

Name: _____

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Please answer 3 of 4 questions, showing all calculations - 35 points each, 105 total.

1. Describe the major similarities and differences between stimulated and spontaneous emission. Describe how stimulated emission is used to make a laser work.
1. A hypothetical quantum-mechanical has the energy levels $E = b n (n + 2)$, where $n = 1, 2, 3, \dots$ and b is a positive constant. The selection rule for radiative transitions is $\Delta n = \pm 2$. For a collection of such systems distributed among many energy levels, the lowest-frequency absorption transition is observed at 80 GHz. Find the next lowest absorption frequency.
3. Without doing any calculations, describe as fully as you can the locations (and relative sizes) of the principal axes of inertia of (a) BF_3 ; (b) H_2O ; (c) CO_2 .
4. For each of the following, state how many proton NMR peaks occur, the relative intensity of each peak, and whether each peak is a singlet, doublet, triplet, etc.: (a) benzene; (b) CH_3F ; (c) methyl acetate; (d) $\text{CH}_2=\text{CHBr}$; (e) $\text{C}_2\text{H}_5\text{CHO}$.

BONUS TIME (10 points)

5. Sketch the 2D COSY and NOESY spectra for m-chlorophenol, shown below.

