Physics 402 Quiz 1, February 1, 2018

1) If $|A\rangle = \frac{i}{2}|\uparrow\rangle - \frac{\sqrt{3}}{2}|\downarrow\rangle$, what is $\langle A|\uparrow\rangle$?

a) $i/2$

b) $-i/2$

c) $-\sqrt{3}/2$

d) $\sqrt{3}/2$

2) Which of the following equals the average value of energy E that we would obtain if we made measurements of energy on many identical states $|\Psi\rangle$?

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

3) If $\hat{\mathcal{O}}_1$ and $\hat{\mathcal{O}}_2$ are both time-independent Hermitian operators, which of the following is a consequence of $[\hat{\mathcal{O}}_1, \hat{\mathcal{O}}_2] = 0$?

a) The expectation value of the physical observables associated with $\hat{\mathcal{O}}_1$ and $\hat{\mathcal{O}}_2$ are unchanging in time.

b) We can find a basis of states which have definite values for the quantities $\mathcal{O}_1$ and $\mathcal{O}_2$.

c) The operation $(\mathbb{1} - i\epsilon\mathcal{O}_1)$ is a symmetry of the theory.

d) All of the above.

Answers

1	2	3	4	5	6

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

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.

5) For the linear combination $\frac{1}{\sqrt{5}}(|E = 1eV\rangle + 2|2eV\rangle)$ of energy eigenstates, suppose we measure the energy. We will find

a) either $E = 1eV$ or $E = 2eV$, with equal probability

b) $E = 9/5eV$,

c) something between $E = 1eV$ and $E = 2eV$ with all values being possible

d) either $E = 1eV$ or $E = 2eV$ with $E = 2eV$ more likely

e) None of the above: it is not possible to measure the energy for such a state, since the energy does not have a definite value.

6) If $\hat{\mathcal{P}}$ is the momentum operator, which of the states below represent the state $|\Psi\rangle$ of a particle in one dimension translated to the right by a non-infinitesimal amount a?

a) $a\hat{\mathcal{P}}|\Psi\rangle$

b) $(1 - ia\hat{\mathcal{P}}/\hbar)|\Psi\rangle$

c) $e^{-ia\hat{\mathcal{P}}/\hbar}|\Psi\rangle$

d) $\langle a|\hat{P}|\Psi\rangle$