Chapter 7

The time-dependent wave equation of a particle in a three dimensional box (L, L, L) is

$$-\frac{\hbar^2}{2m}\nabla^2\Psi(\vec{r},t) + U(\vec{r})\Psi(\vec{r}) = i\hbar\frac{\partial\Psi(\vec{r},t)}{\partial t}$$

Laplacian ; $\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$

For stationary states $\Psi(\vec{r},t) = \Psi(\vec{r})\, e^{-i\omega t}$

The time-independent S.E. is

$$\underbrace{\left[-\frac{\hbar^2}{2m}\nabla^2 + U(\vec{r})\right]}_{\text{Hamiltonian operator}}\Psi(\vec{r}) = \underbrace{E}_{\text{energy observable}}\Psi(\vec{r})$$

$\Psi(\vec{r}) = \Psi(x)\cdot\Psi(y)\cdot\Psi(z)$ in Cartesian Coordinates

In this case $\Psi(x) = \sqrt{\frac{2}{L}}\sin\left(n_1\frac{\pi}{L}x\right)$

$$\Psi(y) = \sqrt{\frac{2}{L}}\sin\left(n_2\frac{\pi}{L}y\right)$$

$$\Psi(z) = \sqrt{2/L}\sin\left(n_3\frac{\pi}{L}z\right)$$