Quantum Mechanics II, Problem Set 11

Due Monday, April 28

1. Townsend Chapter 14, Problem 9.

2. Griffiths Chapter 9, Problem 8.

3. Griffiths Chapter 9, Problem 12.

4. Griffiths Chapter 9, Problem 17.

5. Griffiths Chapter 9, Problem 18.

6. Consider a particle with mass m and charge q moving in a one-dimensional simple harmonic oscillator potential

$$V(x) = \frac{1}{2} m\omega_0^2 x^2 \,.$$

The system is acted on with an oscillating uniform electric field,

$$\mathbf{E}(x) = \begin{cases} 0 & t < 0 \\ E_0 \hat{x} \sin \omega t & 0 \leq t \leq T \\ 0 & t > T \end{cases}$$

At $t = 0$, the system is in its ground state $|0\rangle$. First, working to first order in perturbation theory, compute the probability that at $t = T$, the system is in the excited state $|n\rangle$ for $n \geq 1$. Note that to do so, you will have to compute the matrix elements $\langle n|H_1|0\rangle$, where H_1 is the perturbing potential due to the electric field. Next, compute the transition probabilities at second order.