Examine time dependence of Particle in a Box ψ

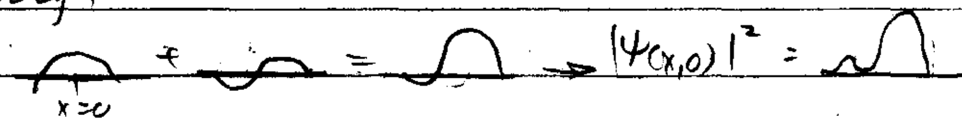
Ex: $|\psi(0)\rangle = \sqrt{\tfrac{1}{2}}\,|1\rangle + \sqrt{\tfrac{1}{2}}\,|2\rangle$
$= \sqrt{\tfrac{1}{2}}\,\psi_1(x) + \sqrt{\tfrac{1}{2}}\,\psi_2(x) = \sqrt{\tfrac{1}{L}}\left[\cos\left(\tfrac{\pi x}{L}\right) + \sin\left(\tfrac{2\pi x}{L}\right)\right]$

$E_n = n^2 E_1$

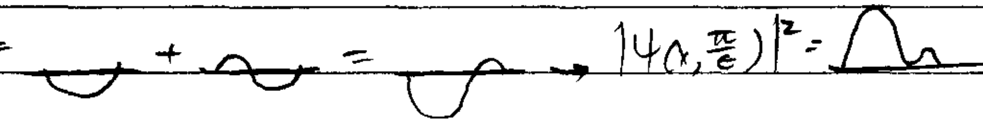
$\psi(x,t) = \sqrt{\tfrac{1}{L}}\left[\cos\left(\tfrac{\pi x}{L}\right)e^{-i\epsilon t} + \sin\left(\tfrac{2\pi x}{L}\right)e^{-4i\epsilon t}\right]$ where $\epsilon = \frac{E}{\hbar}$

QUALITATIVELY:

$\psi(x,0) =$



$\psi(x,\tfrac{\pi}{\epsilon}) =$



MATHEMATICALLY:

$|\psi(x,t)|^2 = \frac{1}{L}\left[\cos(\ )e^{i\epsilon t} + \sin(\ )e^{i4\epsilon t}\right]\left[\cos(\ )e^{-i\epsilon t} + \sin(\ )e^{-i4\epsilon t}\right]$

$= \frac{1}{L}\left[\cos^2(\ ) + \sin^2(\ ) + \sin(\ )\cos(\ )e^{i3\epsilon t} + \cos(\ )\sin(\ )e^{-i3\epsilon}\right.$

$= \frac{1}{L}\left[\cos^2(\ ) + \sin^2(\ ) + \sin(\ )\cos(\ )\{e^{i3\epsilon t} + e^{-i3\epsilon t}\}\right]$

use $2\cos\theta = e^{i\theta} + e^{-i\theta}$ and simplify

What is the oscillation frequency of the overall $|\psi(x,t)|^2$?