

INDIAN INSTITUTE OF SCIENCE EDUCATION & RESEARCH
MOHALLI

CHM 201, II Mid Semester Examination

October 10, 2018

1. Attempt all questions. Total number of questions: 4
2. Show clearly all the steps in your calculations.

Time: 1 hour
Total Marks: 25

1. A spectroscopist records the rotational-vibrational spectrum of a diatomic molecule for the fundamental band but reported the wavenumbers of only the following three R branch transitions, $R(0)=2905.8\text{ cm}^{-1}$, $R(1)=2925.7\text{ cm}^{-1}$, $R(2)=2944.7\text{ cm}^{-1}$. Using the above values, calculate B_0 and B_1 values for the $v=0$ and $v=1$ vibrational levels. (6)

2. Derive the term symbols for the following electronic configuration and express the term states in the format $(2s+1)L_J$.
a) $2p\ 3d^1$ b) $1s^2, 2s^2, 2p^6, 3s^2, 3d^1$ c) $1s^2$ (6)

3. For each of the observations given below for electronic transitions, predict if $R_e > R_e''$ or $R_e' < R_e''$ or $R_e' \approx R_e''$.
a) No long vibrational progression is seen in this electronic transition, but only sequence bands are observed (i.e. transitions where $\Delta v=0$). In particular, the $v''=0 \rightarrow v'=0$ transition is very strong.
b) In this electronic transition, the P branch forms the head.
c) The spacing between rotational lines in the R-branch of the vibrational bands seem to be decreasing very slowly and band head formation does not seem to be imminent (i.e. band head is most likely to form, if at all, only at very large J values).
d) In this electronic transition, red-degraded band heads are observed. (8)

4. We had seen that each line in the Lyman spectra of the hydrogen atom, was split into two components. If one of the electrons from the ground state configuration of the **He atom** was excited from the $1s$ orbital to a $2p$ orbital (i.e. consider a $1s^2 \rightarrow 1s^1 2p^1$ transition in He), would the *observed* transition appear as a single line or would it appear as two components, as in the Lyman spectra. Explain your prediction. (5)