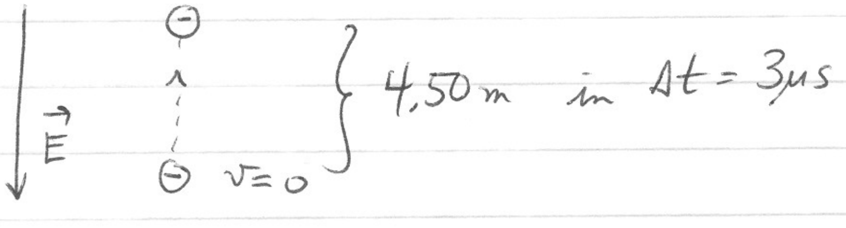
21.26

(a) The electric field must point **downward** because electrons are negatively charged and the electron accelerates upward. That is $\vec{F} = q\vec{E} = -e\vec{E}$, hence $\vec{F}$ and $\vec{E}$ are anti-parallel.



Since the force is uniform, the acceleration must also be uniform, and we can use the equations of kinematics from Physics I that are valid for constant acceleration. The most helpful is

$$x = x_0 + v_0 t + \frac{1}{2}at^2 \quad \text{but } x_0 = 0 = v_0$$

so, solving for $a = \dfrac{2\Delta x}{\Delta t^2} = \dfrac{2(4.50\text{m})}{(3\times10^{-6}\text{s})^2} = 1.0\times10^{12}\ \frac{\text{m}}{\text{s}^2}$

Keeping track of magnitudes only, $F = ma = qE$, or solving for E:

$$E = \frac{ma}{e} = \frac{9.1\times10^{-31}\text{kg}}{1.6\times10^{-19}\text{C}}\left(1.0\times10^{12}\ \frac{\text{m}}{\text{s}^2}\right) = \boxed{5.69\ \frac{\text{N}}{\text{C}}}$$

(b) The gravitational force on an electron is mg, but since $g = 9.8\ \frac{\text{m}}{\text{s}^2} \ll 1.0\times10^{12}\ \frac{\text{m}}{\text{s}^2}$, the acceleration due to gravity is small — and negligible — compared to the electric acceleration. **YES** we are justified in ignoring gravitational effects