Units?
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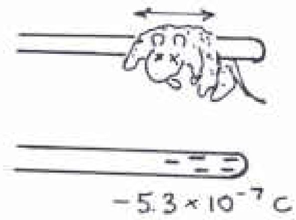
Name____________________________

Phys 122 — Section 1

Quiz #1

1. A neutral plastic rod is rubbed with a piece of roadkill; it acquires a charge of -5.3×10^{-7} C. Did it gain or lose electrons? How many electrons did it gain or lose?

Electrons are neg'ly charged so it gained electrons.
Charge of electron is -1.60×10^{-19} C, so # of excess electrons on rod is



$$N = \frac{-5.3 \times 10^{-7}\,C}{-1.60 \times 10^{-19}\,C} = 3.3 \times 10^{12}$$

2. A charge of $+6.0\,\mu$C sits on the x-axis at $x = 0.65$ m while a $-9.0\,\mu$C charge is on the x-axis at $x = -0.42$ m.

a) Find the magnitude and direction of the force on the $+6.0\,\mu$C charge (due to the other charge).

From Coulomb's law, mag. of force is, with $r = 0.65\,m + 0.42\,m = 1.07\,m$

$$F = k\frac{|q_1 q_2|}{r^2} = \left(8.99 \times 10^9 \frac{Nm^2}{C^2}\right)\frac{(6.0 \times 10^{-6}C)(9.0 \times 10^{-6}C)}{(1.07\,m)^2} = 0.42\ N$$

The direction of the force is toward the $-9.0\,\mu$C charge, i.e. in the $-x$ direction.

b) Find the magnitude and direction of the electric field at the origin ($x = 0$).

At the origin, the $+6.0\,\mu$C charge contributes

$$E_{x,6} = -k\frac{(6.0\,\mu C)}{(0.65\,m)^2} = -1.28 \times 10^5\ N/C$$

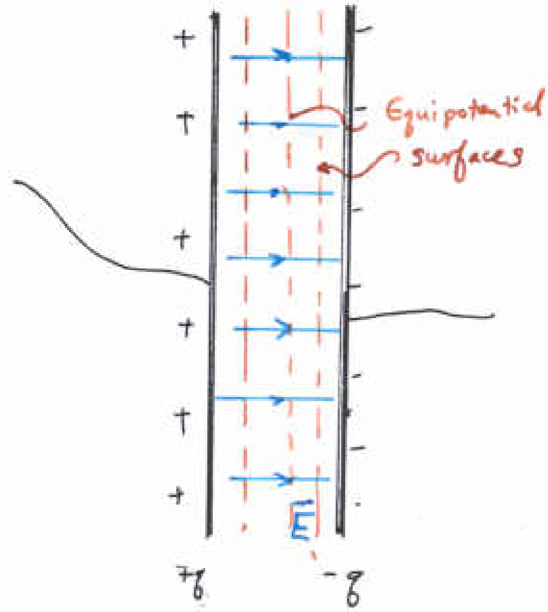
and the $-9.0\,\mu$C charge contributes

$$E_{x,9} = -k\frac{(9.0\,\mu C)}{(0.42\,m)^2} = -4.59 \times 10^5\ N/C$$

Both are dir'd in the $-x$ direction.

Total is $E_x = -5.9 \times 10^5\ N/C$, i.e. $\vec{E}$ field has mag $5.9 \times 10^5\ N/C$ and points in the $-x$ direction.

3. Shown here is a parallel–plate capacitor with charges $+q$ and $-q$ on the plates. The separation of the plates is 3.0×10^{-3} m.



a) On the figure, sketch the electric field lines and the equipotentials.

b) If the electric field between the plates has magnitude 590 $\frac{\text{N}}{\text{C}}$, find the potential difference between the plates. Which one is at a higher potential?

$$|\Delta V| = |E_x| \Delta x$$
$$= (590 \tfrac{N}{C})(3.0\times10^{-3} m)$$
$$= 1.8 \text{ V}$$

The positive plate is at the higher potential (V).

c) Find the work required to push an electron from the positive plate to the negative plate.

$$\Delta EPE = q \Delta V = (-1.6\times10^{-19} C)(-1.8 \text{ V})$$
$$= 2.8\times10^{-19} \text{ J}$$

So 2.8×10^{-19} J of work are required.

You must show all your work!

$e = 1.60 \times 10^{-19}$ C $\quad k = 8.99 \times 10^{9} \frac{\text{N}\cdot\text{m}^2}{\text{C}^2} \quad \epsilon_0 = 8.85 \times 10^{-12} \frac{\text{C}^2}{\text{N}\cdot\text{m}^2} \quad m_e = 9.11 \times 10^{-31}$ kg

$\mathbf{F} = m\mathbf{a}$ Like charges repel... $\mathbf{E} = \dfrac{\mathbf{F}}{q_0}$ $\mathbf{E}$ points away from a positive charge...

$$V = \frac{\text{EPE}}{q_0} \quad 1\,\frac{\text{J}}{\text{C}} = 1\text{ V} \quad E_x = -\frac{\Delta V}{\Delta x} \text{ (For const. } \mathbf{E})$$

$$g = 9.80\,\frac{\text{m}}{\text{s}^2} \qquad \text{Point charge:} \quad E = k\frac{q}{r^2} \quad V = k\frac{q}{r}$$

$$\text{Cap:} \quad E\,(\text{No diel.}) = \frac{q}{\epsilon_0 A} = \frac{\sigma}{\epsilon_0} \qquad q = CV \qquad \frac{E}{E_0} = \kappa \qquad C = \frac{\kappa\epsilon_0 A}{d}$$