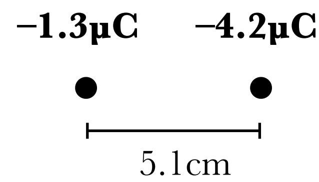
Physics 102 Homework #7

first draft due Wednesday, March 22nd
final draft due Sunday, March 26th

1. These two negative charges are 5.1cm apart. What is the force on the −1.3μC charge?
Give the magnitude **and the direction** of the force.



The magnitude of the force on one charge due to another is given by Coulomb's law:

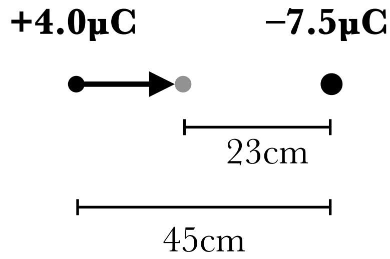
$$F = k\frac{|q_A q_B|}{d^2}$$

$$= \left(9\times 10^9 \frac{\text{Nm}^2}{\text{C}^2}\right)\frac{(1.3\times 10^{-6}\text{C})(4.2\times 10^{-6})}{(5.1\times 10^{-2}\text{m})^2}$$

$= 18.9$N.

The two charges have the same sign, so the −1.3μC charge is pushed away from the other charge, or to the left. Thus the force on the charge is $\vec{F}$ = **18.9N to the left.**

2. A +4.0μC charge starts at a distance of 45cm from a −7.5μC charge. By how much does the potential energy of this system change when the +4.0μC charge moves closer, until this is 23cm away? Include the right sign (positive for an increase, or negative for a decrease).



The change in potential energy is $\Delta PE = PE_f - PE_i$. The initial potential energy of this configuration is

$$PE_i = k\frac{q_1 q_2}{d} = \left(9\times 10^9 \frac{\text{Nm}^2}{\text{C}^2}\right)\frac{(+4.0\times 10^{-6}\text{C})(-7.5\times 10^{-6})}{(45\times 10^{-2}\text{m})} = -0.60\text{J}$$

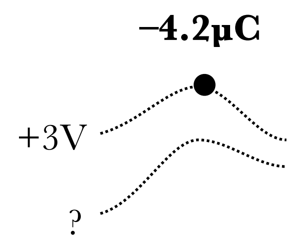
while the final potential energy is

$$PE_f = k\frac{q_1 q_2}{d} = \left(9\times 10^9 \frac{\text{Nm}^2}{\text{C}^2}\right)\frac{(+4.0\times 10^{-6}\text{C})(-7.5\times 10^{-6})}{(23\times 10^{-2}\text{m})} = -1.17\text{J}.$$

Thus the change in potential energy is

$\Delta PE = PE_f - PE_i = -1.17\text{J} - (-0.60\text{J}) = \mathbf{-0.57J}$.

3. A −4.2μC charge sits on a +3V equipotential line.



a. What is the potential energy of the charge?

The potential energy PE_T is given by $PE_T = q_T V$.

$PE_T = (-4.2\mu\text{C})(3\text{V}) = \mathbf{-12.6\ \mu J.}$

b. Suppose the charge is given +5μJ of energy as it is pushed onto the second equipotential line. What is the potential of the second equipotential line?

The change of potential energy is $\Delta PE = +5\mu\text{J}$, and so the change in the charge's potential is

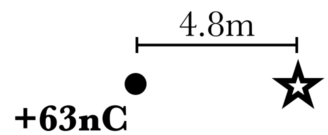
$$\Delta V = \Delta PE / q_T = 5\mu\text{J}/(-4.2\mu\text{C}) = -1.19\text{V}$$

Since the first line is at +3V, the second line is at

$$V = 3 - 1.19 = +\mathbf{1.8V.}$$

(The negative charge moved downhill which it does not want to do, so it requires positive work to move there.)

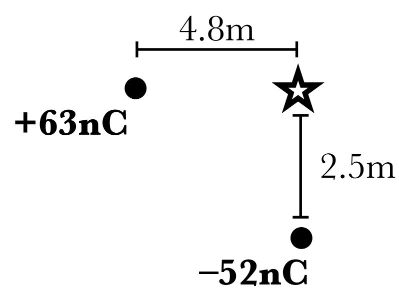
4a. What is the electric potential 4.8m from a +63nC charge? Assume $V_\infty = 0$.



The potential at the star is

$V = k\frac{q}{d} = (9 \times 10^9)\frac{+63 \times 10^{-9}}{4.8} = \mathbf{118V}.$

4b. Suppose I had a negative charge, $q = -52\text{nC}$, 2.5m below the target. What is the potential at the star now?



The potential at the star due to the negative charge is

$V = k\frac{q}{d} = (9 \times 10^9)\frac{-52 \times 10^{-9}}{2.5} = -187\text{V}.$

The total potential at the star is

$V = +118 - 187 = \mathbf{-69V}.$