

Solution Electron in static electric field



- 1) Work done by electric field when the electron moves from $x = \frac{1}{4}L$ tot $x = 0$:

$$W = \int_{\frac{1}{4}L}^0 \vec{F} \cdot d\vec{s} = -eE_0 \int_{\frac{1}{4}L}^0 \sin\left(2\pi \frac{x}{L}\right) dx = -eE_0 \frac{L}{2\pi} \left[-\cos\left(2\pi \frac{x}{L}\right)\right]_{\frac{1}{4}L}^0 = \frac{1}{2\pi} eE_0 L$$

- 2) Work done is gain in kinetic energy: $\Delta E_{kin} = W$. Assuming the only work done is by the electric field and using initial velocity is zero: $v_i = 0$:

$$\frac{1}{2}mv^2 = \frac{1}{2\pi} eE_0 L \Rightarrow v = \sqrt{\frac{eE_0 L}{\pi m}}$$

Note that indeed the work done is positive, as it should in this case since the electron starts with zero velocity.