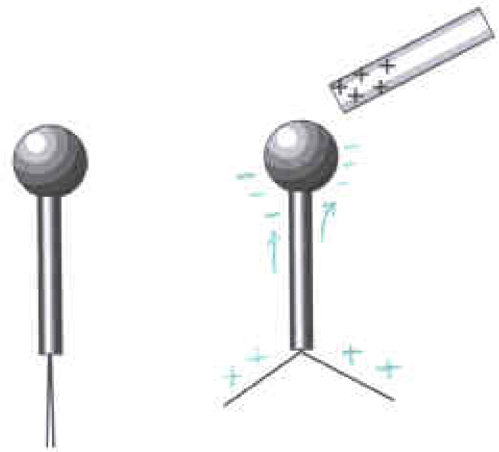
Name ________________ Units? Units?

Phys 2020

Quiz #1 — Spring 2004

1. In a classroom demonstration of the "electroscope", a charged rod is brought close to one end of a conductor at the other end of which are two lightweight metallic leaves. When the rod gets close to the top of the conductor the leaves move apart.

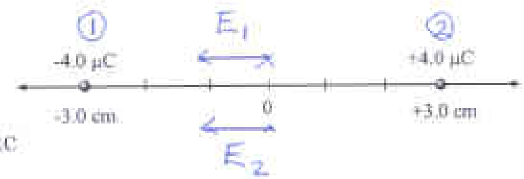
Explain why this happens.



If (as indicated) the rod is positively charged the electrons will be attracted to the upper end of the conductor; as the electrons drift upward the leaves on the opposite end become positively charged. Having the same charge they repel one another and move apart.

2. There is a $+4.0\,\mu$C charge on the x axis at $x = 3.0$ cm and a $-4.0\,\mu$C charge at $x = -3.0$ cm.

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



E fields point away from positive charges and toward negative charges, so at the origin the E fields from both of the charges point in the $-x$ direction. The magnitudes of the fields are:

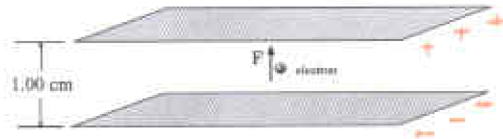
$$E_1 = k\frac{|q_1|}{r_1^2} = \left(8.99\times10^9\,\frac{\mathrm{Nm^2}}{\mathrm{C^2}}\right)\frac{(4.0\times10^{-6}\,\mathrm{C})}{(3.0\times10^{-2}\,\mathrm{m})^2} = 4.00\times10^7\,\frac{\mathrm{N}}{\mathrm{C}}$$

$$E_2 = k\frac{|q_2|}{r_2^2} = k\frac{|q_1|}{r_1^2} = 4.00\times10^7\,\frac{\mathrm{N}}{\mathrm{C}}$$

$$E_{x,\,\text{Total}} = -4.00\times10^7\,\frac{\mathrm{N}}{\mathrm{C}} - 4.00\times10^7\,\frac{\mathrm{N}}{\mathrm{C}} = -8.00\times10^7\,\frac{\mathrm{N}}{\mathrm{C}}$$

E field has magnitude $\boxed{8.00\times10^7\,\frac{\mathrm{N}}{\mathrm{C}}}$ and points in the $\boxed{-x}$ direction

3. An electron moves in the space between two large horizontal parallel plates which carry opposite charges of the same magnitude. The plates are separated by 1.00 cm



The electron experiences an upward electrical force of magnitude 6.00×10^{-16} N.

a) Which plate carries the positive charge?

Electron is negatively charged. $\boxed{\text{Top plate}}$ must be positively charged (to pull electron upward).

b) What is the direction of the electric field between the plates?

E field points in opposite direction to the force since the charge is negative

$\vec{E}$ field points $\boxed{\text{downward}}$.

c) What is the magnitude of the electric field?

Use $F = |q| E$, then:

$$E = F/|q| = (6.00 \times 10^{-16} N)/(1.602 \times 10^{-19} C) = \boxed{3.75 \times 10^{3} \ N/C}$$

d) What is the potential difference between the two plates?

Use $|\Delta V| = E \Delta x$, then pot'l diff. is

$$\Delta V = (3.75 \times 10^{3} \tfrac{V}{m})(1.00 \times 10^{-2} m) = \boxed{37.4 \ V}$$

e) What is the magnitude of the charge density (charge per area) on each plate?

Use $E = |\sigma|/\epsilon_0$, then

$$|\sigma| = \epsilon_0 E = (8.85 \times 10^{-12} \tfrac{C^2}{Nm^2})(3.75 \times 10^{3} \tfrac{N}{C}) = \boxed{3.31 \times 10^{-8} \ C/m^2}$$

f) An alpha particle has a charge of **+2e** If an alpha particle goes between the plates what is the magnitude and direction of the electrical force on it?

Force on pos. charge is in same direction as $\vec{E}$ field, i.e. $\boxed{\text{downward}}$.

Magnitude of the force must be twice the force on the electron,

$$F_{alpha} = 2 F_{elec} = 2 (6.00 \times 10^{-16} N) = \boxed{1.20 \times 10^{-15} N}$$

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

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

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

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

$$\Delta\text{EPE} = q_0 \Delta V \qquad V_{\text{pt-ch}} = k\frac{q}{r} \qquad E_x = -\frac{\Delta V}{\Delta x} \qquad 1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$$