculate the electric field inside the sphere at 2cm from the center. What is the direction?

$E_{magnitude}$=
$E_{direction}$=

   c. Calculate the electric field outside the sphere at a distance r (greater than the radius of the sphere). Leave your answer as a function of r.

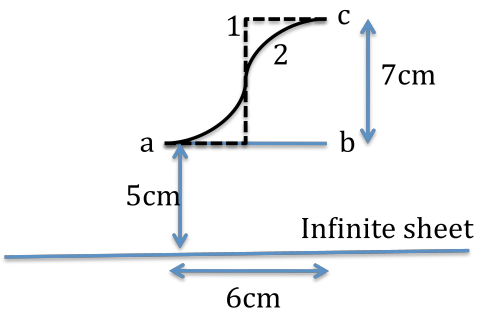
   d. Find direction and magnitude calculate of the electric force on a +10nC point charge located at a distance 20cm from the center of the sphere.

$F_{magnitude}$=
$F_{direction}$=

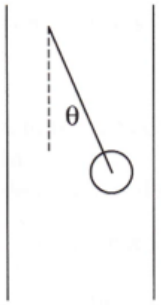
2. (20 points) An infinite plate has an electric field of 1.00E5N/C directed towards the plate.
   a. 5 points) Calculate the surface charge density and its sign on the plate?

   b. (5 points) Calculate the amount of work needed to move a -5nC point charge **from point a to b**. What is the **potential difference** between points a and b?

   c. (10 points) Calculate the amount of work needed to move a -5nC point charge from **point a to point c along path 1 and 2.** What is the change in potential energy of the system once the move is complete **via paths 1 and 2?** What is the potential difference between points **a and c**?



3. (20 points) A 2.0gm ball with -5.0 microC charge on it is hanging still between two parallel vertical metal plates at an angle 35 degree with vertical direction.
   a. (15 points) Fid the magnitude and direction of the electric fields between the plates. Don't forget to draw the free body diagram.




   b. (5 points)Determine the surface charge density on one of the plates.

4. (25 points) A parallel plate capacitor with air between the plates has a capacitance of 5.0 nF. The capacitor is attached to a 20 V battery.
    a. How much energy is stored in the capacitor?

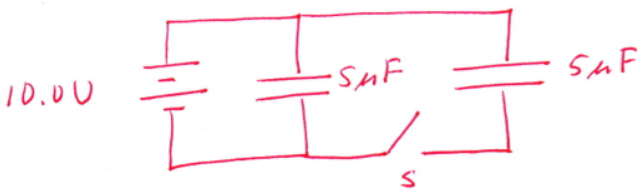
    b. If the separation between plates is 1mm, what is the area of each plate?

    c. A thin piece of glass, with a dielectric constant 6.0, is slid between the plates. What is the new capacitance ?

    d. Compare the potential difference across the capacitor before and after the glass is used.

    e. A thin piece of glass, with a dielectric constant 6.0, is slid **half way** between the plates. What is the new capacitance?

5. (20 points) In the circuit shown, switch S is initially open. The capacitor on the right is initially uncharged.
   a. (10 points )Find the potential V across each capacitor, and the charge on each, before the switch is closed.




   b. (10 points )Find the potential V across each capacitor, and the charge on each, after the switch is closed.