PHYS 487 – Homework 2

ideal = **Wednesday Feb 17**, deadline = **Friday Feb 19 @ midnight**

All solutions must clearly show the steps and/or reasoning you used to arrive at your result. You will lose points for poorly written solutions or incorrect reasoning. Answers given without explanation will not be graded: our master rule for homework and exams is **NO WORK = NO POINTS**. *However you may always use without proof any relation from the 486 or 1D-Math formula sheets. Please upload your solution as 1 PDF file using the my.physics course upload tool.*

Problem 1 : Space × Spin *Griffiths 4.55*

The electron in a hydrogen atom occupies the combined spin and position state

$$R_{21}\left(\sqrt{\frac{1}{3}}\,Y_1^0\,\chi_+ + \sqrt{\frac{2}{3}}\,Y_1^1\,\chi_-\right)$$

where the spinors χ_+ and χ_- denote the $m_S = +½$ and $m_S = -½$ states respectively (i.e. the "spin-up" and "spin-down" states).

(a) If you measured the orbital angular momentum squared (L^2), what values might you get, and what is the probability of each?

(b) Same question for the z component of orbital angular momentum (L_z).

(c) Same question for the spin angular momentum squared (S^2).

(d) Same question for the z component of spin angular momentum (S_z).

(e) Let $\vec{J} \equiv \vec{L} + \vec{S}$ be the total angular momentum of the electron. If you measured J^2, what values might you get, and what is the probability of each?

(f) Same question for J_z.

(g) If you measured the *position* of the particle, what is the probability density for finding it at (r,θ,ϕ)?

(h) If you measured both the z component of the spin *and* the distance from the origin (note that these are compatible observables), what is the probability density for finding the particle with spin up and at radius r?

Problem 2 : Three Particles *Griffiths 5.33*

Suppose you have three particles, and that three distinct one-particle states ($\psi_a(x)$, $\psi_b(x)$, and $\psi_c(x)$) are available. How many different three-particle states can be constructed,

(a) if they are distinguishable particles,

(b) if they are identical bosons,

(c) if they are identical fermions?

NOTE: The particles need not be in *different* states — $\psi_a(x_1)\,\psi_a(x_2)\,\psi_a(x_3)$ would be one possibility, if the particles are distinguishable.