

B.Sc.24121-Physics Paper-I (Quantum Mechanics and Molecular Physics)

P. Pages : 3

Time : Three Hours



GUG/S/19/1300

Max. Marks : 50

- Notes :
1. All questions are compulsory.
 2. Draw well labelled diagrams wherever necessary.
 3. The values of constants are given below.

Constants :

- i) Charge of electron $e = 1.6 \times 10^{-19} \text{C}$
- ii) Mass of electron $m_e = 9.1 \times 10^{-31} \text{kg}$
- iii) Mass of proton $m_p = 1.67 \times 10^{-27} \text{kg}$
- iv) Planck's constant $h = 6.63 \times 10^{-34} \text{J.S.}$
- v) Constant $\hbar = \frac{h}{2\pi} = 1.054 \times 10^{-34} \text{J.S.}$
- vi) Velocity of light $C = 3 \times 10^8 \text{m/s}$
- vii) $1\text{eV} = 1.6 \times 10^{-19} \text{J}$

1. Either :

- a) i) Describe Davisson and Germer experiment to confirm wave nature of particle. 5
- ii) Discuss the result and conclusion. 2
- iii) Calculate debroglies wavelength of electron moving with velocity 3/5 times the velocity of light. 3

OR

- b) i) What is free particle? 1
- ii) Write Schrodinger's time independent wave equation for a free particle in 3 – dimensional rectangular box and solve it to obtain the eigen value of energy. 7
- iii) Show that, ground state of energy is non – degenerate. 2

2. Either :

- a) i) State the different kinds of molecular spectra. 3
- ii) Obtain an expression for rotational energy level of diatomic molecule. 4
- iii) Hence obtain frequency of rotational spectra. 3

OR

- b) i) What is Raman effect? 1
- ii) How it differs from fluorescence? 2
- iii) Give the experimental arrangement to study the Raman effect. 3
- iv) Explain Raman effect on the basis of quantum theory. 4

3. Either :

- a) Find the energy of neutron in eV having the Debroglie's wavelength 1\AA and mass $1.67 \times 10^{-27} \text{ kg}$. 2½
- b) Explain the physical significance of wave function ψ . When it is said to be well behaved function. 2½
- c) What is diatomic molecule? Distinguish between Homo – nuclear and Hetro-nuclear diatomic molecule with examples. 2½
- d) Describe in brief electronic spectra of diatomic molecules. 2½

OR

- e) State and prove Heisenberg's uncertainty principle in position and momentum. 2½
- f) Find the energy of a particle of mass $9 \times 10^{-31} \text{ kg}$ in one dimensional box of length 1\AA for $n = 1$. 2½
- g) Explain the molecular spectra. 2½
- h) State and explain any two applications of Raman effect. 2½

4. Either :

- a) Obtain the relation between phase velocity and group velocity. When they are equal? 2½
- b) What is an operator? Derive an operator in quantum mechanics for momentum. 2½
- c) Find the frequency of vibration of CO molecule. The force constant of CO bond is 187 N/m , mass of carbon atom = $1.99 \times 10^{-26} \text{ kg}$ and mass of O atom = $2.66 \times 10^{-26} \text{ kg}$. 2½
- d) State Frank – Condon principle. What are its limitations? 2½

OR

- e) Obtain Schrodinger's time dependent equation in one dimension. 2½
- f) Explain reflection and transmission of particle of energy $E < V_0$ through the barrier of potential V_0 . 2½

- g) Hetro-nuclear diatomic molecules shows vibrational spectra but homo-nuclear molecule do not show it. Why? **2½**
- h) Using mercury green radiation of wavelength 5461 \AA , Stoke's lines of wavelength 5543 \AA was observed. Find the Raman shift of frequency. **2½**

5. Attempt **any ten** of the following. **10**

- a) What is dispersive and non – dispersive medium.
- b) What is wave packet?
- c) Find uncertainty in the momentum of a particle when its position is determined with 0.01cm .
- d) What is eigen function and eigen value?
- e) What is degenerate function and degree of degeneracy?
- f) Show that sum of co-efficient of reflection and coefficient of transmission is unity.
- g) What is harmonic oscillator?
- h) State the selection rule for pure vibrational spectra.
- i) What is NMR?
- j) State any two applications of ESR.
- k) Find the wave number of Raman Stoke's lines of wavelength 5520 \AA .
- l) What is Dissociation energy of molecule?
