

PROBLEM SET 2

Physics 215C- Quantum Mechanics, SPRING 2008

(Due Wednesday, April 16.)

1. Electromagnetic radiation characterized by the vector potential,

$$A(\vec{x}, t) = \hat{x} \int_0^\infty \frac{d\omega}{2\pi} [a(\omega) e^{i(\frac{\omega}{c}z - \omega t)} + a^*(\omega) e^{-i(\frac{\omega}{c}z - \omega t)}]$$

is incident on a hydrogen atom in its ground state.

- a. Calculate the probability of exciting the atom to the 2p state to first order in perturbation theory. You may leave your answer in terms of an integral over radial wave functions, but perform all angular integrals. Hint: The problem simplifies if you notice that the wavelength of the absorbed radiation is much larger than the Bohr radius. What is the order of magnitude of the ratio of these two quantities?
 - b. Calculate the probability of exciting the atom to the 2s state to first order in perturbation theory.
2. A uniform electric field $E \cos(\omega t)$ is applied to a hydrogen atom in its ground state. Calculate the rate of ionization as a function of ω . Assume the proton does not recoil, and also that you can use plane wave states for the continuum.
 3. Determine the selection rules for electric quadrupole and magnetic dipole transitions.