

NAME: _____

CHEM 3520 – Physical Chemistry II

EXAM #

Wednesday, April, 2002

INSTRUCTIONS:

1. Show all work, including all formulas used.
2. Provide all units.
3. Keep your work covered.
4. GOOD LUCK!

100 pts total

Short answer:

1. What is the transition $v = 2 \leftarrow 0$ called? (2 pts)
2. What is the transition $v = 1 \leftarrow 0$ called? (2 pts)
3. How does centrifugal distortion affect a diatomic molecule? (An equation is NOT the appropriate response!) (4 pts)
4. Explain the difference between D_e and D_0 ? Why are both necessary? (6 pts)

Constants:

$$h = 6.62608 \times 10^{-34}$$

$$1 \text{ u} = 1.66054 \times 10^{-27}$$

$$k_B = 1.38066 \times 10^{-23}$$

Problems:

5. How many independent nodes of vibration are expected for the molecule NH_3 ? Show your work. (4 pts)
6. Will Stokes or anti-Stokes lines have higher frequency? Show your work. (No points for guessing!) (9 pts)
7. Express the separation between spectral lines in GHz, cm^{-1} , and mm for (a) pure rotation; and (b) rotational Raman. Show your work. (25 pts)

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8. What is the spacing between energy levels of a pure rotation for a spherical rotor in cm^{-1} ? in J? Show your work. (10 pts)
9. The wavenumber of the fundamental vibrational transition of $^{79}\text{Br}^{81}\text{Br}$ is 323.2 cm^{-1} . Calculate the force constant of the bond. (8 pts)
(Useful information: $m(^{79}\text{Br}) = 78.9183 \text{ u}$; $m(^{81}\text{Br}) = 80.9163 \text{ u}$)
10. Rotational absorption lines from $^1\text{H}^{35}\text{Cl}$ gas were found at the following wavenumbers: (30 pts)
 $83.32, 104.13, 124.73, 145.37, 165.89, 186.23, 206.60, 226.86 \text{ cm}^{-1}$
- (a) Calculate the moment of inertia and bond length of the molecule.
(b) Predict the positions of the corresponding lines in $^2\text{H}^{35}\text{Cl}$