1. Physical interpretation of wave function in quantum mechanics. Basic properties of wave function (finite, unique , continuous and superposition). Density of probability. Normalizing the wave function and its physical interpretation.

2. Schrödinger equation. Gradient and Laplas operators. Operator of momentum (definition).

3. Continuity equation for wave function. Probability current density (derive). Probability current density and density of current.

4. Stationary Schrödinger equation (derive). Total (time dependent) wave function. Hamilton operator.

5. Operators, linear operators, eigenvalue problem. Hermitian operator (definition). Show that momentum operator is hermitian(derive).

6. Eigenvalues and eigenfunctions of Hermitean operators (definition and formulas). Show that eigenvalues of Hermitian operators are real numbers (derive).

7. Show that the wave function of hermitian operators forms the system of orthonormal functions (derive).

8. Find the solution of eigenvalue problem for one dimensional motion of free particle (derive). Calculate the energy, momentum, wavefunction normalized on unit.

9. Completeness of eigenfunctions of Hermitian operators. Calculation of coefficient of linear expantion of arbitrary wave function $\psi=\sum_n c_n \cdot \varphi_n$ . Normalizing of arbitrary wavefunction ψ and physical meaning of $c_n$ coefficients.

10. Mean values of physical quantities (general equation). Calculation of the average value of the system energy for an arbitrary wave function $\psi=\sum_n c_n \cdot \varphi_n$ .

11.Commutative and noncommutative operators and condition for simultaneous measurement of physical quantities(definition). Show that if operators ( $\hat{A}$ and $\hat{B}$ ) of two physical quantities A and B are commute so the physical quantities A and B are simultaneously exactly measureable and vice versa (derive).

12. Uncertainty relations (Heisenberg uncertainty principle) (derive).

12a. Show that coordinate $x$ and x-momentum projection $p_x$ are could not be measurable simultaneously.

12b. The coordinate $x$ and y-momentum projection $p_y$ , are could be measured simultaneously?

12c. Is it possible to measure simultaneously coordinate x and kinetic energy of particle?

13. Potential barrier (for E > Uo). Schrodinger equation. Wave function. Eigenvalues. Transmission and Reflection coefficients(derive). How looks like ea motion of particle if E=Uo ?

14. Potential barrier (for E < Uo). Wave function. Eigenvalues. Transmission and reflection coefficients(derive).

15. Tunnel effect (tunneling).Wave function. Eigenvalues. Transmission and reflection coefficients(derive).

16. Infinite potential well. Wave function. Eigenvalues(derive).

17. Finite potential well. Wave function. Eigenvalues(derive).

18. Harmonic oscillator. Schrodinger equation. Dimensionless variables. Asymptotic solution. Nonasymptotic part of the total wave function. Total wave function (derive).

19.Harmonic oscillator. Energy calculation. Eigenfunction. Hermite polynomials. Normalizing of wave function (derive).

20. Harmonic oscillator. Calculation the mean values of <x>,<v>, $<U_{pot}>$ , $<E_{kin}>$ , $<E_{tot}>$ (derive).

21.Creation and annihilation operators. Commutation relation. Hamilton operator for harmonic oscillator in creation-annihilation operators approaches.

22. Calculation of specific heat for chain of identical atoms.

23. Angular momentum operator. Commutation relations.

24. Square of angular momentum operator $\hat{L}^2$ . Commutation relations between $\hat{L}^2$ and $\hat{L}_z$ .

25. Representation of $\hat{L}^2, \hat{L}_x, \hat{L}_y$ and $\hat{L}^2$ operators in spherical coordinates. Eigenvalue problem for $\hat{L}_z$ operator. Magnetic quantum number. Normalizing the wave function(derive).

26. Eigenvalue problem for operator $\hat{L}^2$ . Spherical function. Legendre polynomial. Orbital quantum number. Relation between orbital and magnetic quantum numbers. Normalizing the spherical wave function.