

Exercise 5 : Some Theory Questions

1. Consider a system with Hamiltonian  $\hat{H}$ .  
What are the possible outcomes of experimental measurements of the energy ?
  - (a) in general ?
  - (b) for the case when  $\Psi(x, t) = c_1\psi_1e^{-iE_1t/\hbar} + c_7\psi_7e^{-iE_7t/\hbar} + c_{300}\psi_{300}e^{-iE_{300}t/\hbar}$  ?
  - (c) What happens after an actual energy measurement has been carried out ?
  
2. What is the first thing you should do when asked for  $\Psi(x, t)$  given an initial  $\Psi(x, t = 0)$  ?
  
3. At which stage of solving,  $\hat{H}\psi = E\psi$  do discrete energy levels appear ?
  
4. Describe very briefly what is meant by, and the relation between
  - (i) eigenfunctions of  $\hat{H}$
  - (ii) the wave function  $\Psi(x, t)$  of a system described by  $\hat{H}$
  - (iii) stationary states ?What equation(s) does each obey ?
  
5. A particle in a harmonic oscillator potential has its position measured to be  $x = 0$  at time  $t = 0$ . Argue that, immediately after the position measurement, the probability of finding it in an energy eigenstate  $\phi_n$  with  $n = \text{odd}$  is zero. (Hint: what is the wave function for the particle just after the position measurement?)