Problem E16:

The fine-structure splitting (i.e. the energy splitting between the upper and lower j level) in hydrogen is given by the formula $\Delta E = [\alpha^4 mc^2] \,/\, [2n^3\ell(\ell+1)]$, where m is the electron mass.

(a) Use this formula to find the fine-structure splitting for the 3d and 2p states.

(b) Draw an energy level diagram for these two states which shows the fine structure. Indicate on the diagram the value of j for each level. Then show all the possible 3d $\rightarrow$ 2p transitions that obey the selection rules $\Delta\ell = \pm 1$, $\Delta j = 0, \pm 1$