

Physics 4803  
Homework Assignment 4  
Due Sept 24 at 5:00

1) A particle of mass  $m$  is placed in a finite spherical well.

$$V(r) = \begin{cases} 0, & \text{if } r \leq a; \\ V_o, & \text{if } r > a \end{cases}$$

Find the ground state by solving the radial equation with  $\ell=0$ . Show that there is no bound state at all if  $V_o a^2 < \pi^2 \hbar^2 / 8m$ .

2) Show that the expression  $\langle L^2 \rangle = \hbar^2 \ell(\ell + 1)$  is implied directly by the two assumptions

a) The only possible values that the components of the angular momentum can have on any axis are  $\hbar(-\ell, \dots, +\ell)$

b) All of these components are equally probable.

(Hint  $\sum_{m=1}^{\ell} m^2 = \frac{\ell(\ell+1)(2\ell+1)}{6}$ )

3) Consider a system of 2 particles. If the particles are in the states  $|2, 1\rangle$  and  $|1/2, 1/2\rangle$ , what is the probability that the total angular momentum is in the state  $|3/2, 3/2\rangle$ . Do not use the Clebsch-Gordon tables, derive the expression.

4) **Derive** all of the Clebsch-Gordon coefficients when adding two spin 1 particles.

5) Using the Clebsch-Gordon coefficients. Write down all  $|J, M\rangle$  states when adding a spin 3/2 particle to a spin 1/2 particle.