VCD04/23 S.Y.B.Sc. PHYSICS II SEM-IV 100 MARKS TIME:3HRS

Note: i) All the questions are compulsory
ii) Figures to the right indicate ful' marks.
iii) Use of non programmable calculator is allowed.

Q1. A] Select the correct option from the following: **[12M]**

1. $|\psi|^2$ represents
   a. Probability current b. probability density c. Wave vector d. none of the above
2. Eigenfunction of operator $\frac{d}{dx}$ with eigenvalue a is
   a. Ae^{ax} b. $Ae^{\sqrt{ax}}$ c. $Ae^{i\sqrt{ax}}$ d. Ae^{-ax}
3. Two identical particles having energies E1 and E2 are incident on a potential barrier of height more than E_1 as well as E_2. Δx_1 and Δx_2 are their respective penetration depths If $E_1 > E_2$, then
   a. $\Delta x_1 > \Delta x_2$ b. $\Delta x_1 = \Delta x_2$ c. $\Delta x_1 < \Delta x_2$ d. none
4. An electron of energy E approaches a potential barrier of height V. greater than E. Classically, it cannot cross the barrier because if it does, its velocity becomes
   a. infinity b. imaginary c. zero d. finite
5. Zero-point energy is in conformity with
   a. Planck's law b. Bohr's postulates c. Heisenberg's Uncertainty principle d. none
6. Classically, the kinetic energy of a particle at 0°K is
   a. negative b. zero c. positive d. infinite

Q1. B] Answer in one sentence. **[3M]**

1. The function which represent de Broglie waves is called?
2. Write down expectation value of momentum for free particles.
3. The Radioactive elements which emit alpha particles are called?

Q1.C] Fill in the blanks: **[5M]**

1. Theoretical work of Schrodinger, Heisenberg, Dirac, Bohr and Max Born led to the development of _____ Mechanics.
2. Ψ and its derivatives must go to _____ at infinite distances.
3. If there is no restriction on the energy values of the particle, the energy states are called _____.
4. The lowest energy state of the particle (E_1 state) is called its _____ state.
5. Energy levels of a bound system are_____.

Q2. A] Attempt any 1 **[8M]**

1. Derive an expression for Schrodinger's time independent equation.
2. Explain what is meant by expectation value of x. Why is it necessary to use the operator form of a physical quantity in calculating its expectation value? Why should the operator be sandwiched between ψ^* and ψ.

B] Attempt any 1 **[8M]**

1.Starting from a one dimensional simple harmonic progressive wave, derive classical wave equation. Comment on it.

2. If $\psi_1(x)$ and $\psi_2(x)$ are the solutions of STIE for a system for two different energy eigenvalues E1 and E2, then.

$\int_{-\infty}^{\infty} \psi_1^* \psi_2 dx = 0$

C] Attempt any 1 **[4M]**

1. Find the eigenfunction of operator $\frac{d^2}{dx^2}$ if its eigenvalue is (i) +4, (ii) - 4.
2. The eigenfunction of a particle moving in x-direction is given by

$\psi = ax. \quad 0 < x < 1$

$= 0 \quad$ elsewhere

Calculate the probability of locating the particle between x=0.45 and x=0.55.

Q. 3. A] Attempt any 1 **[8M]**

1.Set up the STIE for a particle in a three dimensional rectangular box. Solve it to obtain an expression for the discrete energies allowed to the particle. What is meant by degenerate and nondegenerate energy levels? Draw the energy level diagram for the particle in a 3-D rigid box.

2. Explain what is meant by one dimensional infinite rectangular potential well. Why is it also called a one dimensional box with rigid walls?

B] Attempt any 1 **[8M]**

1. Set up STIE for a particle in a one dimensional finite square well potential. Solve it to obtain the two classes of energy eigen functions.
2. Set up STIE for a particle approaching a step potential with energy greater than the height of the step. Solve the equation and obtain expressions for the reflection coefficient and the transmission coefficient. Comment on the result.

C.] Attempt any 1 **[4M]**

1. Calculate the momentum of an electron in the ground state when it is confined to a one dimensional rigid box of width 10^{-10} m.
2. Find the zero.point energy in electron-volt of a pendulum whose period is 1s.

Q.4.A] Attempt any 1 **[8M]**

1. Explain in detail alpha emission of particles with suitable example.
2. One-dimensional rectangular potential barrier is given by

$V(x) = 0 \quad ; x \leq 0$

$= V_o \quad ; 0 \leq x \leq a$

$= 0 \quad ; x \geq a$

A particle with energy Eo is incident on the barrier from the left. If Eo< Vo, write down the STIE for the particle, solve it and obtain expressions for reflection coefficient and the transmission coefficient. And explain tunnel effect

B] Attempt any 1 **[8M]**

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