Name_____

Physics 111 Quiz #2, September 23, 2022

Please show all work, thoughts and/or reasoning in order to receive partial credit. The quiz is worth 10 points total.

I affirm that I have carried out my academic endeavors with full academic honesty.

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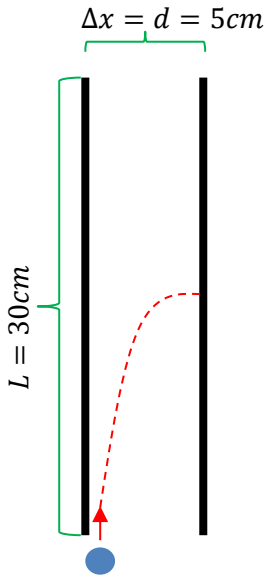
1. Consider the accelerator shown below in which two parallel metal plates have a potential difference of $\Delta V = -10kV$ across them. A proton (initially located at the lower plate) is accelerated from rest and emerges from the hole in the top plate with a vertical velocity. What is the speed of the proton when it leaves the hole in the upper plate?

$$W = -q\Delta V = -\left(e \times \frac{1.6 \times 10^{-19}C}{1e}\right)(-10000V) = 1.6 \times 10^{-15}J$$

$$W = \Delta K = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2 = \tfrac{1}{2}mv_f^2 \rightarrow v_f = \sqrt{\frac{2W}{m}} = \sqrt{\frac{2 \times 1.6 \times 10^{-15}J}{1.67 \times 10^{-27}kg}} = 1.38 \times 10^6 \tfrac{m}{s}$$

2. Suppose the proton is then incident on a second set of plates shown below. The proton enters this set of plates at the left plate at the point $(x, y) = (0,0)$ and suppose that the proton strikes the right plate at a point $(x, y) = \left(d, \frac{L}{2}\right)$ above where it enters. How long does it take the proton to strike the right plate from the time it enters the field?



$$y_f = y_i + v_{iy}t + \tfrac{1}{2}a_y t^2 \rightarrow \frac{L}{2} = v_{iy}t \rightarrow t = \frac{L}{2v_{iy}}$$

$$t = \frac{0.30m}{2 \times 1.38 \times 10^6 \frac{m}{s}} = 1.1 \times 10^{-7}s$$

3. What electric field, magnitude and direction, would be needed to achieve the scenario in question 2?

$x_f = x_i + v_{ix}t + \frac{1}{2}a_x t^2 \rightarrow d = \frac{1}{2}a_x t^2 \rightarrow a = \frac{2d}{t^2} = \frac{2 \times 0.05m}{(1.1 \times 10^{-7}s)^2} = 8.46 \times 10^{12}\frac{m}{s^2}$

$F_x = ma_x = eE \rightarrow E = \frac{ma_x}{e} = \frac{1.67\times10^{-27}kg\times8.46\times10^{12}\frac{m}{s^2}}{1.6\times10^{-19}C} = 8.8 \times 10^4\frac{N}{C}$ in the positive x-direction.

4. What potential difference was applied across the set of plates in question 2?

$E = -\frac{\Delta V}{\Delta x} \rightarrow \Delta V = -E\Delta x = -8.8 \times 10^4\frac{N}{C} \times 0.05m = -4.4 \times 10^3 V = -4.4kV$

5. What was the change in electric potential energy for the proton in part 2 in keV?

$\Delta U_e = q\Delta V = e \times (-4.4kV) = -4.4keV$