Quiz #9

1. Find the Clebsch-Gordan coefficient

$$\langle \ell = 2, s = 1/2, J = 1/2, M = 1/2 | \ell = 2, s = 1/2, m_\ell = 1, m_s = -1/2 \rangle$$

2. A proton and neutron with magnetic moments μ_p and μ_n sit in s-wave states of a nuclear well. They exhibit a spin-spin attraction,

$$V_{ss} = \alpha \mathbf{S}_p \cdot \mathbf{S}_n$$

They are also placed in a constant magnetic field, B.

   (a) Find the four eigen-energies when $B = 0$.

   (b) Find the four eigen-energies when $\alpha = 0$.

   (c) When $\alpha \neq 0$, and $B \neq 0$ and points along the z axis, which of the following operators commute with the Hamiltonian. Yes-or-no answers are fine and no credit is given for wrong answers with good reasoning. (Note: $\vec{J} \equiv \vec{S}_p + \vec{S}_n$)

      i. $|\vec{J}|^2 = J_x^2 + J_y^2 + J_z^2$.

      ii. J_z

      iii. $\vec{S}_p \cdot \hat{z}$

      iv. $|\vec{S}_p|^2$

   (d) Find the four eigen-energies for arbitrary α and B.

1