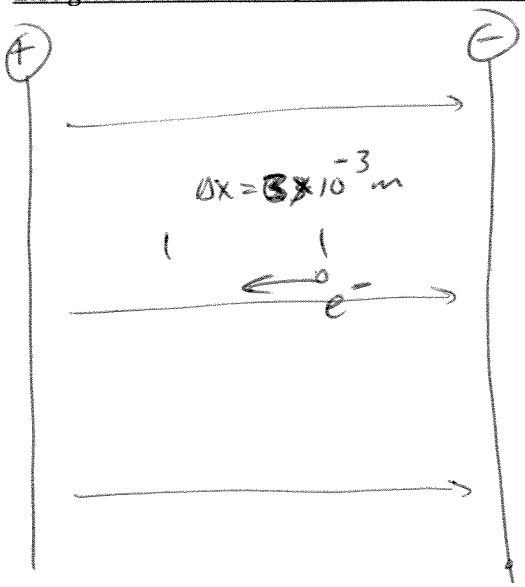
General Problem Solving Guide

Date:
Recorder: KEY
Skeptic:
Timekeeper:
Psychic:

List given information, define variables, sketch picture:



$R = 0.22$ m

$A = \pi R^2$

Assume infinite plates

* electron moves toward positive plate

Simplify question, list target quantity:

Find velocity and time after 3mm of being pushed by Electric Field.

List all related quantitative relationships:

For infinite plates

$\sigma = \frac{Q}{A}$ $E = \frac{\sigma}{2\epsilon_0}$ for each plate

$E_{INT} = \frac{\sigma}{\epsilon_0}$ inside plates $\vec{F} = q\vec{E}$

$\vec{a} = \frac{\vec{F}}{m}$ $\vec{v} = \vec{v}_0 + \vec{a}t$ $\vec{x} = \vec{x}_0 + \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$

Outline approach, sketch diagrams if needed (or sketch next to pictures above):

- Find $\vec{E}$
- Find $\vec{F}$
- Find $\vec{a}$
- Solve $\vec{x}(t)$ for time, use $\vec{a}$ ~~and~~ ~~Δx~~ to find t
- Solve $\vec{v}(t)$ for final velocity using t

Obtain a general solution:

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

$q_e = 1.602 \times 10^{-19}$ C

$k = 9 \times 10^9 \frac{Nm^2}{C^2}$

$E = \frac{Q}{A\epsilon_0} \qquad F = \frac{qQ}{A\epsilon_0}$

$a = \frac{F}{m_e} = \frac{q_e Q}{A\epsilon_0 m_e} = \frac{4\pi k q_e Q}{A m_e}$

$= \frac{4\pi k q_e Q}{\pi R^2 m} = \frac{4 k q_e Q}{m_e R^2}$

$a = 4.58 \times 10^{15}\ m/s^2$

$t^2 = \frac{x - x_0}{\frac{1}{2}a} = \frac{2\Delta x}{a}$

$t = \left(\frac{2\Delta x}{a}\right)^{1/2} = 1.14 \times 10^{-9}$ sec

$v = at = 5.24 \times 10^6\ m/s$

Check Units:

$m/s^2 = \frac{Nm^2}{C^2} \cdot \frac{CC}{m^2 \cdot kg} = \frac{m\,kg}{s^2\,kg}$ ✓

Check Limiting Cases:

$Q \uparrow \quad a \uparrow$

$R \uparrow \quad a \downarrow$ less electric field

$m_e \uparrow \quad a \downarrow$

$q_e \uparrow \quad a \uparrow$

Obtain a numeric solution:
(i.e. plug in the numbers)

$t = 1.14 \times 10^{-9}$ sec

$v = 5.24 \times 10^6\ m/s$

Why is solution reasonable? Explain.

units check ✓

limiting cases ✓

- velocity is very large which is expected for a ~~light~~ low mass particle like an electron