

S.Y.B.Sc. (With Credits)-Regular-Semester 2012 Sem IV
B.Sc.24121 - Physics-I (Quantum Mechanics and Molecular Physics) Paper-I

P. Pages : 3

Time : Three Hours



GUG/W/16/5614

Max. Marks :50

- Notes : 1. All question are compulsory.
2. Draw well labelled diagram wherever necessary.

Either

1. a) i) State and explain De-Broglie hypothesis. 2
ii) Describe Davission and Germer experiment for electron diffraction. How does this experiment verify the existence of wave nature of an electron? 6
iii) Calculate De-Broglie wavelength of proton which has kinetic energy of 1MeV. 2
(mass of proton= 1.67×10^{-27} kg) and ($h=6.62 \times 10^{-34}$ J/S).

OR

- b) i) What is wave function (ψ) of a moving particle? 1
ii) State the conditions for the wave function to be well behaved. 2
iii) Obtain an expression for energy of a particle in one dimensional rigid potential box of equal sides. 5
iv) Find the energy of a electron in one dimensional rigid box of length 1Å for $n=1$ and $n=2$ (mass of electron = 9.1×10^{-31} kg) 2

Either

2. a) i) What are the different kinds of molecular spectra? 2
ii) Obtain an expression for rotational energy levels of a diatomic molecule. 6
iii) Show that energy levels are not equally spaced 2

OR

- b) i) What is Raman effect? 1
ii) Distinguish between stokes and anti stokes lines in Raman spectra. 2
iii) Describe the experimental arrangement to study the Raman effect. 4
iv) With the radiation of wavelength 4358Å incident on a sample, stoke's line is obtained at wavelength 4458Å find the wavelength of antistoke's line. 3
Give $c=3 \times 10^8$ m/s.

- Either**
3. a) Define the term phase velocity and group velocity. Obtain the relation between them. 2½
- b) Discuss the physical significance of wave function. What does a square of wave function signify? 2½
- c) Obtain an expression for vibrational energy using quantum mechanics. 2½
- d) State the applications of Raman effect. 2½

OR

- e) State and explain Heisenberg's uncertainty principle using De-Broglie wave concept. 2½
- f) What is eigen function and eigen value? Explain them with example. 2½
- g) Draw and explain the energy level diagram in vibrational rotational spectra. 2½
- h) Explain in brief NMR. 2½

Either

4. a) Derive Schrodinger time dependent wave equation. 2½
- b) What is an operator? Define linear operator mention any two quantum mechanical operators. 2½
- c) Calculate the rotational energy corresponding to J=1 for hydrogen molecule, If bond length is 0.074 nm. Given - mass of hydrogen atom is 1.674×10^{-27} kg. 2½
- d) State and explain Franck-Condon principle for the intensity distribution. 2½

OR

- e) An electron is confine to a box of length 10^{-8} m. Calculate the minimum uncertainty in its velocity. Given : $m_e = 9 \times 10^{-31}$ kg, $h = 6.63 \times 10^{-34}$ J.S 2½
- f) Explain the tunnel effect with neat diagram using quantum mechanics. 2½
- g) Distinguish between homonuclear and heteronuclear molecules with examples of each. 2½
- h) Obtain an expression for frequency of electron spin resonance. 2½

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

- a) What is wave packet? 1
- b) State the relation between energy and time using Heisenberg's uncertainty principle. 1
- c) Write Schrodinger's time independent equation. 1
- d) Define free particle. 1

- e) Write the condition for normalised wave function. 1
- f) What is zero point energy of quantum mechanical simple Harmonic oscillator? 1
- g) Calculate the rotational energy of a diatomic for $J=0$. 1
- h) Why H_2 molecule does not show rotational spectra? 1
- i) Write the selection rule for pure vibrational spectra. 1
- j) What are the characteristics of Raman lines? 1
- k) Write the importance of Raman effect. 1
- l) Frequency of Stoke's line in Raman scattering is $5.5 \times 10^{14}/S$ and Raman shift is $8 \times 10^{12}/S$ find frequency of antistokes lines. 1
