Module 04 Homework

1. For this question, consider Figure 3. The image shows some hypothetical electric field vectors.
    1. Is the electric potential at the position marked "A" geater than or less than the potential at the position marked B?
    2. Is the electric potential at the position marked "A" geater than or less than the potential at the position marked D?
    3. Is the electric potential at the position marked "A" geater than or less than the potential at the position marked C?
    4. Imagine a path that starts at position "B", goes to position "D", and then ends on position "C". Will the electric potential at the end of the path be greater than or less than the potential at the beginning of the path?
2. Consider the conductor described in Problem 9.. What would the electric potential of the conductor be if $D = 24\,\text{cm}$, $\sigma = 0.0166\,\frac{\mu\text{C}}{\text{cm}^2}$? These values are close to the values for our Van de Graaff generator.
3. A $1.00 \times 10^1\,\text{cm}$ diameter conducting sphere has an excess charge of $0.02\,\text{nC}$.
    1. What is the electric potential at the center of the conductor?
    2. How far from the surface of the conductor is the electric potential $1.00\,\text{V}$?
4. Recall from Module 01 homework that the Bohr radius, which gives the most probable distance between the electron and proton in a Hydrogen atom, is $5.29 \times 10^{-11}\,\text{m}$.
    1. What is the electric potential at a distance equal to the Bohr radius from a proton?
    2. What is the electric potential energy of an Hydrogen atom when the electron is a one Bohr radius away from a proton? Give your answer in J.
    3. Use the same model you used in Module 01 to compute the total energy of an electron orbiting a proton at a distance equal to the Bohr radius. This is the sum of the kinetic and potential energies. Give your answer
5. Two protons are accelerated to the same speed and directed toward each other (perhaps in a large particle accelerator for example).
    1. What minimum speed would be required to make the protons come within a $1\,\text{nm}$ of each other.
    2. What minimum speed would be required to make the protons come within Bohr radius of each other.
6. Consider a uniform electric field, $\vec{E} = 2.50\,\frac{\text{N}}{\text{C}}\hat{x} + 1.00\,\frac{\text{N}}{\text{C}}\hat{y}$.

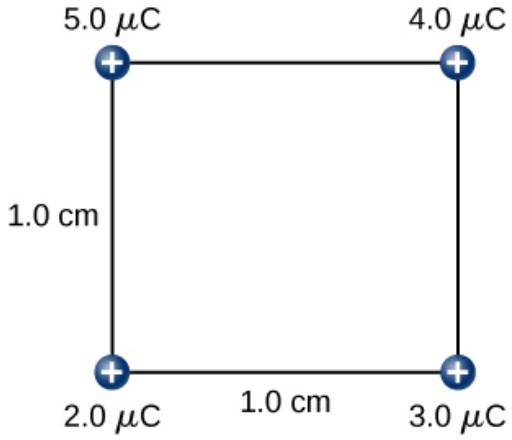

Figure 1:

1. What is the electric potential difference from the point (2 m, 3 m) to (−1 m, 6 m) (with the correct sign)

2. What is the electric potential difference from the point (−3 m, −3 m) to (3 m, −6 m) (with the correct sign)

7. Consider the charge configuration shown in Figure 1. How much work would it take to assemble this configuration? Start by determining how much work would be required to bring each charge into place, noting that each time a new charge is put into place, it exerts a force on the next charge brought into place.

8. Consider the arc of charge shown in Figure 2. Assume that a total charge Q is uniformly distributed over the arc. What is the electric potential at the point P?

    1. Using the angle (call it θ) between the line from P to b and the arrow next to the R as your integration parameter, construct an integral that could be evaluated to determine the electric potential at the point P. Remember that a positive angle corresponds to counter-clockwise rotation.

    2. Using the distance (call it s) along the arc from the pont a as your integration parameter, construct an integral that could be evaluated to determine the electric potential at the point P.

9. **Example Problem Write-up** An isolated conducting sphere with surface area A has an excess charge spread uniformly over the its surface with a surface charge density σ. Assume that the sphere is centered at the origin. Sketch a plot of the electric potential and the x component of the electric field along the x axis as a function of x. Provide a explanation for the main features of your graph (in other words, where should it be positive, negative, zero, large, small etc.)

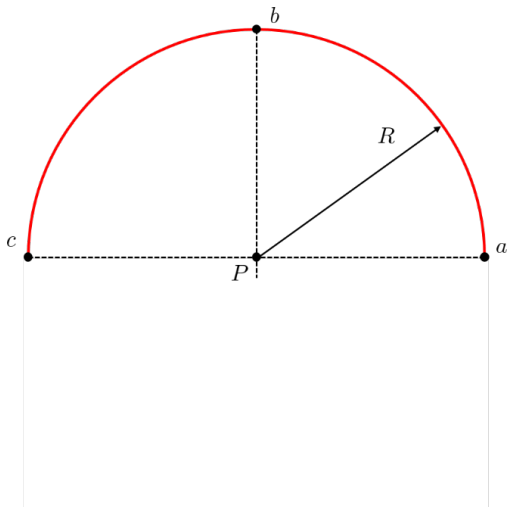

Figure 2:

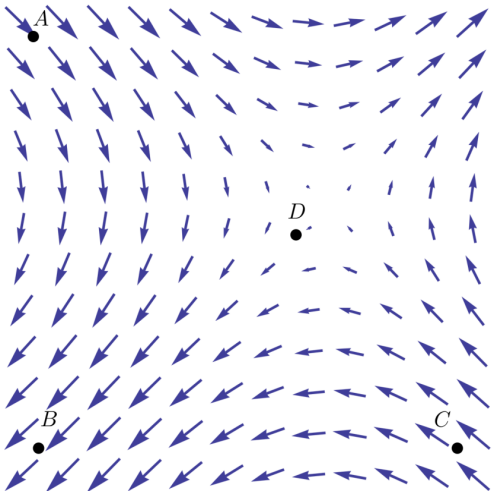

Figure 3: