Units? Units?

Name________________________________

Phys 2020, Section
Quiz #1 — Fall 2003

1. Two 2.0 μC charges exert a repulsive force of 0.300 N on each other. What is the separation of the charges?

Force between two charges is $F = k\frac{|q_1 q_2|}{r^2}$, so:

$$r^2 = \frac{k|q_1 q_2|}{F} = \frac{(8.99\,\frac{Nm^2}{C^2})(2.0\times10^{-6}\,C)^2}{(0.300\,N)} = 0.120\ m^2$$

$$\longrightarrow\ r = \boxed{0.346\ m}$$

2. If 6.0×10^{23} electrons move through a potential difference of $\Delta V = +5.00$ V, what is their loss in electrical potential energy? Express the answer in Joules.

6.0×10^{23} electrons have a total charge of magnitude

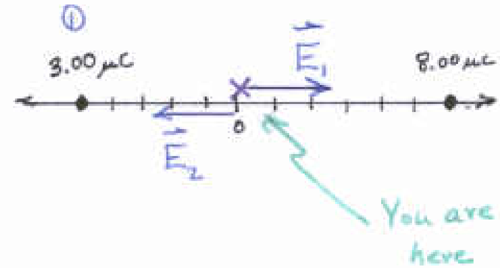
$$|q| = (6.0\times10^{23})\,e = (6.0\times10^{23})(1.602\times10^{-19}\,C) = 9.61\times10^4\,C$$

The total charge of the electrons is -9.61×10^4 C. The change in EPE of this amt of charge is

$$\Delta EPE = q\,\Delta V = (-9.61\times10^4\,C)(+5.00\,V) = -4.81\times10^5\,J$$

So the electrons lose $\boxed{4.81\times10^5\,J}$ of potential energy.

3. Two positive charges are located on the x axis: A $3.00\,\mu\text{C}$ charge is located at $x = -5.00$ cm and a $8.00\,\mu\text{C}$ charge is located at $x = +6.00$ cm.



a) What is the magnitude and direction of the electric field at the origin?

E field from the 3.00μC charge has magnitude

$$E_1 = k\frac{|q_1|}{r_1^2} = \left(8.99\times10^9 \frac{N m^2}{C^2}\right)\frac{(3.00\times10^{-6}C)}{(5.00\times10^{-2}m)^2} = 1.079\times10^7 \, N/C$$

& points in the +x dir.

E field from the 8.00μC charge has magnitude

$$E_2 = k\frac{|q_2|}{r_2^2} = \left(8.99\times10^9 \frac{N m^2}{C^2}\right)\frac{(8.00\times10^{-6}C)}{(6.00\times10^{-2}m)^2} = 1.998\times10^7 \, N/C$$

& points in the −x dir.

The total E field in the +x dir is

$$E_{x,\,tot} = +1.079\times10^7 \tfrac{N}{C} - 1.998\times10^7 \tfrac{N}{C} = \boxed{-9.2\times10^6 \tfrac{N}{C}}$$

This is the x-component of the total E-field.

b) If a $-4.00\,\mu\text{C}$ charge is placed at the origin what is the magnitude and direction of the force on the charge? (Hint: the answer to (a) could be useful here.)

Since $\vec{F} = q\vec{E}$ then the force on the charge has x-component

$$F_x = q\,E_x = (-4.00\times10^{-6}C)(-9.2\times10^6 \tfrac{N}{C}) = \boxed{+36.8\ N}$$

i.e. 36.8 N in the +x direction.

You must show all your work and include the right units with your answers!

$$k = \frac{1}{4\pi\epsilon_0} = 8.99\times10^9\,\frac{\text{N}\cdot\text{m}^2}{\text{C}^2} \qquad \epsilon_0 = 8.85\times10^{-12}\,\frac{\text{C}^2}{\text{N}\cdot\text{m}^2} \qquad F = k\frac{|q_1q_2|}{r^2} = \frac{1}{4\pi\epsilon_0}\frac{|q_1q_2|}{r^2}$$

$$\mathbf{F} = m\mathbf{a} \qquad g = 9.80\,\frac{\text{m}}{\text{s}^2} \qquad m_{\text{elec}} = 9.1094\times10^{-31}\ \text{kg} \qquad e = 1.602\times10^{-19}\ \text{C}$$

$$\mathbf{F} = q\mathbf{E} \qquad E_{\text{pt ch}} = k\frac{|q|}{r^2} \qquad E_{\text{plates}} = \frac{\sigma}{\epsilon_0} \qquad E_{\text{plane}} = \frac{\sigma}{\epsilon_0}$$

$$\Delta\text{EPE} = q_0\Delta V \qquad E_x = -\frac{\Delta V}{\Delta x} \qquad 1\ \text{eV} = 1.602\times10^{-19}\ \text{J}$$