SEAT No. . ———

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[24]

SARDAR PATEL UNIVERSITY
Six Semester B. Sc. Examination -2022
Thursday23June 2022
Time: 10:00 A. M. to 12:00 P. M
Physics US06CPHY01 (Quantum Mechanics) TotalMarks: 70

Q – 1 Choose correct option to answer the question. [10]

(1) According to wave function and its first partial derivative should be ____ function of for all value of x

(a) zero (b) continuous (c) infinite (d) discontinuous

(2) The square of magnitude of wave function is called _____ density

(a) current (b) mass (c) probability (d) volume

(3) In the time independent Schrodinger wave equation HU = EU, E is called ____

(a) heat energy (b) energy eigen value(c) potential (d) potential eigen value

(4) The limit of region I of square well potential is ______

(a) $-\infty < x < 0$ (b) $-\infty < x < -a$ (c) $-a < x < a$ (d) $\infty < x < a$

(5)In shorter notation of integral $\int \phi^* \psi d\tau$ =_____

(a) (ϕ, ψ) (b) (ϕ^*, ψ) (c) $(\phi, A\,\psi)$ (d) $(A\,\phi, \psi)$

(6) For the adjoint of the product of the two operator A and B, $(A\,B)^\dagger =$ ___

(a) $B^\dagger A^\dagger$ (b) $A^\dagger B^\dagger$ (c) 1 (d) none of these

(7) The commutation relation of position and momentum [x, p_y] = _____

(a) zero (b) one (c) $i\hbar$ (d) -$i\hbar$

(8) Energy of an isotropic oscillator is _____

(a) zero (b) continuous (c) discrete (d) $h\nu$

(9) Central potential is a function of _____ only

(a) r (b)θ (c)ϕ (d)$r and \theta$

(10) Angular momentum is defined as L = _____

(a) $\vec{r} \cdot \vec{p}$ (b) $\vec{r} x \vec{p}$ (c)$\vec{r} x \vec{p}^2$ (d) none of these

Q – 2 Fill in the blanks [8]

(1) For a bound state of a particle energy E is always _____

(2) Each dynamical variable in quantum mechanics is represented by _____

(3) The kinetic energy of one dimensional harmonic oscillator ______

(4) The expectation value of self-adjoint operator is always _____

Identify true or false

(5) For energyE > 0, the particle has a positive kinetic energy.

(6) Energy momentum relation is given by $E = \frac{p^2}{2m}$

(7)For a square well any particle with energy E < 0 cannot enter in the region I and III

(8) Theenergy levels are equispaced for rigid rotator

Q – 3 Answer briefly any ten of following question. [20]

(1)State de Broglie hypothesis.

(2)Write the three-dimensional Schrodinger wave equation for a free particle.

(3) Describe normalizable wave function in brief.

(4) Define square well potential.

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(5)Write down expression of potential energy of square well potential for its different region.

(6) Define degeneracy of eigen values.

(7) Explain adjoint operator and self-adjoint operator.

(8) Write the expression of operator L^2 in spherical polar co-ordinate.

(9)Draw energy level diagram of simple harmonic oscillator.

(10) Show that $[L_x , L^2] = 0$

(11) Write down expression for potential energy of simple Harmonic oscillator.

(12) Write down component of angular momentum in Cartesian co ordinates.

Q – 4 Answer the following questions. (Attempt any four) [32]

(1) Obtain one dimensional Schrodinger wave equation for a free particle.

(2) Discuss Ehrenfest's theorem in detail.

(3) Obtain an expression of energy eigen valuefor a particle in square well potential using admissiblesolution.

(4) Obtain an expression of energy eigen function for a particle in square well potential using admissible solution.

(5) Discussuncertainty principle for quantum mechanical observableand show that product of uncertainty in observables is of the order of commutator

(6)Show that any two eigen functions belongs to distinct (unequal) eigen values of self adjoint operator are mutually orthogonal.(7) Obtain dimensionless Schrodinger equation for a simple harmonic oscillator as;

$$\frac{d^2u}{d\rho^2} + [\lambda - \rho^2]u = 0$$

Write down an expression for its energy eigen values.

(8) Derive radial Schrodinger wave equation for motion of a particle central force field.

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