Bachelor of Science (B.Sc.) Fourth Semester

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

P. Pages : 3 **GUG/W/18/1300**

Time : Three Hours * 1 0 1 3 * Max. Marks : 50

Notes : 1. All questions are compulsory.
2. Draw well labelled diagrams wherever necessary.

1. Either

a) i) State and explain Heisenberg's uncertainty principles. Also write it in terms of energy and time. **3**

ii) Illustrate the uncertainty principle using Heisenberg's ν-ray thought experiment. **4**

iii) Find the smallest possible uncertainty in the position of an electron moving with velocity 3×10^7 m/s. **3**
(Given : $\hbar = 1.054 \times 10^{-34}$ Js, $m_o = 9.11 \times 10^{-31}$ kg)

OR

b) i) What is free particle? **1**

ii) Write Schrodinger's wave equation for a free particle in one dimensional box and solve it and obtain eigen value of energy. **3**

iii) Find the lowest energy of a neutron confined to a nucleus of size 10^{-14} m. **3**
(Given : mass of the neutron = 1.67×10^{-27}kg)

2. Either

a) i) What are the different types of molecular spectra? **3**

ii) Obtain an expression for vibrational energy levels of a diatomic molecules. **5**

iii) Show that, vibrational energy levels are equally spaced. **2**

OR

b) i) Describe the experimental arrangement to study the Raman effect with the help of a neat diagram. **4**

ii) Explain the term. **3**

a) Stoke's lines.

b) Anti-Stoke's lines.

iii) The wavelength of an exciting line in an experiment is 5460 Aº and Stokes' line is at 5520Aº. Find the wavelength of antistoke line. **3**

3. Either

a) Define the term phase velocity and group velocity. Obtain the relation between them. **2½**

b) What is an operator? Derive an expression for linear momentum operator. **2½**

c) Distinguish between homonuclear and heteronuclear molecules with examples of each. **2½**

d) Explain elementary idea of NMR. **2½**

OR

e) Calculate the de-Broglie wavelength of an electron moving with velocity **2½**

$\frac{3}{5}$ c. $\left(\begin{array}{l}\text{Given} \quad h = 6.63\times10^{-34}\,\text{Js} \\ \qquad\quad m_o = 9.11\times10^{-31}\,\text{kg}\end{array}\right)$

f) What is eigen function and eigen value? Explain them with example. **2½**

g) Why all molecules do not show rotational spectra? Explain.

h) Explain in brief ESR. **2½**

Either

4. a) Obtain an expression for Schrodinger's time dependent equation for a particle moving along x-axis. **2½**

b) Find the eigen values for the operator d^2/dx^2 operating on the wave function. **2½**

i) $\Psi = \cos x$ ii) $\Psi = e^x$

c) Obtain an expression for rotational energy of a diatomic molecule. **2½**

d) State and explain Franck-Condon principle for the intensity distribution. **2½**

OR

e) State de-Broglie's hypothesis for matter waves. Obtain de-Broglie wave equation. **2½**

f) Discuss the physical significance of wave function. what does square of wave function signify? **2½**

g) For HCl molecule the frequency of rotational absorption line is 20.7 cm^{-1} and B = 10.35 cm^{-1}. Atomic mass number of chlorine is 35.46. $m_\mu = 1.0008$ and $N_o = 6.024x10^{23}$ molecule/mole. Determine bond length of HCl molecule. **2½**

h) Describe in brief electronic spectra of a diatomic molecules. **2½**

5. Solve **any ten** of the followings.

a) What is wave packet? **1**

b) Draw the experimental set up for Davisson and Germer experiment. **1**

c) What is dispersive and non dispersive medium? **1**

d) What is step potential? **1**

e) Define transmission coefficient. **1**

f) What is degeneracy of energy level? **1**

g) Write selection rule for pure vibrational spectra. **1**

h) Write the expression for frequency of rotational spectra. **1**

i) What is harmonic oscillator? **1**

j) Discuss the practical importance of Raman effect. **1**

k) What is Dissociation energy? **1**

l) State two application of ESR. **1**

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