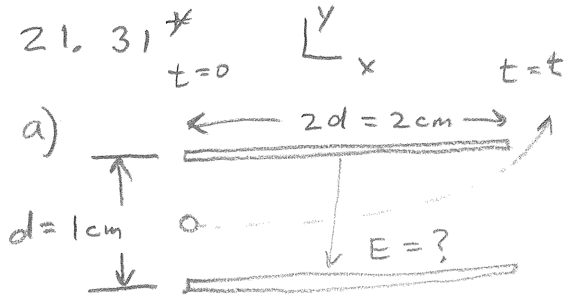
21.31*

ignore gravity

a)



$v_{0x} = 1.6 \times 10^{6}$ m/s

$$\sum F_y = Ee = m_e a_y$$

$$y\text{ motion} \quad \frac{d}{2} = \frac{1}{2} a_y t_f^2$$

$$x\text{ motion} \quad 2d = v_{0x} t_f \Rightarrow t_f = \frac{2d}{v_{0x}}$$

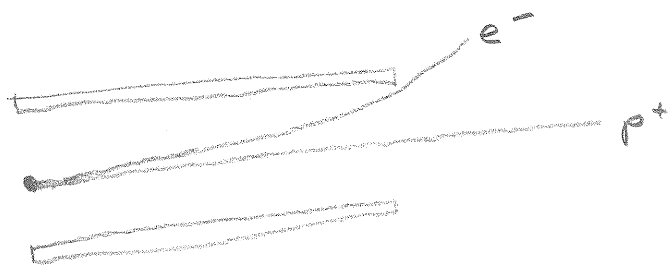
$$\Rightarrow \frac{d}{\cancel{2}} = \frac{1}{\cancel{2}} a_y \left(\frac{2d}{v_{0x}}\right)^2 \Rightarrow a_y = \frac{v_{0x}^2}{4d}$$

$$\Rightarrow E = \frac{m}{e} a_y = \frac{m_e}{e}\frac{v_{0x}^2}{4d} = \frac{9.1 \times 10^{-31}\text{ kg}}{1.6 \times 10^{-19}\text{ C}} \frac{(1.6 \times 10^{6}\text{ m/s})^2}{4(10^{-2}\text{ m})}$$

$$\Rightarrow E \cong \boxed{364 \ \frac{N}{C}}$$

b) $\boxed{\text{No}}$, the proton would not hit the plate because the E-field needed for the more massive proton would not be there.

$$F_y = Ee = m_p a_y \Rightarrow a_y = \frac{Ee}{m_p} < \frac{Ee}{m_e}$$



$m_p \simeq 2000\ m_e$

The proton will be deflected down just a little

c) $$a_{y_p} \cong \frac{364 \frac{N}{\cancel{C}}(1.6 \times 10^{-19} \cancel{C})}{1.7 \times 10^{-27}\text{ kg}} \simeq 1.3 \times 10^{10}\text{ m/s}^2 \gg g$$

21.31 c) (continued)

Gravity can be ignored since the verticle acceleration due to E-field on the proton is much much greater than g.

Same goes for the electron.

21.54

a) ↑ ↓ $E_{Top} = \frac{\sigma}{2\epsilon_0} - \frac{\sigma}{2\epsilon_0} = \boxed{0}$

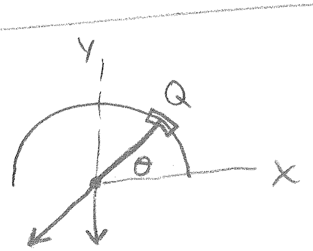
σ

c) ↓ $E_{Between} = \frac{\sigma}{2\epsilon_0} + \frac{\sigma}{2\epsilon_0} = \boxed{\frac{\sigma}{\epsilon_0}}$ ↓

$-\sigma$

b) ↑ ↓ $E_{Bottom} = \frac{\sigma}{2\epsilon_0} - \frac{\sigma}{2\epsilon_0} = \boxed{0}$

21.94



$E_x = 0$

$$E_y = \int_{\theta=0}^{\pi} \frac{1}{4\pi\epsilon_0}\left(\frac{Q}{\pi a}\right)\frac{(a\,d\theta)}{(a^2)}\sin\theta = \frac{1}{4\pi^2\epsilon_0}\frac{Q}{a^2}(-\cos\theta)\Big|_0^{\pi}$$

$$E_y = \frac{Q}{2\pi^2\epsilon_0 a^2} \implies \boxed{\vec{E} = -\frac{Q}{2\pi^2\epsilon_0 a^2}\hat{y}}$$