Physics 402 Quiz 1, January 31, 2019

Name/Student Number:

1) A certain quantum mechanical system is associated with a three-dimensional Hilbert space. We can say that in a measurement of the energy for such a system

a) No more than three outcomes are possible, regardless of which state we are measuring.

b) No more than three outcomes are possible for any given state $|\Psi\rangle$, but these possible outcomes can be different for different states.

c) More than three outcomes are possible; the number is determined by the number of eigenstates in the energy basis.

d) There are always an infinite number of possible of outcomes for a measurement of energy, since the state can be in any superposition of the energy eigenstates.

2) For an operator associated with a physical observable, which of the following is not necessarily true?

a) The operator has only real eigenvalues.

b) The eigenvectors for this operator form a basis for the Hilbert space.

c) The operator maps states to other states with the same norm.

d) The operator will be a linear map from the Hilbert space to itself.

3) A spin half particle is in an eigenstate of S_x with eigenvalue $\hbar/2$. If we measure the z component of spin for this particle,
a) we will definitely find $S_z = 0$, and the state afterwards will be an eigenstate of S_z.
b) we might find any value between $S_z = -\hbar/2$ and $S_z = \hbar/2$, and the state afterwards will be an eigenstate of S_z.
c) We will find either $S_z = -\hbar/2$ or $S_z = \hbar/2$, and the state afterwards will be an eigenstate of S_z.
d) we will definitely find $S_z = 0$ and the state afterwards will still be an eigenstate of S_x.
e) we might find any value between $S_z = -\hbar/2$ and $S_z = \hbar/2$; and the state afterwards will still be an eigenstate of S_x.

4) For a quantum system with Hamiltonian operator $\hat{H}$ in a state $|\Psi\rangle$, we can say that $\hat{H}|\Psi\rangle$ is

a) the state $|\Psi\rangle$ after a measurement of energy.

b) proportional to the infinitesimal change in the state $|\Psi\rangle$ under a time evolution.

c) always just equal to the state $|\Psi\rangle$ again but multiplied by a phase.

d) the expectation value of energy in the state $|\Psi\rangle$.

5) If $\mathcal{O}$ is an observable that is conserved in a system with time-independent Hamiltonian H, which of the following is **not** necessarily true?

a) There is a basis of states with definite values for both $\mathcal{O}$ and H.

b) Both $\mathcal{O}$ and H are represented by diagonal matrices in every basis.

c) For any state, the probabilities for various measurement outcomes of $\mathcal{O}$ do not change with time.

d) The operator associated with $\mathcal{O}$ commutes with the Hamiltonian.

6) Suppose that a physical transformation $|\Psi\rangle \to \hat{\mathcal{T}}|\Psi\rangle$ acting on the states in the Hilbert space is a symmetry of a quantum system. True or false: if $|E\rangle$ is an energy eigenstate, then $\hat{\mathcal{T}}|E\rangle$ is also an energy eigenstate with the same energy.

a) True

b) False

Answers

1	2	3	4	5	6