Rest of this class was mathematica demo.

Particle in a box

$$E_n = \frac{\hbar^2 \pi^2 n^2}{2mL^2}$$

Stationary states

$$\int_0^L \rho\, dx = 1 \Leftrightarrow \sum_{n=1}^{\infty} |C_n|^2 = 1$$

$$\Psi_n(x,t) = \sqrt{\frac{2}{L}}\, e^{-i\frac{E_n t}{\hbar}} \sin\left(\frac{n\pi x}{L}\right)$$

Most general solution: $\Psi(x,t) = \sum_{n=1}^{\infty} C_n \Psi_n(x,t)$ $C_n \in \mathbb{C}$
                                                                    (Ψ time independent)

Probability to measure x within $[x, x+dx] = \underbrace{|\Psi(x,t)|^2}_{\rho(x,t)} dx$

$$j(x,t) = \frac{\hbar}{2mi}\left(\Psi^* \frac{\partial \Psi}{\partial x} - \Psi \frac{\partial \Psi^*}{\partial x}\right)$$

$$\frac{\partial \rho}{\partial t} + \frac{\partial j}{\partial x} = 0$$

$$\langle \dot{x}\rangle(t) = \int_0^L dx\, \Psi^*(x,t)\, \Psi(x,t)\, x^n$$

$$\langle P^n\rangle(t) = \int_0^L dx\, \Psi^*(x,t)\,(-i\hbar)^n \frac{\partial^n \Psi(x,t)}{\partial x^n}$$

$$E_n = E_1 n^2$$

$$\frac{E_n t}{\hbar} = \left(\frac{E_1 t}{\hbar}\right) n^2$$

$$\frac{x}{L} \Rightarrow x \in [0,1]$$ $t \in [-\infty, \infty]$

$$\Psi(x,0) = \boxed{}$$

$$\int_0^1 \sqrt{2}\sin(m\pi x)\Psi(x,0) = \int_0^1 \sum_n C_n \sqrt{2}\sin(n\pi x)\cdot\sin(m\pi x)\sqrt{2}$$

$$\underbrace{\int_0^1 \Psi^*_{(x,0)}\Psi_m(x,0)}_{} = \left(C_m\right)$$ $$\boxed{C_m = \sqrt{2}\int_0^1 dx\, \Psi_m(x,0)}$$