$\boxed{15.5}$ Two protons

What is force each experiences when they are 1×10^{-14} m apart?

$$F_E = \frac{k_o q_1 q_2}{r^2} = \frac{k_o q^2}{r^2}$$

$q_+ = 1.602\times10^{-19}\ C$

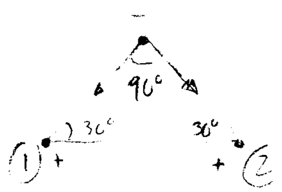
$r = 1\times10^{-14}\ m$

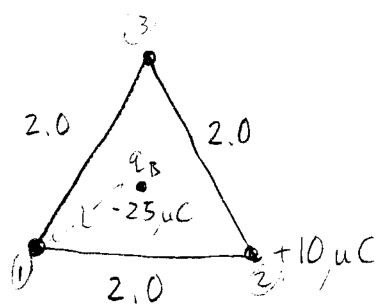
$k_o = 9.0\times10^{9}\ N\cdot m^2/C^2$

$$F_E = \frac{(9.0\times10^{9}\ N\cdot m^2/C^2)(1.6\times10^{-19}\ C)^2}{(1\times10^{-14}\ m)^2}$$

$$\boxed{F_E = 2.3\ N}$$

$\boxed{15.11}$





$$F_1 = \frac{k_o q_A q_B}{r^2} = \frac{k_o q_A q_B}{L^2} = F_2$$

horizontal components cancel out:

vertical component: $F_{vert} = F_1 \sin 30° = \frac{1}{2} F_1$

$F_{tot} = \frac{1}{2}F_1 + \frac{1}{2}F_2 = F_1$

$$F_3 = -\frac{k_o q_A q_B}{L^2} = -F_1 \quad \text{(vertical only)}$$

<u>vert.</u> $\Sigma F = \frac{1}{2}F_1 + \frac{1}{2}F_1 - F_1 = \boxed{0}$

$\boxed{15.9}$ Separation of electron and proton for $F = -1.00\ N$?

Force is Coulomb Force:

$$F = \frac{k_0 q_1 q_2}{r^2}$$

q_1 = electron = -1.6×10^{-19} C

q_2 = proton = $+1.6\times10^{-19}$ C

$k_0 = 8.99\times10^{9}\ N\cdot m^2/C^2$

$F = -1.00\ N$ (attractive)

$$\Rightarrow r = \sqrt{\frac{k_0 q_1 q_2}{F}}$$

$$= \sqrt{\frac{(8.99\times10^{9}\ N\cdot m^2/C^2)(-1.6\times10^{-19}\ C)(1.6\times10^{-19}\ C)}{-1.00\ N}}$$

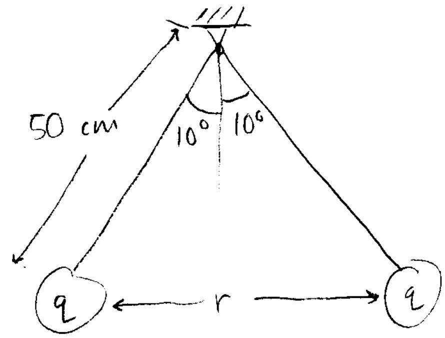
$$\boxed{r = 1.52\times10^{-14}\ m}$$

WEEK 3 HW

$\boxed{15.29}$

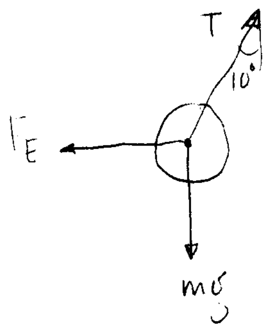
$m = 2.0\,g$

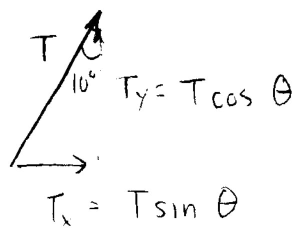
$L = 50\ cm$



$\frac{r}{2} = L\sin\theta$

Free-Body Diagram





Force Balance

horizontal components:

$F_E = T\sin\theta$

$F_E = \frac{k_c q_1 q_2}{r^2} = \frac{k_o q^2}{r^2} = \frac{k_o q^2}{(2L\sin\theta)^2}$

$\Rightarrow \frac{k_c q^2}{(2L\sin\theta)^2} = T\sin\theta$

vertical components:

