

5.73

Quiz 3

1.

$$\hat{H}\psi_n = E_n \psi_n$$

$$\hat{H}\Psi = i\hbar \frac{\partial \Psi}{\partial t}$$

$$\Psi(x,t) = \sum_n \psi_n(x) e^{-iE_n t/\hbar} \quad \text{where } \psi_n \text{ is an eigenstate of } \hat{H}$$

$$\Psi(x,t) = \sum_n \psi_n(x) e^{-iE_n t/\hbar} \quad \text{superposition of eigenstates of } \hat{H}$$

$$\int_{-\infty}^{\infty} \psi_n^* \psi_m dx = 0 \quad \text{if } n \neq m$$

$$= 1 \quad \text{if } n=m$$

A. What, if any, is the time dependence of $|\Psi_n(x,t)|^2$?

B. Let $\Psi(x,t) = 2^{-1/2} [\psi_1 e^{-iE_1 t/\hbar} + \psi_2 e^{-iE_2 t/\hbar}] = 2^{-1/2} e^{-iE_1 t/\hbar} [\psi_1 + \psi_2 e^{+i\omega_{12} t}]$
and $\omega_{12} \equiv (E_1 - E_2)/\hbar$. Assume that ψ_1 and ψ_2 are real, not complex. Solve for $|\Psi_n(x,t)|^2$.

2. Let $\psi(x) = e^{-ikx}$, $E_{|k|} = \frac{\hbar^2 k^2}{2m} + V_0$, and $\Psi(x,t) = e^{i(-kx - E_{|k|} t/\hbar)}$. Think of $\Psi(x,t)$ as a rigid object, $\Psi(x,0)$, moving along the x-axis at a constant velocity. This is the phase velocity, v_ϕ . The motion of the constant phase point is described by

$$x_\phi(t) = x_\phi(0) + v_\phi t.$$

Solve for v_ϕ .

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