

[133] SEAT No. _____

No. of printed pages:02

SARDAR PATEL UNIVERSITY
B.Sc. (6th- Semester) Examination
Code No. US06CPHY21: [Quantum Mechanics]



Date: 04-04-2022, Monday

Time: 3:00 p.m. to 5:00 p.m.

Note: (i) All the symbols have their usual meanings

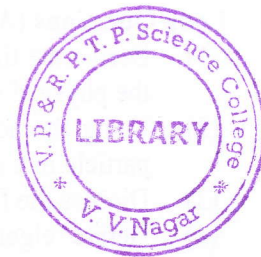
Total Marks: 70

(ii) Figures at the right side of questions indicate full marks

Q.1 Multiple Choice Questions (Attempt All)

[10]

- (1) For $E > 0$, the particle has a _____ kinetic energy
(a) zero (b) positive
(c) negative (d) infinity
- (2) Any particle with energy _____ cannot enter in the regions I and III
(a) $E = 0$ (b) $E = \alpha$
(c) $E < 0$ (d) $E > 0$
- (3) If the particle moving in a _____ potential then the solution of the wave equation is described as a stationary state
(a) time independent (b) time dependent
(c) velocity dependent (d) velocity independent
- (4) For adjoint operator A, $(\phi, A\psi) =$ _____
(a) $(\phi^*, A\psi)$ (b) $(A^+\phi, \psi)$
(c) $(\phi, A\psi)$ (d) $(A\phi, \psi)$
- (5) Eigen values of a self adjoint operator is _____
(a) always 0 (b) infinite
(c) real (d) imaginary
- (6) If $\delta_{m,n}$ is Kronecker delta function then $\delta_{m,n} = 1$ when _____
(a) $m = n$ (b) $m > n$
(c) $m < n$ (d) $m \neq n$
- (7) If A & B are a canonically conjugate pair of operator, then $[A, B] =$ _____
(a) $i\hbar/2$ (b) $i\hbar$
(c) \hbar (d) $2i\hbar$
- (8) Force acting on the pendulum is proportional to _____
(a) velocity (b) time
(c) displacement (d) acceleration
- (9) In a rigid rotator distance between two particles is _____
(a) constant (b) zero
(c) infinite (d) variable
- (10) Energy of an isotropic oscillator is _____
(a) continues (b) discrete
(c) zero (d) infinity



Q.2 Filling the blanks and True-False

[08]

- (1) Any wave function having symmetry property is said to be of odd parity (True/False)
- (2) The limit of a region-III for a square well potential is _____
- (3) If A and B are non-commutative self-adjoint operators then $(AB)^\dagger = BA$ (True/False)
- (4) The value of constant of integration for δ function normalized momentum eigen function is _____
- (5) The same state of all the components of \vec{L} operator is possible (True/False)

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- (6) The ground state energy for simple harmonic oscillator is $E =$ _____
- (7) The H- atom is a two-particle system (True/False)
- (8) Angular momentum is defined as $L =$ _____

Q.3 Short Questions (Attempt any Ten)

[20]

- (1) Define square well potential .
- (2) Write the admissible solution for a particle in a square well potential .
- (3) What is the condition of the total probability of the wave function ?
- (4) Define adjoint and self-adjoint operator .
- (5) What is Dirac delta function?
- (6) Define degenerate and non-degenerate eigen values .
- (7) Define simple harmonic oscillator .
- (8) Define Bosons and Fermions .
- (9) Write the Hamiltonian for interacting and non-interacting systems .
- (10) Write down expression for ∇^2 in spherical polar coordinates .
- (11) What is rigid rotator? State the expression for its energy level separation .
- (12) What is isotropic oscillator? Write the expression for its energy .

Q.4 Long Questions (Attempt any four) All questions carry equal marks

[32]

- (1) Derive the time independent Schrodinger equation and find its solution. Also state the physical significance .
- (2) Using the admissible solutions derive the equation of energy eigen values for a particle in a square well potential .
- (3) Discuss the fundamental postulates of wave mechanics with properties .
- (4) Derive eigen function in momentum space and normalized it by δ function normalization method .
- (5) State uncertainty principle and prove it for any pair of quantum mechanical observables
- (6) Derive the expression of energy eigen value of simple harmonic oscillator
- (7) Derive the expression of angular momentum operator L^2 in terms of spherical polar coordinates
- (8) Derive the radial wave equation for H-atom

