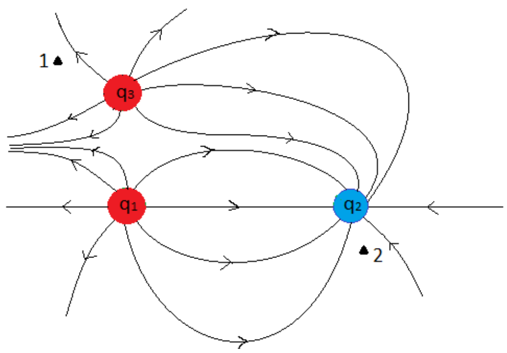
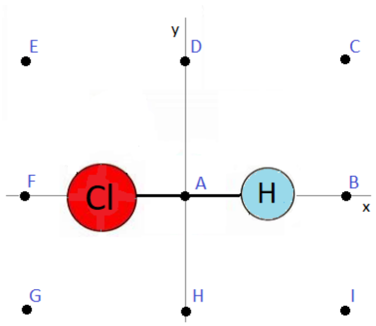
Homework 3: Electric Potential   due 4/27

Problem 1. Consider the two points below. Draw the equipotential curve running through each. Then determine which is at the higher potential, and justify your answer by drawing a path between the equipotentials which follows a field line.



Problem 2. Let's reconsider the HCl molecule from before . Calculate the electric potential at each of the following points. Recall H has a charge +e, Cl a charge -e, and that the bond length is ℓ = 127pm. Answers should be in the 0 to $\pm$100 Volt range, when they're not zero.



(a) Point A = (0pm, 0pm).

(b) Point B = (100pm, 0pm)?

(c) Point C = (100pm, 100pm)?

(d) Point D = (0pm, 100pm)?

(e) Point E = (-100pm, 100pm)?

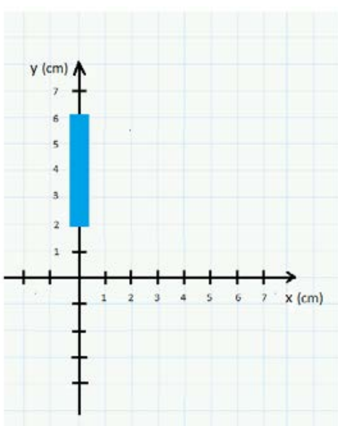
(f) Point F = (-100pm, 0pm)?

(g) Point G = (-100pm,-100pm)?

(h) Point H = (0pm, -100pm)?

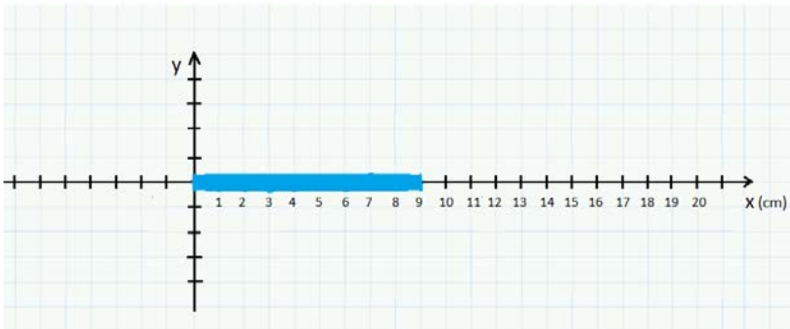
(i) Point I = (100pm, -100pm)?

Problem 3. Remember this guy, the plastic rod charged non-uniformly as $\lambda(y) = -2y$ (nC/m)?
(a) Calculate its electric potential at the point x = 5cm. Answer should be in the half Volt range.

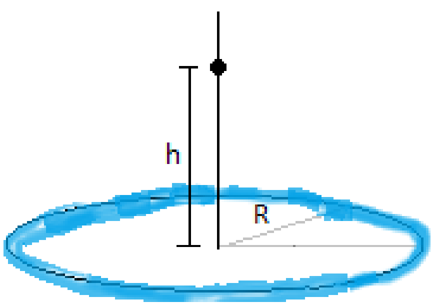


(b) Now give an expression for the potential at general coordinate y, below the origin. If you do it right, then you should get V(-1·meter) = -28mV, for instance.

Problem 4. Now consider the other plastic rod from HW 1, charged uniformly with 10nC. Give an expression for the electric potential at any point (x,y) in the third quadrant. If you do this right, then you should get V(-1·meter,-1·meter) = 62V, for instance.

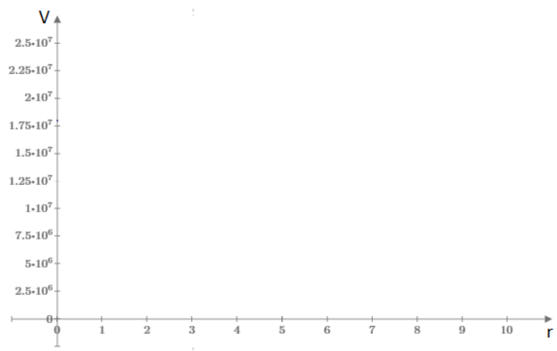


Problem 5. Say we have the same R = 3m ring as last time, and that we again smear 7nC of charge on it, but this time uniformly over the entire ring. Give an expression for the potential at height h. If you do this right then you should get V(h = 1·meter) = 20V.

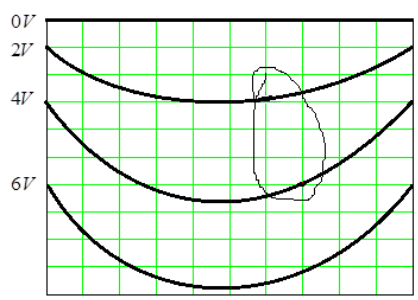


Problem 5. Now let's go back to that dustcloud problem. Recall that it had a 3m radius, and that its field was (hopefully) this thing below. Make a plot of the cloud's electric potential as a function of radius, taking r = ∞ as your reference point. Should get V(0) as about 18MV.

$$E = \frac{kq_{enclosed}}{r^2} = \begin{cases} 1.33\times 10^6 r & \text{inside} \\ \dfrac{36\times 10^6}{r^2} & \text{outside} \end{cases}$$



Problem 6. Consider the equipotentials displayed on the grid below. Draw in five electric field lines (including arrows) that would correspond to them. And estimate the field strength in the circled region.



Problem 7. Going back to problem 3b, use your V(y) expression to calculate the electric field strength and direction at y = -3cm. You should get what you calculated in HW 1.

Problem 8. Going back to problem 4, use your V(x,y) expression to calculate the electric field strength and direction at the coordinate (-4cm, -4cm). You should get what you calculated in HW 1.

Problem 9. Last one. Reconsider that ring in problem in problem 5. Use your V(y) formula to get a formula for the electric field at any height y above the ring.