CSM : 17

PHYSICS

PAPER - II

Time Allowed : 3 hours | Full Marks : 100

Marks for each question is indicated against it.

Attempt <u>any 5 (five)</u> questions taking not more than 3 (three) questions from each Part.

PART - A

1. (a) What is meant by expectation value of a quantum variable? A particle is described by the wave function $\psi(x,t) = (2/L)^{3/2} e^{ikx}$ in the interval (0, L). Obtain the expectation value of momentum.

(3+5=8)

(b) What is Heisenberg's uncertainly principle? Deduce the relation $\Delta x.\ \Delta p \geq h$ where symbols have usual meanings. **(3+4=7)**

(c) Develop the Schrodinger equation for a free particle. How does it differ from the same equation for a particle moving under the action of some force? **(3+2=5)**

2. (a) Obtain expressions for the reflection and transmission coefficient for a particle of mass m and energy E ($E < V_o$) incident on finite rectangular potential barrier of width L height V_o. **(5+5=10)**

(b) Solve Schrodinger equation for a linear harmonic oscillator to obtain the eigenvalues and eigenfunctions. **(2+4+4=10)**

3. (a) Write the expressions for the components of angular momentum operator in Cartesian coordinates and prove the following commutation relations $[L_x, L_y] = I\ h\ L_z$ and $[L^2, L_z] = 0$. **(2+3+3=8)**

(b) Find the expression for wave function and energy eigen values for electrons confined to a line of length L. Derive expression for Fermi energy and density of states. **(8+2+2=12)**

4. (a) Starting from the two body Schrodinger wave equation of hydrogen atom obtain the Schrodinger wave equations for the (one body) reduced mass and the total mass of the system. Further reduce the one body Schrodinger equation into r, θ and Φ equations and solve the Φ equation. State the condition for this separation to be possible.

(2+3+5+2+1=13)

(b) Write the matrix form of the Pauli spins matrices σ_x, σ_y and σ_z and show that $(\boldsymbol{\sigma}.\mathbf{A})(\boldsymbol{\sigma}.\mathbf{B}) = \mathbf{A}.\mathbf{B} + i\boldsymbol{\sigma}.(\mathbf{A}X\mathbf{B})$ Where **A** and **B** are two constant operators (or vectors). **(2+5=7)**

PART - B

5. (a) Discuss the liquid drop model of the nucleus and hence establish the semi-empirical mass formula. Explain its application in predicting the most stable isotope in a mass parabola of an isobar. **(2+6+4=12)**

(b) Describe the ground state of a deuteron and give an account of the nature of the forces between a proton and a neutron in a deuteron. **(4+4=8)**

6. (a) State and explain with examples the conservation laws which govern the elementary particle reactions and decay. **(10)**

(b) What are quarks? Outline the basis assumptions and properties of quarks. Give the quark model of (i) mesons (ii) protons and anti-protons. **(2+2+3+3=10)**

7. (a) On the basis of Debye theory of specify heat, show that the specific heat is proportional to the cube of absolute temperature at low temperature. **(9)**

(b) Discuss Langevin theory of diamagnetism and show that the susceptibility is independent of temperature. **(11)**

8. (a) Describe the construction and working of FET. Discuss the static characteristic of JFET. What is pinch - off voltage? **(4+3+2=9)**

(b) What is OP-AMP? Discuss the use of OP-AMP as adder and integrator. **(2+5=7)**

(c) Add the binary numbers 100101, 101, 1101 and 100. Check the result by converting each binary number to its decimal equivalent. **(4)**

* * * * * * *