

Problem Set 8**Physics 607****(due Nov. 26, 2001)**

1. Verify the relation:

$$\langle b || \nabla || a \rangle = \langle l_b || C_1 || l_a \rangle \begin{cases} \int_0^\infty dr P_b \left(\frac{d}{dr} + \frac{l_a}{r} \right) P_a, & \text{for } l_b = l_a - 1, \\ \int_0^\infty dr P_b \left(\frac{d}{dr} - \frac{l_a+1}{r} \right) P_a, & \text{for } l_b = l_a + 1. \end{cases}$$

Hint: Use vector spherical harmonics. at the first step.

2. Verify

$$\sum_n \bar{f}_{ks \rightarrow np} = 1$$

and

$$\begin{aligned} \sum_n \bar{f}_{kl \rightarrow nl-1} &= -\frac{l(2l-1)}{3(2l+1)}, \\ \sum_n \bar{f}_{kl \rightarrow nl+1} &= \frac{(l+1)(2l+3)}{3(2l+1)}. \end{aligned}$$

3. Determine the lifetime of the $3p_{3/2}$ excited state in Al. Hint: This state decays to the ground state by an M1 transition. The transition energy is found in the spectroscopic tables.