19

Quantum Mechanics 2

The Hamiltonian acting on any allowed state of a quantum system will give you the same state back, scaled by a numerical factor.

a) always true	b) always false
c) sometimes true sometimes false	d) the numerical factor is the energy of the state

An electron in an infinite square well has the wave function $\Psi(x,0) = \sqrt{\frac{2}{7}}\phi_1(x) + \sqrt{\frac{5}{7}}\phi_2(x)$, where ϕ_1 is the ground state and ϕ_2 is the first excited state. The wave function at a time $t \neq 0$ is

a) $\Psi(x,t) = \Psi(x,0)$	b) $\Psi(x,t) = \Psi(x,0)\exp\left(-\frac{iEt}{\hbar}\right)$
c) $\Psi(x,t) = 0 \forall t$	d) either $\Psi(x,0) = \sqrt{\frac{2}{7}}\phi_1(x)$ or $\Psi(x,0) = \sqrt{\frac{5}{7}}\phi_2(x)$, depending upon w.f. collapse

Consider the same wave function $\Psi(x,0) = \sqrt{\frac{2}{7}}\phi_1(x) + \sqrt{\frac{5}{7}}\phi_2(x)$. The wave function and its associated probability density will decay exponentially over time.

a) always true	b) always false
c) sometimes true, sometimes false	d) not enough info

$\psi_1(x)$ and $\psi_2(x)$ are different solutions of the time-independent Schrödinger equation, and $\Phi_1(t,x)$ and $\Phi_2(t,x)$ are different solutions of the time-dependent Schrödinger equation for a given system.

a) $\psi_1(x)$ has definite energy	b) $\frac{1}{\sqrt{2}}(\psi_1+\psi_2)$ is always a solution of the time-independent S.E.
c) $\Phi_1(t,x)$ has definite energy	d) $\frac{1}{\sqrt{2}}(\Phi_1+\Phi_2)$ is always a solution of the time-dependent S.E.

Consider the $n=4$ state in an infinite potential well and a finite potential well.

a) The energy of a particle in a well is given relative to the top of the well.	b) The energy of the 4th state in the finite potential well is higher than the energy of the infinite square well.
c) When the well is very deep, the energies of the lowest states in the infinite and finite potential wells are similar.	d) There is never a state with $n=0$ in any type of potential.

Consider the nth state in a finite well.

a) Inside the well, the solutions may have either even or odd parity with respect to the centre of the well.	b) Inside the well, the solution is always $\psi \sim \cos(kx)$, where k is the wave number.
c) Outside the well, the solution always takes the form $\psi \sim e^{-\alpha x}$ for some attenuation constant α.	d) An analytic solution for the energy can always be found.