HW Quiz 2

Answer one of the following questions. If you answer both questions, you will be scored on each and you will receive the lower of the two.

1) Consider the time-**dependent** Schrodinger equation: $i\hbar\frac{\partial\Psi}{\partial t}=-\frac{\hbar^2}{2m}\frac{\partial^2\Psi}{\partial x^2}+V\Psi$

Is it possible to consider only real solutions to this equation **without** losing generality? Explain your answer. $\boxed{\text{No}}$ Conjugating the equation $-i\hbar\frac{\partial\Psi^*}{\partial t}=-\frac{\hbar^2}{2m}\frac{\partial^2\Psi^*}{\partial x^2}+V\Psi^*$ tells us that Ψ^* satisfies a different equation. So the real linear combinations $\Psi+\Psi^*$ and $i(\Psi-\Psi^*)$ do not satisfy the original equation.

2) The total initial wavefunction for a particle in an infinite well (from $x = 0$ to a) is

$$\Psi(x,0)=\frac{1}{\sqrt{3}}\psi_2+\frac{2}{\sqrt{3}}\psi_5$$

Note: This Ψ was not properly normalized!!

An orthonormal set of solutions to the T.I.S.E. for this system and their energies is given by:

$$\psi_n(x)=\sqrt{\frac{2}{a}}\sin(\frac{n\pi}{a}x) \qquad E_n=\frac{n^2\pi^2\hbar^2}{2ma^2}$$

a) Evaluate $\int_0^a\psi_2^*(x)\Psi(x,0)dx$. $=\int_0^a\psi_2^*\left(\frac{1}{\sqrt{3}}\psi_2+\frac{2}{\sqrt{3}}\psi_5\right)dx=\frac{1}{\sqrt{3}}\int_0^a\underbrace{\psi_2^*\psi_2}_{1}dx+\frac{2}{\sqrt{3}}\int_0^a\underbrace{\psi_2^*\psi_5}_{0}dx=\boxed{\frac{1}{\sqrt{3}}}$

b) Write down an expression for $\Psi(x,t)$. **Hint: Recall that** $\phi_n(t)=e^{-i\frac{E_n}{\hbar}t}$

$\boxed{\Psi(x,t)=\frac{1}{\sqrt{3}}\psi_2e^{-i\frac{E_2}{\hbar}t}+\frac{2}{\sqrt{3}}\psi_5e^{-i\frac{E_5}{\hbar}t}}$

c) Calculate $\langle\hat{H}\rangle$ for this total wavefunction.

$\langle\hat{H}\rangle=\frac{1}{3}E_2+\frac{4}{3}E_5$