1 Physics 402 Quiz 1: Fundamentals

1) Which of the following represents the probability of obtaining some particular value E in a measurement of energy on the state $|\Psi\rangle$?

a) $\hat{H}|\Psi\rangle$

b) $\langle\Psi|\hat{H}|\Psi\rangle$

c) $\langle E|\Psi\rangle$

d) $|\langle E|\Psi\rangle|^2$

e) ΔE

2) If $\hat{\mathcal{O}}$ is a time-independent Hermitian operator and $\hat{H}$ is the time-independent Hamiltonian, which of the following is NOT a consequence of $[\hat{\mathcal{O}}, \hat{H}] = 0$?

a) The expectation value of the physical observable associated with $\hat{\mathcal{O}}$ is unchanging in time.

b) All states have definite values for both energy and the physical observable associated with $\hat{\mathcal{O}}$, since the matrices for both are diagonal.

c) Given any solution $|\Psi(t)\rangle$ of the Schrodinger equation, $e^{ia\hat{\mathcal{O}}}|\Psi(t)\rangle$ is also a solution.

d) The uncertainty in both $\mathcal{O}$ and $\mathcal{H}$ can be as small as we want at the same time.

e) The probabilities for measuring various possible values of $\hat{\mathcal{O}}$ are unchanging in time.

3) For a general operator $\hat{B}$ without any special properties, which of the following is always equal to $\langle\chi|\hat{B}|\psi\rangle$?

a) $\langle\psi|\hat{B}|\chi\rangle$

b) $\langle\psi|\hat{B}|\chi\rangle^*$

c) $\langle\psi|\hat{B}^\dagger|\chi\rangle$

d) $\langle\psi|\hat{B}^\dagger|\chi\rangle^*$

4) True or false: if $\langle\Psi|\hat{\mathcal{O}}|\Psi\rangle = 0$ for a Hermitian operator $\hat{\mathcal{O}}$ and for *all* states $|\Psi\rangle$ then it must be that $\hat{\mathcal{O}} = 0$.

a) True

b) False

c) All of the above

d) None of the above

5) If the state of a quantum system with a time-independent Hamiltonian is some energy eigenstate $|E\rangle$ at time $t = 0$, which of the following is NOT true

a) The energy expectation value will be independent of time.

b) All physical observables will be independent of time.

c) If we measure the energy at any later time, we will always find E.

d) The position space probability density for the state will oscillate periodically with a specific frequency.

6) If $\hat{\mathcal{O}}$ is an operator corresponding to some physical observable, we can say that

a) There is a basis of states in the Hilbert space for which each basis element is an eigenstate of $\hat{\mathcal{O}}$ if and only if $\hat{\mathcal{O}}$ is a conserved quantity.

b) There is a basis of states in the Hilbert space for which each basis element is an eigenstate of $\hat{\mathcal{O}}$ if and only if the transformation associated with $\hat{\mathcal{O}}$ is a symmetry.

c) There is a basis of states in the Hilbert space for which each basis element is an eigenstate of $\hat{\mathcal{O}}$ if and only if the eigenvalues of $\hat{\mathcal{O}}$ are all different.

d) There is always a basis of states in the Hilbert space for which each basis element is an eigenstate of $\hat{\mathcal{O}}$.