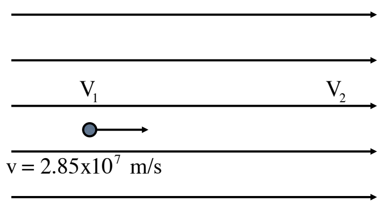
16.8)

a.) What is the voltage difference needed to stop the electron?



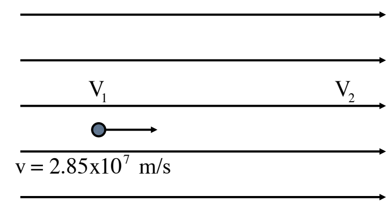
b.) Would it require a greater, less or the same voltage difference to stop a proton?

c.) What's the ratio of $\Delta V_p / \Delta V_e$?

16.8)

a.) What is the voltage difference needed to stop the electron?

The first thing to remember is that electrons speed up when they are moving *opposite* the direction of an E-fld. If the electron is slowing down, it means it must be moving *in* the direction of the E-fld. In other words, E in this case must be as shown in the sketch.



The second thing to note is that voltages are larger *upstream* and smaller *downstream* in an E-fld. That means V_1 is greater than V_2 and $V_2 - V_1$ is negative.

The third thing to note is that the amount of potential energy a negative charge has at a point where the voltage is positive will be negative, or U=(-q)V.

This is a *conservation of energy* problem. As such, we have to relate the voltages at the start and end points with the associated potential energies of the electron when it is at those points. Again noting that the voltage at point 1 has to be bigger than at point 2 (otherwise the electron wouldn't slow down), we can write::

8a.)

$$\sum KE_1 + \sum U_1 + \sum W_{ext} = \sum KE_2 + \sum U_2$$

$$\Rightarrow \frac{1}{2}mv^2 + (-q)V_1 + 0 = 0 + (-q)V_2$$

$$\Rightarrow \frac{1}{2}mv^2 = (-q)(V_2 - V_1)$$

$$\Rightarrow \frac{mv^2}{2q} = (V_1 - V_2)$$

$$\Rightarrow \frac{(9.1x10^{-31})(2.85x10^7)^2}{2(1.6x10^{-19})} = (V_1 - V_2)$$

$$\Rightarrow \Delta V = 2310 \text{ volts}$$

Note that for the e^- to slow, the E-fld has to be in the same direction as the motion. That means V_1 is greater than V_2 and V_1 - V_2 is positive.

b.) Would it require a greater, less or the same voltage difference to stop a proton?

To begin with, the proton would have to be moving in the opposite direction and would have positive *potential energy* values at the first and second points. The potential difference would also have to be larger as energy is a mass related quantity (look at the relationship above), and a proton is approximately 1835 times more massive than an electron.

c.) What's the ratio of $\Delta V_p / \Delta V_e$?

You do the math!