

Homework #7

(due Wednesday, March 4, 2026)

1. (10 pts) Work through section 12.2.1, in particular:
 - (a) Show term-by-term how to get from Eq. 12.23 to 12.24.
 - (b) Eq. 12.24 gives the diagonal elements of H'_{rel} . These diagonal elements are indeed the first-order corrections to the energy IF the matrix is diagonal in the degenerate sub-space of states of the same n (i.e. degenerate unperturbed states.) Show that the off-diagonal elements within a particular degenerate subspace n are zero. i.e. show that $\langle n \ell' m' | p^4 | n \ell m \rangle = 0$.
 - (c) Show that the formula 12.27 works for the $n=2$ states of hydrogen. Use Mathematica or similar, but show your working. Then assume that the general form stated is correct (too messy to prove in general).
 - (d) Then collect all the terms and show that 12.30 follows from 12.26.
2. (10 pts) (a) Explain the meaning of the terms on the right of Figure 12.4 (i.e. $3d_{5/2}$ etc.).
 - (b) For the $3p_{3/2}$, $3d_{3/2}$ “coupled” states, calculate the total fine structure correction to the Bohr energy.
 - (c) For the $3p_{3/2}$ state, write down explicitly this coupled state as the linear combination of uncoupled states.
3. (10 pts) McIntyre 12.12
4. Reading: Ch. 12 of McIntyre.