Week 8 Quiz

Monday, May 17, 2021 12:16 PM

Rubric

~~ Part (a) ~~
0.5 pt - Newton's 2nd Law equation
0.5 pt - F = qE equation
1 pt - E = -deltaV/deltaE equation
0.5 pt - Electric field value
1 pt - combining equations
0.5 pts - answer + units

~~ Part (b) ~~
0.5 pt - Answer
1.5 pt - Reasoning

~~ Part (c) ~~
2 pts - Reasoning

~~ Part (d) ~~
2 pts - Reasoning

The electric potential in a region of empty space is given in the graph below. The electric potential does not change with Y or Z coordinates. This region of space is far from any other objects.

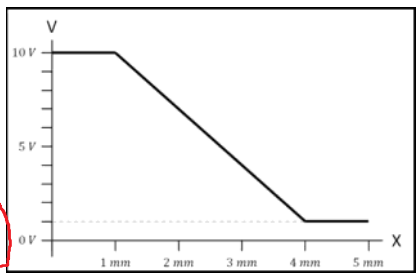
(a) (4 pts) If an electron is placed at x = 3 mm, what is the acceleration of the electron along the x axis? (m_e = 9.11 x 10^{-31} kg, e = 1.60 x 10^{-19} C)

$\Sigma F_x = ma_x$, $F_x^E = q_o E_x$, $E_x = -\frac{\Delta V}{\Delta X}$ ← slope

Slope of $V(x) = -3000 \frac{V}{m}$, so $E_x = +3000 \frac{V}{m}$

& $F_x^E = -e E_x$

finally, $a_x = \frac{F^E}{m} = \frac{-e E_x}{m} = -5.27 \times 10^{14} m/s^2$

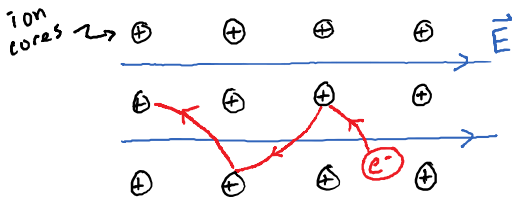


(b) (2 pts) If the electron starts at x = 3 mm with an initial velocity of v_x = -0.735 mm/s, does the electron gain, lose, or maintain constant kinetic energy as it travels to x = 1 mm? Explain.

w/ e^- moving in $-\hat{x}$ & a_x in $-\hat{x}$ direction, it will speed up, gaining K.E.

or neg charges decrease P.E. as move to higher electric potential, thus increasing K.E.

(c) (2 pts) Let's explore an alternate scenario. The region between x = 1 mm and x = 4 mm is now occupied by a resistor, instead of the empty space of parts (a) and (b). The resistor experiences the same electric potential as outlined in the graph. There is an electron inside the resistor experiencing a drift velocity of v_x = -0.735 mm/s. The electron starts at x = 3 mm and travels to x = 1 mm, just as in part (b). Does the electron gain, lose, or maintain constant kinetic energy as it travels to x = 1 mm? Explain.



In between the atoms the e^- speeds up, & K.E. ↑.
When e^- scatters off an atom it loses K.E..
So while traveling through the e^- is gaining & losing K.E.. Overall the e^- maintains a constant drift velocity, which means on average the K.E. is constant.

(d) (2 pts) Using relevant physics, explain what happens to the electron to cause a difference in your answers to parts (b) and (c). Also explain what happens to the energy that makes up the difference.

In (b) the e^- continually increases in K.E.
In (c) the e^- gains & loses K.E. resulting in a constant Average K.E.
the extra K.E. gained in (b) shows up as thermal Energy in (c).
Its the energy transfered from the e^- to the atoms during collisions.