

YOU NEED TO KNOW

1. Numerical data and units.
2. Delta-function.
3. Main characteristics of the hydrogen atom.
4. Simple one-dimensional problems, reflection and transmission coefficients, resonances.
5. Potential box. Bound states in rectangular potentials. Shallow well, delta-function potential.
6. Coordinate and momentum representation. Motion of a wave packet, spreading, Gaussian wave packets.
7. Hermitian and unitary operators. Eigenfunctions and eigenvalues. Commutators and simultaneous measurability. Uncertainty relation. General formulation in terms of commutators. Application for simple estimates.
8. Schrödinger equation. Completeness and orthogonality.
9. Continuity equation, probability density and probability current.
10. Time evolution of an initial state. Green functions.
11. Displacement operator $\mathcal{D}(a)$.
12. Heisenberg equations of motion. Solution for free motion, uniform field and harmonic oscillator. Conservation laws and relation to symmetry properties.
13. Virial theorem.
14. Direct variational method.
15. Bohr-Sommerfeld quantization.
16. Full solution of the Schrödinger equation for the harmonic oscillator and related potentials, Hermite polynomials.
17. Creation and annihilation operators, ladder construction.
18. Coherent states and their properties.
19. Two-dimensional harmonic oscillator, degeneracy problem.
20. A charged particle in the magnetic field. Gauge invariance.
21. Landau levels.