Chapter 2: Solving 1D State Equations

Quantum Mechanics

1 Momentum Operator

Definition 1.1 (Momentum Operator (Position Representation))**.** [def:momentum-operator-position] In one dimension, the momentum operator $\hat{p}$ acts on a position-space wavefunction $\psi(x)$ as

$$\hat{p}\,\psi(x) \;=\; -i\hbar\,\frac{d\psi}{dx}(x),$$

or equivalently, as a differential operator,

$$\hat{p} \;=\; -i\hbar\,\frac{d}{dx}.$$

In three dimensions, $\hat{\vec{p}} = -i\hbar\,\nabla$.

2 Hamiltonian

Definition 2.1 (Hamiltonian in 1D)**.** [def:hamiltonian-1d] For a particle of mass m in a potential $V(x)$, the Hamiltonian is

$$\hat{H} \;=\; \frac{\hat{p}^2}{2m} + V(\hat{x}).$$