F20 PHYSICS 137B: HW 7

October 23 at 11:59 pm

October 13, 2020

1 Griffiths problems

Do the following problems from Griffiths: 11.27

2 Other problems

2.1

A harmonic oscillator of mass m, charge e, and classical frequency ω is in its ground state. A uniform electric field $\mathbf{E}$ is turned on at $t = 0$ and turned off at $t = \tau$. Use first-order time-dependent perturbation theory to estimate the probability that the system is excited to its nth state.

2.2

Suppose that an electron in a one-dimensional harmonic oscillator potential $\frac{1}{2}m\omega_0^2 x^2$ is subjected to an oscillating electric field $E = E_0 \cos(\omega t)$ pointing in the x-direction.

a) If the electron is initially in the ground state, what is the probability that the electron will be in the nth excited state at time t?

b) If $\omega = \omega_0$, perturbation theory will fail at some time t. What is the critical time?

2.3

At $t < 0$, an electron is assumed to be in the $n = 3$ eigenstate of an infinite square potential well, which extends from $-a/2 < x < a/2$. At $t = 0$, an electric field is applied, with the potential $V = Ex$. The electric field is then removed at time $\tau > 0$. Determine the probability that the electron is in any other state at $t > \tau$.

2.4

Justify the following version of the energy-time uncertainty principle (due to Landau): $\Delta E \Delta t \geq \hbar/2$, where Δt is the time it takes to execute a transition involving an energy change ΔE, under the influence of a constant perturbation (Δt is the time it takes for $P(t)$ to reach a peak in its oscillation). Explain more precisely what ΔE and Δt mean in this context.