Quiz 4

The following information may or may not be of use:

$$
\begin{aligned}
m_{\text{electron}} &= 9.1 \times 10^{-31}\ \text{kg} \\
e &= 1.6 \times 10^{-19}\ \text{C} \\
\varepsilon_0 &= 8.85 \times 10^{-12}\text{C}^2\ \text{N}^{-1}\ \text{m}^{-2} \\
k &= \frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \text{N}\ \text{m}^2\ \text{C}^{-2} \\
\Delta V &= -\vec{E} \cdot \Delta\vec{r} \\
\Delta U &= q\Delta V \\
V_{pt} &= \frac{1}{4\pi\epsilon_0}\frac{q}{r}
\end{aligned}
$$

In a region of space there is a uniform electric field $\vec{E} =< -100, 400, 0 >\ \frac{\text{N}}{\text{C}}$. Point A is located at $\vec{r_A} =< 0, 3, 0 >$ m, and point B is located at $\vec{r_B} =< 5, 1, 0 >$ m.

An electron starts from rest at point A and moves to point B. What is the electron's speed at point B?

$\Delta K = -\Delta U$

$\Delta U = q\Delta V$

$\Delta V = -\vec{E} \cdot \Delta\vec{r}$

$= -\langle -100, 400, 0 \rangle \frac{\text{N}}{\text{C}} \cdot \langle 5, -2, 0 \rangle \text{m}$

$= -(-500 - 800)\ \text{V}$

$\Delta V = 1300\ \text{V}$

$\Delta U = q\Delta V = -e\Delta V = -1.6 \times 10^{-19}\ \text{C} \cdot 1300\ \text{V}$

$= -2.1 \times 10^{-16}\ \text{J}$

$\Delta K = -\Delta U = 2.1 \times 10^{-16}\ \text{J}$

$$\Delta K = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$= \frac{1}{2} m v_f^2 = 2.1 \times 10^{-16} \text{ J}$$

$$v_f = \sqrt{\frac{2}{9.1 \times 10^{-31} \text{ kg}} \cdot 2.1 \times 10^{-16} \text{ J}}$$

$$v_f = 2.1 \times 10^{7} \ \frac{m}{s}$$