(7 pages)

S.No. 371 **17PPH03**

(For the candidates admitted from 2017-2018 onwards)

M.Sc. DEGREE EXAMINATION, NOVEMBER 2017.

First Semester

Physics

QUANTUM MECHANICS – I

Time : Three hours Maximum : 75 marks

SECTION A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. The expectation value of momentum is

(a) $\langle P \rangle = \int \psi^* (i\hbar\nabla)\psi \, d\tau$

(b) $\int \psi^* (-i\hbar\nabla)\psi \, d\tau$

(c) $\langle P \rangle = \int \psi \langle i\hbar \rangle \psi \, d\tau$

(d) $\int \psi^* (-i\hbar)\psi \, d\tau$

2. The parity operator 'P' leaves the Hamiltonian

(a) variant (b) invariant

(c) covariant (d) contravariant

3. In WKB approximation the expansion of wave function is

(a) powers of $\hbar$ (b) powers of h

(c) powers of $\hbar e$ (d) powers of he

4. The first order stark effect is absent in

(a) ground state of Hydrogen atom

(b) ground state of helium atom

(c) excited state of hydrogen atom

(d) excited state of helium atom

5. The value of $[J_x, J_y]$ is

(a) $i\hbar J_y$ (b) $-i\hbar J_y$

(c) $i\hbar J_z$ (d) $-i\hbar J_z$

6. The s_y component of spin matrix is

(a) $\frac{\hbar}{2}\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$ (b) $\frac{-\hbar}{2}\begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}$

(c) $\frac{\hbar}{2}\begin{pmatrix} -i & 0 \\ 0 & i \end{pmatrix}$ (d) $\frac{+\hbar}{2}\begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}$

7. Harmonic perturbation arises due to the molecule under the exposure of

(a) chemical reaction

(b) electromagnetic radiation

(c) thermal energy

(d) sound waves

8. The energy of the ground state of He atom does not change due to the fact that

(a) The Hamiltonian is invariant

(b) The Hamiltonian has no spin dependency

(c) The Hamiltonian has no energy change

(d) The Hamiltonian has constant angular momentum

9. Hilbert space represents

(a) orthonormal unit vectors of the co-ordinate system

(b) nonlinear functional space

(c) finite dimensional nonlinear space

(d) finite dimensional linear space

10. The probability density of momentum representation is

(a) $\int_{-\infty}^{\infty} \phi^*(p,t)\, \phi(p,t)\, dp$

(b) $\int_{0}^{\infty} \phi^*(p,t)\, \phi(-p,t)\, dp$

(c) $\int_{-\infty}^{\infty} \phi^*(-p,t)\, \phi(p,t)\, dp$

(d) $\int_{0}^{\infty} \phi^*(-p,t)\, \phi(-p,t)\, dp$

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions.

11. (a) What is Hamiltonian operator? Explain its properties.

Or

(b) Derive the Heisenberg's uncertainty relation from operators.

12. (a) Obtain the first order energy correction for time independent non-degenerate perturbation.

Or

(b) Derive the ground state of He atom using variational method.

13. (a) Explain the eigen value spectrum of J^2 and J_z.

Or

(b) Explain about raising and lowering operators.

14. (a) Describe the representation of state vectors by Bra and Ket vector notation.

Or

(b) Explain unitary transformation and its properties.

15. (a) Derive the Fermi Golden rule for transition probability.

Or

(b) Explain the action of charged particle in electromagnetic field.

SECTION C — (5 × 8 = 40 marks)

Answer ALL questions.

16. (a) State and prove Ehrenfest theorem.

Or

(b) Explain :

(i) Dirac delta function. (4)

(ii) Completeness property of Eigen function. (4)

17. (a) Discuss the perturbed harmonic oscillation and obtain its energy correction.

Or

(b) Describe the WKB approximation method to the penetration of barrier by electrons.

18. (a) Explain the state vectors using co-ordinate and momentum representation.

Or

(b) Explain Schrodinger picture and derive the equation of motion using the same.

19. (a) Describe the commutation rules for angular momentum.

Or

(b) Discuss the matrix representation of angular momentum.

20. (a) Derive the expression for time dependent first order perturbation.

Or

(b) Explain in detail the adiabatic approximation procedure.
