

QUANTUM MECHANICS: CORE PRINCIPLES

1. WAVE-PARTICLE DUALITY

$$\lambda = h/p$$

Postulates that every particle or quantum entity may be described as either a particle or a wave. De Broglie's relation links momentum to wavelength.

2. SCHRÖDINGER EQUATION

$$i\hbar \frac{\partial \psi}{\partial t} = \hat{H} \psi$$

The fundamental equation of motion for non-relativistic quantum systems, describing how the quantum state (wavefunction) changes over time.

3. HEISENBERG UNCERTAINTY

$$\Delta x \Delta p \geq \hbar/2$$

States a fundamental limit to the precision with which certain pairs of physical properties, such as position and momentum, can be known simultaneously.

4. SUPERPOSITION PRINCIPLE

$$|\psi\rangle = \sum c_i |\phi_i\rangle$$

A system can exist in multiple states simultaneously until a measurement is performed, resulting in the collapse of the wavefunction.

5. PAULI EXCLUSION PRINCIPLE

$$\psi(1,2) = -\psi(2,1)$$

Two identical fermions (e.g., electrons) cannot occupy the same quantum state simultaneously within a quantum system.

6. BORN RULE (PROBABILITY)

$$P(x) = |\psi(x)|^2$$

Provides the bridge between the wavefunction and experimental observation, stating the probability density of finding a particle at a given point.