PHY 4203/5443 – Quantum Mechanics

Exam #1

Name: ______________________

Major: ______________________

Date: 5:30-6:45 PM, Thursday, 25 Feb 2021

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1. A particle of mass *m* in one dimension has the quantum mechanical wave function

$$\psi(x)=\begin{cases}0 & x<1\\ \dfrac{A}{x} & 1\le x\le 2\\ 0 & x>2\end{cases}$$

(a) Find the constant A so that $\psi(x)$ is normalized. (b) Find the probability of finding the particle in the interval $1.5\le x\le 2$.

2. A particle of mass *m* is trapped between $x=0$ and $x=a$ in an infinite potential well in the quantum state described by the wave function

$$\Psi(x,t)=i\sqrt{\frac{3}{2a}}\sin\left(\frac{\pi x}{a}\right)e^{iE_0t/\hbar}+\sqrt{\frac{1}{2a}}\sin\left(3\frac{\pi x}{a}\right)e^{i9E_0t/\hbar}$$

where E_0 is the ground state energy. (a) Write $\Psi(x,t)$ in terms of the eigenstates $\psi_n(x)=\sqrt{\frac{2}{a}}\sin\left(\frac{n\pi}{a}x\right)$. (b) Find $\psi(x)=\Psi(x,0)$. Is $\psi(x)$ normalized? If not, normalize it. (c) If a measurement is made of the energy of this system, what are the only possible values that can be obtained? (d) What is the probability measuring each of the possible energies. (e) What is the expectation value of energy of the system?

3. A measurement of the energy of the mass *m* is made and returns the measured value $E=9E_0$. What is the state $\Psi(x,t)$ of the system after the measurement?

4. Given $|u\rangle=\begin{bmatrix}3i\\2\end{bmatrix}$ and $|v\rangle=\begin{bmatrix}3\\2i\end{bmatrix}$, find (a) $\langle u|$ and $\langle v|$ (b) compute $\langle u|v\rangle$ and $\langle v|u\rangle$.

STATEMENT OF OWN WORK

I affirm that I have done my own work on this take-home part of the exam using only my course lecture notes as a reference and have neither given nor received assistance on the attached problem solutions.

Signature ______________________

Date ______________________