

C 80720

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Name.....

Reg. No.....

**FOURTH SEMESTER M.Sc. DEGREE EXAMINATION, MARCH 2020**

(CUCSS)

Physics

**PHY 4C 12—ATOMIC AND MOLECULAR SPECTROSCOPY**

(2017 Admission onwards)

Time : Three Hours

Maximum : 36 Weightage

**Section A**

*Answer all questions, each carries weightage 1.*

1. Explain Stark effect.
2. State and explain Hund's rule. Give an example.
3. Give the selection rules for Zeeman pattern.
4. What are hot bands ? How are they formed ?
5. How do you find out the bond length and angles from the rotational spectra for a symmetric top molecule ? Give the relevant equations.
6. Explain Mutual exclusion principle. In which type of molecule it is observed and why ?
7. Distinguish between Anti-Stokes Raman scattering and inverse Anti-Stokes Raman Scattering. Give the conditions for them to occur.
8. Explain the intensity variation of vibrational electronic spectra on the basis of Franck -Condon principle.
9. What are progressions and sequences in the vibrational analysis of a spectrum ?
10. Briefly explain recoilless emission and absorption of gamma rays.
11. What is chemical shift ? Describe its relevance.
12. Derive the resonance condition in ESR spectroscopy.

(12 × 1 = 12 weightage)

**Section B**

*Answer any two questions, each carries weightage 6.*

13. Compare Paschen Back Effect and Zeeman effect. Illustrate with the example of a principal series doublet.
14. Discuss in detail the spectra of a diatomic vibrating rotator. Explain the break down of the Born Oppenheimer approximation.

Turn over

15. Describe with the diagrams the Raman Spectrometer and the sample handling techniques for the same.
16. Derive Bloch equations in NMR spectroscopy. Describe how they can be used to define the susceptibilities.

(2 × 6 = 12 weightage)

### Section C

*Answer any four questions, each carries weightage 3.*

17. Compute the interaction energies for pd electrons in LS coupling.
18. Rotational and centrifugal distortion constants of HCl molecule are  $10.593 \text{ cm}^{-1}$  and  $5.3 \times 10^{-4} \text{ cm}^{-1}$  respectively. Estimate the vibrational frequency and the force constant of the molecule. Given the mass of hydrogen and chlorine are  $1.673 \times 10^{-27} \text{ kg}$ . and  $58.06 \times 10^{-27} \text{ kg}$ . respectively.
19. Describe the method for the structure determination of triatomic molecules using Raman Spectroscopy. Illustrate with the example of  $\text{CO}_2$ .
20. The band origin of a transition in  $\text{C}_2$  is observed at  $19,378 \text{ cm}^{-1}$  while the rotational fine structure indicates that the rotational constants in excited and ground states are respectively  $B' = 1.7527 \text{ cm}^{-1}$  and  $B'' = 1.6326 \text{ cm}^{-1}$ . Estimate the position of the band head. Which state has the larger inter nuclear distance ?
21. The spectroscopic bond dissociation energy of  $^{35}\text{Cl}^{16}\text{O}$  radical is 1.9 eV. Calculate the equilibrium bond dissociation energy of ClO, if the fundamental frequency is  $780 \text{ cm}^{-1}$ . Given Avagadro number =  $6.022 \times 10^{23} \text{ mol}^{-1}$ , Planck's constant =  $6.626 \times 10^{-34} \text{ Js}$ .
22. Illustrate the decay scheme of  $^{57}\text{Co}$  in  $^{57}\text{Fe}$  with respect to Mössbauer transition.

(4 × 3 = 12 weightage)