Quantum Mechanics, Spring 2004

Homework #8, Due 27/4/2004

1. A particle confined to an one-dimensional potential well of size L is in the ground state. The size of the well is suddenly magnified to $2L$.

(a) What is the probability that the particle will be in the n^{th} excited state of the new well ?

(b) What is the expectation value of energy after the expansion ?

2. A 1-d harmonic oscillator is acted upon by a uniform electric field (small enough in magnitude to be considered a perturbation), whose time dependence is given by

$$E(t) = \frac{A}{\sqrt{\pi}\tau} e^{-(t/\tau)^2} \quad ,$$

where A is a constant.

(a) If the oscillator is in the ground state at $t \to -\infty$, find the probability that it is in an excited state at $t \to +\infty$.

(b) In the limit $\tau \gg 1/\omega$, relate the result to that obtained by the adiabatic approximation.

3. Consider a particle that experiences a potential V that is constant $(= V_0)$ for $0 \leq t \leq \tau$ and zero otherwise.

(a) Using sudden approximation, find the state the particle will be in at $t \gg \tau$, if its initial state was $\sum a_n |n\rangle$. Take $|n\rangle$ to be the eigenstates of H_0 and $|\mu\rangle$ to be the eigenstates of $(H_0 + V_0)$. Find the answer keeping only terms linear in $V_0\tau$.

(b) Relate this result to that obtained in problem 1 in the limit $\tau \ll 1/\omega$.

4. Sakurai, Chapter 5, Problem 29

5. Sakurai, Chapter 5, Problem 35

6. Sakurai, Chapter 5, Problem 40