$mg = T\cos\theta$

Solve for Unknown, q

$T\sin\theta = \frac{k_c q^2}{4L^2\sin^2\theta}$

$T\cos\theta = mg$

$\Rightarrow \tan\theta = \frac{k_o q^2}{4L^2\sin^2\theta\, mg}$

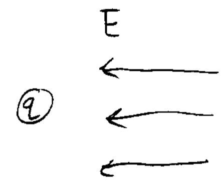
$\Rightarrow q^2 = \frac{4L^2 mg\sin^2\theta\tan\theta}{k_o}$

$q = \sqrt{\frac{4L^2 mg\sin^2\theta\tan\theta}{k_o}} = \boxed{1.1\times 10^{-7}\ C = +0.11\ \mu C}$

$\boxed{15.41}$

$q = -40\,nC$

$E = 2000\ N/C$. West



$F = ?$

$F = qE$

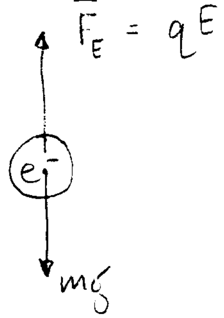
$= (-40 \times 10^{-9}\,C)(2000\ N/C)$

$\boxed{F = -8 \times 10^{-5}\ N}$

Direction is $\boxed{\text{EAST}}$ since q is negative.

15.43

Find $\vec{E}$ if $\vec{E}$ cancels weight electron



electron

$m = 9.1 \times 10^{-31}$ kg

$q = -1.6 \times 10^{-19}$ C

$mg = qE$

$$E = \frac{mg}{q} = \frac{(9.1\times 10^{-31}\ \text{kg})(9.81\ \text{m/s}^2)}{-1.6\times 10^{-19}}$$

$$\boxed{E = 5.58 \times 10^{-11}\ \text{N/C},\ \text{downward}}$$

Force on an electron is <u>against</u> field lines.

$\Rightarrow$ for an upward force, electric field must point downward.

15.79

Electric flux =

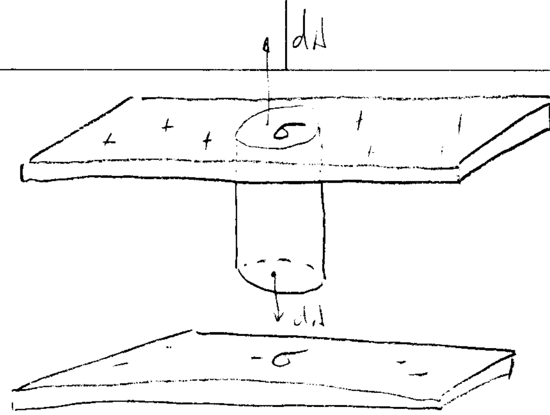
$$\Phi_E = \int E_\perp dA = \frac{1}{\varepsilon_0}\sum q :$$

$$\Phi_E = \frac{1}{\varepsilon_0}\left[22.0\times 10^{-12}\ \text{C} - 12\times 10^{-12}\ \text{C} + 10.0\times 10^{-12}\ \text{C} - 21 - 9\right]$$

$$= \frac{1}{8.854\times 10^{-12}\ \text{C}^2/\text{N}\cdot\text{m}^2}(22 - 12 + 10 - 21 - 9)\times 10^{-12}\ \text{C}$$

$$\boxed{\Phi_E = -1.13\ \text{N}\cdot\text{m}^2/\text{C}}$$

15.83

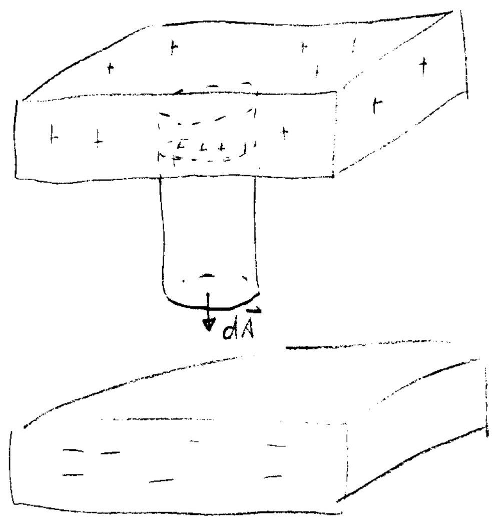


$\sigma = \frac{q}{A}$

Gauss' law

$\oint \vec{E} \cdot d\vec{A} = \frac{1}{\varepsilon_0} \Sigma q$

only $\vec{E} \cdot d\vec{A}$ in vertical direction is non-zero and $E = 0$ inside plate



downward $EA_1 = \frac{1}{\varepsilon_0} q_{enc}$ $\quad q_{enc} = \sigma A$

$EA = \frac{\sigma A}{\varepsilon_0} \Longrightarrow \boxed{E = \frac{\sigma}{\varepsilon_0}}$