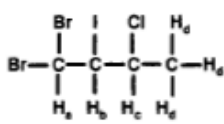


CHM 201
Assignment

- The excited state of the Na D-line emission near 589 nm has a lifetime of 17 ns. What will be the natural linewidth of this transition? Calculate this linewidth in units of Hz and cm^{-1} .
- For the same transition discussed in Problem 4, calculate the Doppler linewidth at temperatures of 300 K, 1000 K and 10 K?
- Comment on the relative values of the natural and Doppler linewidths for this transition in Na, based on your answers in problem 1 and 2.
- Calculate in Hz, the linewidth of transitions in HCN at 25°C, due to Doppler broadening, in regions of the spectrum corresponding to a) rotational transitions (10cm^{-1}); b) vibrational transitions (1500 cm^{-1}) and c) electronic transitions ($60,000\text{ cm}^{-1}$).
- A Nd:YAG laser, with a wavelength of 1064.0 nm, is used to record the rotational Raman spectrum of N_2 . Calculate, in units of nm, where the following rotational Raman lines will occur:
 - first Stokes line, S(0),
 - second Stokes line S(1) and
 - first anti-Stokes line S(0) line. The rotational constant, B_0 , for N_2 is 2.0 cm^{-1} .
- Which of the following nuclei, ^4He , ^6Li and ^7Li , are detectable by NMR?
- What is the energy difference between the two spin of ^1H in a magnetic field of 5.87 T? What is the energy difference between the two spin states of ^{13}C in the same field? Express the energy both in a) Joules and b) in frequency (MHz).
- At 25°C, what fraction of the ^1H nuclei are the upper and lower states, in a field of 5.87 T and 11.74T?
- If the spectrometer's magnetic field varied by +0.00001 T, what magnitude of change would be introduced in the resonance frequency of ^1H nuclei at 5.87 T?
- a) How many peaks would be obtained in the ^1H NMR spectra of the following compounds. Into how many peaks, will each of the NMR signals be split by? Show the splitting pattern.
 - $\text{CH}_3\text{CH}_2\text{CH}_3$
 - $\text{C}_6\text{H}_5\text{CH}_2\text{CH}_3$
 - $(\text{CH}_3)_2\text{-CH-CH}_3$
 - 
- For the three compounds given in problem 7, what would the ^{13}C spectra look like? Would there be a splitting of the ^{13}C NMR signals? If yes, why, and if no, why not?