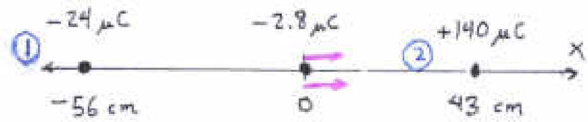
Units?
Units?

Name________________________

Phys 2020
Quiz #1 — Fall 2002

1. A particle with charge $-24\,\mu\mathrm{C}$ is located on the x axis at the point $x_1 = -56$ cm and a second particle with charge $+140\,\mu\mathrm{C}$ is placed on the x axis at $x_2 = +43$ cm.

What is the magnitude and direction of the total electrostatic force on a third particle with charge $-2.8\,\mu\mathrm{C}$ placed at the origin ($x = 0$)?



The force from charge ① has magnitude

$$F_1 = k\frac{|q_1 q_2|}{r^2} = \left(8.99\times10^9\,\frac{\mathrm{Nm^2}}{\mathrm{C^2}}\right)\frac{(24\times10^{-6}\,\mathrm{C})(2.8\times10^{-6}\,\mathrm{C})}{(56\times10^{-2}\,\mathrm{m})^2} = 1.93\ \mathrm{N}$$

and points in the $+x$ direction (repulsive).

The force from charge ② has magnitude

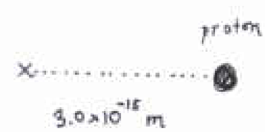
$$F_2 = k\frac{|q_1 q_2|}{r^2} = \left(8.99\times10^9\,\frac{\mathrm{Nm^2}}{\mathrm{C^2}}\right)\frac{(140\times10^{-6}\,\mathrm{C})(2.8\times10^{-6}\,\mathrm{C})}{(43\times10^{-2}\,\mathrm{m})^2} = 19.06\ \mathrm{N}$$

and points in the $+x$ direction (attractive).

The net force in the $\boxed{+x \text{ direction}}$ is then

$$F_x = +F_1 + F_2 = \boxed{20.99\ \mathrm{N}}$$

2. What is the magnitude of the electric potential at a distance of 3.0×10^{-15} m from a proton? (Take the proton to be a point particle even though it really isn't!)



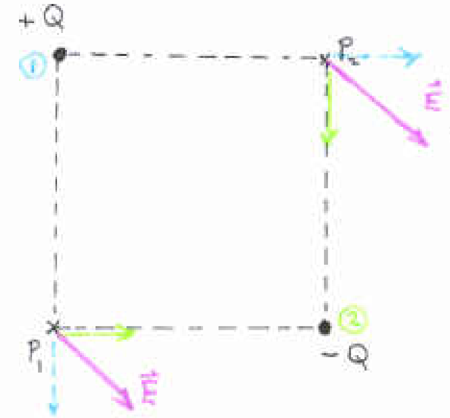
Proton is a point charge with charge $q = +e$
so the pot'l V at distance $r = 3.0\times10^{-15}$ m is

$$V = k\frac{q}{r} = \left(8.99\times10^9\,\frac{\mathrm{Nm^2}}{\mathrm{C^2}}\right)\frac{(1.602\times10^{-19}\,\mathrm{C})}{(3.0\times10^{-15}\,\mathrm{m})} = \boxed{4.8\times10^5\ \mathrm{V}}$$

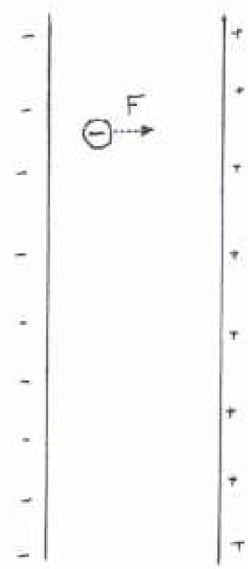
3. Charges $+Q$ and $-Q$ are situated on opposite corners of a square, as shown.

Show the directions of the electric field at the other corners, P_1 and P_2.

Directions of the E-fields due to each of the charges at points P_1 and P_2 are as shown. They add to form the vectors shown.



4. When an electron moves between two large parallel plates (which are separated by 5.0 mm), it feels a force of magnitude 2.3×10^{-14} N.



a) What is the magnitude of the electric field between the plates?

Use $|\vec{F}| = |q\vec{E}|$, with $q = -e$, then

$$|\vec{E}| = \left|\frac{\vec{F}}{q}\right| = \frac{2.3 \times 10^{-14}\ \text{N}}{(1.602 \times 10^{-19}\ \text{C})} = \boxed{1.43 \times 10^{5}\ \frac{\text{N}}{\text{C}}}$$

b) What is the difference in electric potential ("voltage") across the plates?

Use $|E_x| = \left|\Delta V / \Delta x\right|$, then

$$|\Delta V| = |E_x \Delta x| = \left(1.43 \times 10^{5}\ \frac{\text{N}}{\text{C}}\right)\left(5.0 \times 10^{-3}\ \text{m}\right)$$

$$= \boxed{718\ \text{V}}$$

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

$$k = \frac{1}{4\pi\epsilon_0} = 8.99 \times 10^{9}\ \frac{\text{N}\cdot\text{m}^2}{\text{C}^2} \qquad \epsilon_0 = 8.85 \times 10^{-12}\ \frac{\text{C}^2}{\text{N}\cdot\text{m}^2} \qquad F = k\frac{|q_1 q_2|}{r^2} = \frac{1}{4\pi\epsilon_0}\frac{|q_1 q_2|}{r^2}$$

$$\mathbf{F} = m\mathbf{a} \qquad g = 9.80\frac{\text{m}}{\text{s}^2} \qquad m_{\text{elec}} = 9.1094 \times 10^{-31}\ \text{kg} \qquad e = 1.602 \times 10^{-19}\ \text{C}$$

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

$$|E_x| = \left|\frac{\Delta V}{\Delta x}\right| \qquad q = CV \qquad C = \epsilon_0 A/d \qquad E_{nergy} = \tfrac{1}{2}CV^2$$