# Phys 402
# Fall 2022
# Homework 8
# Due Wednesday, 2 November @ 10 AM as a PDF upload to ELMS

**1. Griffiths, 3rd Edition, Problem 11.10 [Stimulated and spontaneous emission rates compared]**

**2. Griffiths, 3rd Edition, Problem 11.13 [Lifetime of the $n = 2$ states in Hydrogen]**
**{*Hint: The lifetime is limited by the spontaneous emission rate. For some of the matrix elements, use the results of problem 11.2 from Homework 6.*}**

**3. Griffiths, 3rd Edition, Problem 11.16 [Decay from the Hydrogen atom $|300\rangle$ state to the ground state]**

**4. Quadrupole Radiation Matrix Element and Selection Rules**

**a) Suppose we relax the constraint that the electric field is uniform over the size of an atom. By expanding the traveling wave (see Fig. 11.6) electric field $\vec{E}(y,t) = E_0 \hat{z} \cos(ky - \omega t)$, find the potential experienced by the electron in the atom to next order of approximation. {Hint: assume $ky << 1$ and expand the $\cos(ky - \omega t)$ term.} This is the electric quadrupole potential. Estimate how big the correction is relative to the original term for visible radiation.**

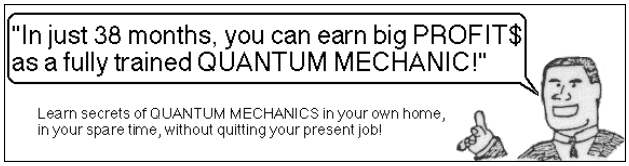
**b) What is the form of the quadrupole matrix element? For the hydrogen atom, what selection rules on changes in the quantum number $m$ arise from this type of matrix element?**

**5. Consider a charged particle (of charge $q$) in a one-dimensional harmonic oscillator potential along the x-axis. It is driven by light that is polarized along the x-direction $\vec{E}(t) = E_0 \hat{\imath} \cos(\omega t)$.**

**a) Write down the perturbing Hamiltonian $\mathcal{H}'(\vec{r}, t)$ assuming the particle has charge $q$.**

**b) Derive a selection rule for electric dipole transitions of the quantum mechanical harmonic oscillator. {*Hint: make use of the harmonic oscillator raising and lowering operators in the matrix element to find the selection rules.*}**

**Extra Credit #8**
**Griffiths, 2nd Edition, Problem 9.17 [Calculating the energy eigenvalues of a symmetric double well in the WKB approximation]**

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