$$\underbrace{H\,\varphi_E(x)}_{=} = E\,\varphi_E(x) \qquad H = \frac{p^2}{2m} + V(x)$$

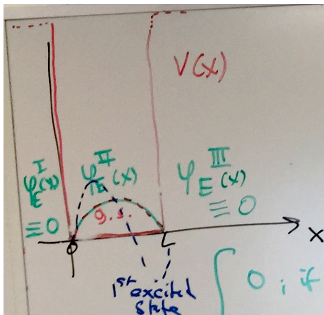
(1) $$\boxed{-\frac{\hbar^2}{2m}\frac{\partial^2 \varphi_E(x)}{\partial x^2} + V(x)\cdot\varphi_E(x) = E\,\varphi_E(x)}$$

Look for φ_E's that follow this equations

Eigenvalue Problem for the Hamiltonian

(2) $$\boxed{\text{Schr. Eq.:} \quad i\hbar\,\frac{\partial \psi(x,t)}{\partial t} = H\,\psi(x,t)}$$

Separable Solution "special": $\psi(x,t) = \underbrace{\varphi_E(x)}_{(1)}\cdot e^{-i\frac{E}{\hbar}t}$



1st trial

$$\psi^{II}_{E}(x) = A \cdot e^{i\frac{p}{\hbar}x} \qquad 0 \le x \le L$$

$p \in \mathbb{R}$

$$E = \frac{p^2}{2m}$$

pick some $p_0 > 0 \rightarrow E = \frac{p_0^2}{2m}$

2 Eigenstates: $e^{i\frac{p_0}{\hbar}x}$, $e^{-i\frac{p_0}{\hbar}x}$

$$\frac{1}{2i}\left(e^{i\frac{p_0}{\hbar}x} - e^{-i\frac{p_0}{\hbar}x}\right) = \sin\frac{p_0 x}{\hbar}$$

$$\psi_E(x) = \begin{cases} 0 ; \text{ if } x < 0 \\ A \sin\frac{p_0 x}{\hbar} \\ 0 , \text{ if } x > L \end{cases}$$

$p_0 = \sqrt{2mE}$

$\sin\frac{p_0 L}{\hbar} \overset{!}{=} 0$

$\hookrightarrow \frac{p_0}{\hbar} \overset{!}{=} 0, \pi, 2\pi, 3\pi, \cdots n\pi$

$p_0 \overset{!}{=} \cancel{0}, \frac{\pi\hbar}{L}, \frac{2\pi\hbar}{L}, \ldots \frac{n\pi\hbar}{L}$ $\rightarrow \sin\frac{\pi x}{L}$

$E = \frac{1}{2m}\frac{\pi^2\hbar^2}{L^2}, 4 \ldots$

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

Prob $(x \ldots x + \Delta x)$

$$= \int_x^{x+\Delta x} \psi^*(x)\,\psi(x)\,dx$$

$$= \int_x^{x+\Delta x} A^2 \sin^2\frac{x\pi}{L}\,dx$$

Normalize:

$$A = \sqrt{\frac{2}{L}}$$

$$\int_{-\infty}^{+\infty} \psi^*(x)\,\psi(x)\,dx \overset{!}{=} 1$$

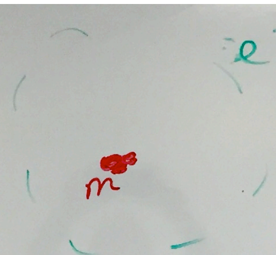
$$= \cancel{\int_{-\infty}^{0}} + \int_{0}^{L} + \cancel{\int_{L}^{\infty}} \qquad A^2 \sin^2 \frac{\pi x}{L}\, dx$$

$$\sin^2 + \cos^2 = 1$$

$$A^2 \cdot \frac{1}{2} L$$

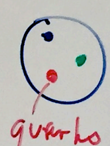
Because

1) you are made of atoms



2) Nuclei " : " # protons + neutrons

→ mass of a proton $\times$ # p + # n



p

$\text{mass}_q \ll \text{mass}_{\text{proton}}$

$r = 10^{-15}\,\text{m} = 10^{-6}\,\text{nm}$

$\hbar = 197\,\frac{\text{eV}}{c} \cdot \text{nm}$

$\sigma_x \simeq 10^{-6}\,\text{nm} \Rightarrow \sigma_p \simeq 197\,\frac{\text{MeV}}{c}$

Energy $\simeq$ 200 MeV / quark