AMR Quantum Mechanics
Homework, Week 4

1. A multi electron atom is known to have a "regular" ^3P state.
    a) What are the possible spin-orbit terms?
    b) If the energy difference between the first two spin-orbit terms is 16.4 cm^{-1} determine the spin-orbit coupling constant.
    c) Determine the energy difference between the next two spin-orbit terms in cm^{-1} units.
    d) Draw a ladder type energy level diagram (not to scale) to show the above spin orbit states with their appropriate spin-orbit splitting.
    e) Determine if transitions from the lowest state to each of the higher states are allowed.

2. The famous "sodium d lines" are transitions from the sodium atom in its ground electronic state ($1s^2\ 2s^2\ 2p^6\ 3s^1$) to the first excited electronic state ($1s^2\ 2s^2\ 2p^6\ 3p^1$).
    a) Generate the grounds electronic state term symbol for sodium. Evaluate if there are any spin-orbit terms.
    b) Generate the first excited electronic state term symbol for sodium that corresponds to $1s^2\ 2s^2\ 2p^6\ 3p^1$ configuration. Evaluate if there are any spin-orbit terms.
    c) Draw a ladder type energy level diagram (not to scale) to show the above energy levels.
    d) Draw the allowed transitions on the above diagram.
    e) The first two transitions occur at 615.42 nm and 616.07 nm. These are the famous "sodium d lines". Use these values to determine the spin-orbit coupling constant for the first excited electronic state.