Question 5:An electron (mass m) with an initial velocity v =$v_0\hat{i}$ is in an electric field

$\boldsymbol{E} = \boldsymbol{E_0}\,\hat{\mathrm{j}}$. If $\lambda_0 = \dfrac{h}{mv_0}$, its de-Broglie wavelength at time t is given by

(a) λ_0

(b) $\lambda_0\sqrt{1+\dfrac{e^2E_0^2t^2}{m^2v_0^2}}$

(c) $\dfrac{\lambda_0}{\sqrt{1+\dfrac{e^2E_0^2t^2}{m^2v_0^2}}}$

(d) $\dfrac{\lambda_0}{\left(1+\dfrac{e^2E_0^2t^2}{m^2v_0^2}\right)}$

Solution:

$v_x = v_0\hat{i}$

$v_y = a_y t = -\dfrac{eE_0 t}{m_e}$

$|\vec{v}| = v = \sqrt{v_0^2 + \left(\dfrac{eE_0t}{m_e}\right)^2}$

$$\lambda = \frac{h}{m_e v} = \frac{h}{m_e\sqrt{v_0^2 + \frac{e^2E_0^2t^2}{m_e^2}}} = \frac{h}{m_e v_0\sqrt{1+\frac{e^2E_0^2t^2}{m_e^2v_0^2}}}$$

$$= \frac{h_0}{\sqrt{1+\frac{e^2E_0^2t^2}{m_e^2v_0^2}}}$$