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Reg. No. : .....

Name : .....

Third Semester M.Sc. Degree Examination, January 2023

Physics

PH 232 : ATOMIC AND MOLECULAR SPECTROSCOPY

(2020 Admission Onwards)

Time : 3 Hours Max. Marks : 75

PART – A

Answer any **five** questions, each question carries **3** marks.

1. Write the matrix representation of the following symmetry elements, $\sigma(xy)$, i and $C_n(z)$.

2. Arrive at an expression for the Lande g-factor

3. Explain Franck-Condon principle.

4. What are Auger electrons? What information one can derive from the Auger spectrum?

5. Distinguish between overtones and hot bands in vibration spectra.

6. Briefly discuss the two types of relaxations in NMR.

7. Distinguish between progression and sequence.

8. Discuss the factors influencing the intensities of spectral lines.

(5 × 3 = 15 Marks)

P.T.O.

PART – B

Answer **three** questions, each question carries **15** marks.

9. (a) Distinguish between normal and anomalous Zeeman effects.

   (b) Sketch the anomalous Zeeman pattern for the sodium D_1 and D_2 lines.

OR

10. (a) Explain Photoelectron spectroscopy. Discuss the information derived from this technique.

    (b) What is X-ray fluorescence? Explain how XRF is useful for the characterization of materials?

11. (a) What is finger print region and explain its relevance in the structure determination of molecules.

    (b) With necessary theory discuss the vibration spectrum of a symmetric top molecule.

OR

12. (a) Discuss the formation of PQR branches in the electronic spectrum of diatomic molecules.

    (b) What is Fortrat diagram? Explain the terms band-head and band-origin.

13. (a) Discuss the principle of Mossbauer spectroscopy.

    (b) Explain quadrupole and magnetic hyperfine interactions in Mossbauer spectroscopy.

OR

14. (a) Discuss the classical theory of Raman effect.

    (b) Explain how Raman and IR spectroscopy is used for the structure determination of H_2O and CO_2 molecules.

(3 × 15 = 45 Marks)

PART – C

Answer any **three** questions. Each question carries **5** marks.

15. Arrive at the character table for C_{3v} point group.

16. Find the spectral terms arising out of the LS coupling between a *p*-electron and a *d*-electron.

17. The rotational spectrum of $^{79}Br^{19}F$ shows a series of equidistant lines 0.71433 cm^{-1} apart. Calculate the rotational constant B and hence the moment of inertia and bond length of the molecule.

18. The fundamental band of HCl is found at 2886 cm^{-1}. Calculate the wave numbers of the first line of P and R branches. The bond length of HCl molecule is 1.276 Å. $\mu HCl = 1.6275 \times 10^{-27} Kg$.

19. An ESR spectrometer operates at 24 GHz. Find the magnetic field used. Sketch out the hyperfine structure of hydrogen atom Zeeman lines and the transitions involved.

20. Find the maximum populated rotational quantum number at 300K for a molecule with rotational constant 10.59 cm^{-1}.

    1 a m u = 1.66×10^{-27} Kg.

    h = 6.626×10^{-34} JS

    k = 1.381×10^{-23} JK^{-1}

(3 × 5 = 15 Marks)
