2/21

0105N096

Candidate's Seat No :_____

MSc Sem.-2 Examination

407

Medical Physics

May-2025

Time : 2-30 Hours] **[Max. Marks : 70**

Q.1 (A) Describe the fine structure observed in the spectra of alkali metals. How does spin-orbit interaction lead to the doublet structure? Derive an expression for the energy splitting due to spin-orbit coupling. [07]

(B) Explain the Thomas-Fermi statistical model for atoms. What are the assumptions involved? Derive the Thomas-Fermi equation and discuss its significance and limitations. [07]

OR

Q.1 (A) Discuss the interaction energy in LS and JJ coupling for a two-electron system. What physical conditions favor each coupling scheme? Provide an example illustrating the energy level splitting. [07]

(B) Describe various line broadening mechanisms in atomic spectra such as natural broadening, Doppler broadening, and collisional broadening. How do these mechanisms affect spectral resolution? [07]

Q.2 (A) Explain how molecules can be classified? Discuss symmetric top and asymmetric top approach of molecules. [07]

(B) Discuss dynamic linear and spherical top approach of molecules. [07]

OR

Q.2 (A) Describe rigid rotor model for diatomic molecules and show that moment of inertia $I = \mu r^2_o$. Also derive an expression for the frequency of an absorption line. [07]

(B) Discuss an energy level spectrum of a non-rigid rotator. [07]

Q.3 (A) Discuss vibrational energy of a diatomic molecules. [07]

(B) Discuss the potential energy function of a diatomic molecules and prove that $\bar{\nu} = \frac{1}{2\pi C}\sqrt{\frac{k}{\mu}}$. [07]

OR

Q.3 (A) Draw a potential energy diagram of a vibrating diatomic molecule and discuss the Morse potential energy diagram. [07]

(B) Discuss theory of diatomic molecules as simple harmonic oscillator. Prove that $V(x) = \frac{1}{2}kx^2$. [07]

Q.4 (A) What are Raman spectroscopy and Raman scattering? Discuss instrumentation for Raman spectroscopy. [07]

(B) Give brief introduction about NMR. Discuss theory and principle of NMR. [07]

OR

(P.T.O)

Q.4 (A) Give brief introduction about Mossbauer effect. Discuss Mossbauer spectroscopic instrumentation. [07]

(B) List various types of spectroscopies. Discuss UV-Vis spectroscopic technique. [07]

Q.5 Answer in brief **Any Seven** questions from the following: (Each question is of **two** mark). [14]

(i) What are the quantum numbers that define the state of a hydrogen-like atom?

(ii) State Pauli's principle exclusion. Why is Pauli's principle important in explaining atomic structure?

(iii) Define an atomic orbital. What is its physical significance?

(iv) Calculate moment of inertia of HC≡ CCl (chloroacetylene). Assume (C–H) =1.10 Å, r(C≡ C) 1.20 Å, and r (C–Cl) =1.60 Å

(v) _____is not a type of a bending molecular vibration (twisting/ stretching)

(vi) Force constant is expressed in _____ (write unit)

(vii) What do you understand by zero-point energy?

(viii) List various applications of Raman spectroscopy.

(ix) List various applications of Mossbauer spectroscopic technique.

(x) List uses of XPS technique and applications in industry

(xi) When $\Delta J = 0$, we get ___ Branch (P/Q/R)

(xii) C_2H_2 is_____type molecule.

***** PAPER ENDS *****