

(2 1/2 Hours)

Total Marks: 75

- N.B. :** (1) All questions are compulsory.
 (2) Figures to the right indicate full marks.
 (3) Draw neat diagrams wherever necessary.
 (4) Symbols have usual meaning unless otherwise stated.
 (5) Use of non-programmable calculator is allowed.

List of Constants:

1. (a) Attempt any one:---
 - (i) State Schrodinger equation for linear simple harmonic oscillator. Using appropriate operator, solve it to obtain zero point energy. 10
 - (ii) Using radial part of Schrodinger's equation for hydrogen atom $R(r)$, Show that the angular momentum of electron is quantized. 10
- (b) Attempt any one:---
 - (i) Describe space quantization of orbital angular momentum of an electron. 5
 - (ii) By using azimuthal probability density $|\phi|^2$, find the value of normalized azimuthal function Φ . 5
2. (a) Attempt any one:---
 - (i) Explain Goudsmith and Uhlenbeck hypothesis in case of spinning of electron. Describe Stern-Gerlach experiment. 10
 - (ii) Give a brief account of the vector atom model. 10
- (b) Attempt any one:---
 - (i) State and explain Pauli's exclusion principle. 5
 - (ii) A beam of electrons enters a uniform magnetic field of induction 1.8 Wb/m^2 . Find the energy difference between the states of the electrons whose spins are parallel to the field and those whose spins are antiparallel to the field. 5
3. (a) Attempt any one:---
 - (i) What is Zeeman effect? Write the classical explanation of Normal Zeeman effect. 10
 - (ii) Write a detailed note on Paschen back effect. What are the selection rules for Paschen back effect? 10
- (b) Attempt any one:---
 - (i) Write a note on Anomalous Zeeman effect 5
 - (ii) Define and explain what is Lande g-factor. 5

4. (a) Attempt any one:---
- (i) Considering the diatomic molecule as a rigid rotator, derive the rotational energy terms E_J and show that the rotational energy levels are not equispaced. **10**
- (ii) What is Raman effect? What are Stoke's & Antistoke's lines? Give the quantum theory of Raman effect. **10**
- (b) Attempt any one:---
- (i) Write note on Frank Condon principle. **5**
- (ii) Explain the Raman activity of vibrations with the example of H_2O molecule. **5**
5. (a) Attempt any one:---
- (i) Calculate the zero point vibrational energy for NaCl molecule, if its fundamental vibrational frequency is 1.5×10^{13} Hz. ($h = 6.63 \times 10^{-34}$ J.s). **4**
- (ii) If $U_0(y) = e^{-y^2/2}$, Find $U_1(y)$. **4**
- (b) Attempt any one:---
- (i) Calculate the values of L, S, and J for 'd' electron in one-electron atomic system. **4**
- (ii) Find the values of S, L and J that correspond to each of the following states: **4**
- ${}^2D_{3/2}, {}^2S_{1/2}$
- (c) Attempt any one:---
- (i) If a sample of an element is placed in magnetic field of strength 0.3wb/m. Find how far apart are the Normal Zeeman components of a spectral line of wavelength 4500\AA ? **4**
- (ii) For $3^2P_{3/2}$ state, Calculate the value of Lande's g-factor. **4**
- (d) Attempt any one:---
- (i) Calculate the moment of inertia of CO molecule if the first absorption line in CO rotational spectrum occurs at 1.153×10^{11} Hz. **3**
- (ii) When radiation of $\lambda = 5460\text{\AA}$ was scattered by a medium, A stokes line of $\lambda = 5440\text{\AA}$ was observed. Calculate the Raman shift $\Delta\nu$. **3**