Phys 402
Spring 2019
Homework 1
Due Friday, February 8, 2019 @ 9 AM

1. Griffiths, 2nd / 3rd Edition, Problem 4.1 (a) only

2. Griffiths, 2nd / 3rd Edition, Problem 4.2 (a) and (b) only

3. Griffiths, 2nd Edition, Problem 4.3
3rd Edition, Problem 4.4

4. Griffiths, 2nd Edition, Problem 4.13 (a) and (b) only
3rd Edition, Problem 4.15 (a) and (b) only

5. Griffiths, 2nd Edition, Problem 4.19 (a) and (b) only
3rd Edition, Problem 4.22 (a) and (b) only

Extra Credit #1

Starting with the time-independent Schrödinger equation in spherical coordinates, Griffiths [4.14], separate variables and derive the "θ equation" for $y(x) = \Theta(\theta)$ by making the substitution $x = \cos\theta$. The result is the Associated Legendre equation:

$$(1-x^2)\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + \left[\ell(\ell+1) - \frac{m^2}{1-x^2}\right]y = 0,$$

where the separation constants were written as $\ell(\ell+1)$ and m^2, as in Griffiths. By taking $m = 0$ (giving the Legendre differential equation), and using a series solution method around $x = 0$, show that ℓ must be an integer to keep the solutions finite near the regular singular points $x = \pm 1$.

Extra Credit #2

Starting with radial part of the Schrödinger equation (Griffiths [4.35]), with $V(r)$ for the Hydrogen atom, make the substitution $u(r) = rR(r)$ and obtain [4.53]. Solve this equation by the power series method after "stripping off" the asymptotic behavior for $u(r)$ in the limits of small and large r (see section 4.2.1). From the resulting recursion relation for the expansion coefficients examine the nature of the solutions at large r. Conclude what must be done to keep the wave function finite at large r, and determine the resulting eigenenergy spectrum. Find the (un-normalized) ground state radial wavefunction $R(r)$.