

HOMEWORK ASSIGNMENT # 4
DUE: MONDAY, 16 FEBRUARY 2009

1. Determine the internuclear separation (Angstroms) in the $v=0$ vibrational state of CO from the frequency of the $J = 1-0$ transition of 115271.2 MHz. Assume the molecule to be rigid.
2. Bernath, page 202, problem 11a
3. Bernath, page 203, problem 20 (the rotational energies and eigenfunctions for linear molecules are the same as for diatomic molecules, although the rotational constants are more complicated).
4. A rigid diatomic rotor with $B = 20$ GHz in its $J=1$ state undergoes an (unallowed) transition between its $|M_J| = 1$ and 0 levels at a frequency of 1 MHz in the presence of a static homogeneous electric field of $E_z = 1,000$ volts/cm. What is the permanent dipole moment of the molecule? The so-called Stark Effect constant $\mu E/h = 0.50348$ MHz/Debye(volt/cm) $\times \mu$ (Debye) $\times E$ (volt/cm).
5. Calculate the overall rotational-nuclear spin degeneracies of the lowest five rotational levels of $^{35}\text{Cl}_2$. The ground electronic state of $^{35}\text{Cl}_2$ is totally symmetric and the nuclear spin of ^{35}Cl is $3/2$.
6. Develop a formula for the Q-branch lines of a diatomic molecule vibrational-rotational band.
7. Using the relations among D_e , ω_e , and $\omega_e x_e$ for the Morse oscillator, find an expression for the number of bound vibrational states in terms of x_e .