

**18P405**

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Name.....

Reg. No.....

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

(CUCSS - PG)

(Regular/Improvement/Supplementary)

**CC17P PHY4 C12 - ATOMIC AND MOLECULAR SPECTROSCOPY**

(Physics)

(2017 Admission onwards)

Time: Three Hours

Maximum: 36 Weightage

**Section A**

Answer *all* questions. Each question carries 1 weightage.

1. Explain Stark Effect?
2. State Hund's rule with an example.
3. Give a brief account of the rotational energy levels and spectra of rigid prolate symmetric top molecule.
4. Explain the effect of centrifugal distortion on the moment of inertia and energy of a diatomic molecule.
5. Give a brief account of the normal modes of vibrations of carbon dioxide molecule.
6. What is Born Oppenheimer approximation? Based on this approximation, what are the salient features of rotation vibration spectra of diatomic vibrating rotor.
7. Explain the basic principle behind non-linear Raman effect.
8. Outline briefly a method for the determination of bond distance of homo nuclear diatomic molecule.
9. Distinguish between  $\nu'$  progression and  $\nu''$  progression.
10. With a suitable example, explain chemical shift in NMR.
11. Discuss the ESR spectra of Hydrogen atom.
12. Outline the principle of Mossbauer spectroscopy.

**(12 x 1 = 12 Weightage)**

**Section B**

Answer any *two* questions. Each question carries 6 weightage

13. With necessary theory account for the splitting of a spectral line in the presence of a weak magnetic field.
14. With a block diagram describe the construction and working of Raman Spectrometer
15. a) Discuss in detail the rotational fine structure of electronic vibration spectra.  
b) Write a short note on Fortrat Parabolae.

16. Explain different relaxation processes for nuclei and derive Bloch equations

(2 x 6 = 12 Weightage)

### Section C

Answer any *four* questions. Each question carries 3 weightage.

17. For pd electronic configuration in LS coupling scheme, find the ratio of energy difference between adjacent terms of its normal triplet state.

18. How many revolutions per second does a CO molecule make when  $J = 4$ ?

The rotational constant of CO molecule is  $1.9313\text{cm}^{-1}$ .

19. Show that the maximum intensity transition for a diatomic vibrating rotator occurs at

$$J = \sqrt{\frac{kT}{2hcB}} - \frac{1}{2}$$

20. The zero point energy of the ground state of  $\text{N}_2$  is  $1176\text{cm}^{-1}$  and that of its first excited state is  $727\text{cm}^{-1}$ . The energy difference between the minima of the two potential energy curves is  $50206\text{cm}^{-1}$ . What is the wave number of the (0,0) band? What is its wavelength?

21. A substance shows Raman line at  $4567\text{Å}$ , when exciting line  $4358\text{Å}$  is used. Deduce the positions of Stokes and anti-Stokes lines for the same substance when the exciting line  $4047\text{Å}$  is used.

22. Calculate the recoil velocity of a free Mossbauer nucleus of mass  $9.4684 \times 10^{-26}\text{Kg}$  emitting a  $\gamma$ -ray of wavelength  $8.57 \times 10^{-11}\text{m}$ . What is the Doppler shift of  $\gamma$ -ray frequency to an outside observer?

(4 x 3 = 12 Weightage)

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