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 chemica in understanding molecular structure.

(2 × 5 = 10 weig

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 so placed in a magnetic field of flux density 8.6 mT, the light being examined in direction perpend 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 3.842 Calculate the rotational constant and hence the C-O bond length in carbon monoxide. Avo number is 6.022×10^{23}/mol.

15. The first three rotational Raman lines of a linear triatomic molecular are at 4.86, 8.1 11.36 cm^{-1} from the exciting Raman lines. Estimate the rotational constant B and the mom inertia of the molecule.

16. The spectroscopic bond dissociation energy of Cl^{35} O^{16} radical is 1.9 eV. Calculate the equili 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 ? Calcul 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 of frequency 5.76×10^{18} Hz. What is the Doppler shift of the γ-ray frequency to a obs 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. Calcu value for the electron in the hydrogen atom. If the operating frequency is 9.5 GHz.

(4 × 3 = 12 weig