Assignment 7

1. The approach of the Hamiltonian operator $H = \frac{p^2}{2m} + V(x)$ to $\Delta x \Delta p = \hbar$ implies that $\frac{p^2}{2m} + V(x)$ is an operator on the given system.

2. Let $\textit{H}$ be an operator on the Hilbert space $\mathcal{H}$ corresponding to an eigenspace $\mathcal{H}_\omega$ for $\lambda$. If $\textit{H}$ is a self-adjoint operator, then $\mathcal{H}_\omega$ is an eigenspace of $\textit{H}$ with eigenvalue $\lambda$. The eigenfunction of $\textit{H}$ is $\psi = \psi (x)$ that satisfies $\textit{H} \psi = \lambda \psi$.

3. $(\textit{H} \phi) (x) = \sum_{n} \lambda_n \phi_n (x)$ where $\lambda_n$ are the eigenvalues of $\textit{H}$ and $\phi_n (x)$ are the corresponding eigenfunctions.

4. The variance of the position $\langle \Delta x^2 \rangle = \langle x^2 \rangle - \langle x \rangle ^2$ is a measurement of the disturbance to the system. The variance is maximized when $\langle x \rangle = 0$ and $\langle x^2 \rangle$ is minimized.

5. $\textit{H} \phi (x) = \sum_{n} \lambda_n \phi_n (x)$ where $\lambda_n$ are the eigenvalues of $\textit{H}$ and $\phi_n (x)$ are the corresponding eigenfunctions.

6. If $\textit{H} \phi = \lambda \phi$, then $\textit{H} \phi (x) = \lambda \phi (x)$ for all $x$.

7. Which of the following atomic transitions are allowed?

8. $\psi (x) = e^{-x^2/2\sigma^2}$ with $\sigma = 1$ is the Gaussian wave function. The expectation value of position $\langle x \rangle$ is $0$ and the expectation value of momentum $\langle p \rangle$ is $0$.

9. $\langle x \rangle = \int d x \psi^* (x) x \psi (x)$ and $\langle p \rangle = \int d x (i/\hbar) \psi^* (x) \partial_x \psi (x)$ are the expectation values of position and momentum.

10. $T_{m,n}(x)$ will be the eigenstate of parity with eigenvalue $(-1)^{m+n}$.

11. $\textit{H} \psi (x) = \lambda \psi (x)$ where $\lambda$ is the eigenvalue of the Hamiltonian operator $\textit{H}$. The eigenvector of $\textit{H}$ is $\psi (x)$ that satisfies $\textit{H} \psi (x) = \lambda \psi (x)$.

12. $\langle x \rangle = \int d x \psi^* (x) x \psi (x)$ and $\langle p \rangle = \int d x (i/\hbar) \psi^* (x) \partial_x \psi (x)$ are the expectation values of position and momentum.