C 42047 **(Pages : 2)** **Name.....**

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2023

(CBCSS)

Physics

PHY 4C 12—ATOMIC AND MOLECULAR SPECTROSCOPY

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

8 *Short questions answerable within* 7.5 *minutes*
Answer **all** *questions, each carry weightage* 1.

1. Give the features of Paschen-Back effect.
2. IR and Raman measurement complement each other and the complete picture of the vibrational problem can only be obtained by using both the techniques. Substantiate.
3. The observed rotational spectrum of HF shows decrease in the line separation on the high frequency side. Why ?
4. State and explain Franck Condon Principle.
5. Obtain the resonance condition in NMR spectroscopy ?
6. Why microwave source and techniques have to be applied for the observation of ESR ?
7. What is the significance of spin-spin coupling ?
8. Explain how Mossbauer spectrum is useful in understanding electronic structure of molecules.

(8 × 1 = 8 weightage)

Section B

4 *essay questions answerable within* 30 *minutes*
Answer any **two** *questions, each carry weightage* 5.

9. Explain the concepts underlaying vector atom model and discuss in details LS and JJ coupling schemes in many electron atoms. Give examples
10. Describe normal modes and vibration of H_2O and CO_2 molecules and explain the principle of Fourier transformation Infrared Spectroscopy.

Turn over

11. Explain the basic principle of stimulated Raman and Inverse Raman scattering.

12. Explain Recoilless emission and absorption of γ-rays and briefly explain the use of chemical shift in understanding molecular structure.

(2 × 5 = 10 weightage)

Section C

7 problems answerable within 15 minutes
Answer any **four** *questions, each carry Weightage 3.*

13. The red line of cadmium splits into three components separated by 120 MHz when the source is placed in a magnetic field of flux density 8.6 mT, the light being examined in direction perpendicular to the magnetic field. Calculate the ratio of charge to mass (e/m) of the electron.

14. The first line in the rotational spectrum of carbon monoxide has a frequency of 3.8424 cm^{-1}. Calculate the rotational constant and hence the C-O bond length in carbon monoxide. Avogadro number is 6.022×10^{23}/mol.

15. The first three rotational Raman lines of a linear triatomic molecular are at 4.86, 8.14 and 11.36 cm^{-1} from the exciting Raman lines. Estimate the rotational constant B and the moment of inertia of the molecule.

16. The spectroscopic bond dissociation energy of Cl^{35} O^{16} radical is 1.9 eV. Calculate the equilibrium bond dissociation energy of ClO , if the fundamental vibrational frequency is 780 cm^{-1}.

17. In the NMR spectrum of N^{14} with I = 1, how many spectral lines will be observed ? Calculate the frequency required for the NMR line at an external field of 1.4T (g = 0.403).

18. Calculate the recoil velocity and energy of the free Mossbauer nucleus S_n^{119} when emitting a γ-ray of frequency 5.76×10^{18} Hz. What is the Doppler shift of the γ-ray frequency to n outside observer ? Avogadro number is 6.02×10^{23} mol^{-1}.

19. Electron spin resonance is observed in atomic hydrogen at a magnetic field B = 0.34T. Calculate g value for the electron in the hydrogen atom. If the operating frequency is 9.5 GHz.

(4 × 3 = 12 weightage)