Quantum II : PHYS 5811

Midterm II

NAME:_____

1) Use the born approximation in 3-d to determine the scattering amplitude, differential cross section and the total scattering crossection for a pair of longitudinally placed delta functions, as shown.

2)(Time Dependent Perturbation Theory) The hyperfine splitting in atomic Hydrogen causes the spin triplet and spin singlet states (Proton + electron spin states here...no angular momentum, electron in the s-wave throughout) to have an energy difference of 1.4GHz. The states couple to each other through the radiation field (here a 1.4 GHz radio wave) via the magnetic dipole hamiltonian, which for simplicity assume is of the form $H^1 = \mu \vec{S} \cdot \vec{B}$ where S is the total spin (here just S_- for example, taking you from spin 1 to spin 0) operator and B is the magnetic field of the radio waves, which has a magnitude E/c where E is the electric field of the radio wave.

a) Use the usual approximate normalization of the cavity modes of a box to determine the magnitude of the $< 0|H^1|1 >$ matrix element for this decay, assuming that the direction of the outgoing photon doesn't matter (crude, but approximate).

b) With that same assumption, use Fermi's Golden rule to estimate the lifetime of the higher energy state due to spontaneous emission of a radio photon. You may take for (in energy units) $\mu \sim 5GHz/Tesla$.

Extra Credit: Can you find a condition in θ and $P_{incident}$ for which the scattering amplitude in Problem 1 in a particular direction (in the Born approximation) actually vanishes?