1) Wave function: $\psi(x) = A(x) + i B(x)$ or e^{ikx}

$|\psi|^2$ = Probability of finding the quantum particle at position x.

$$P = 1 = \int_{-\alpha}^{\alpha} |\psi|^2 dv.$$

2). Schroedinger Wave equation (S.W.E)

Time Independent: Non-relativistic

$$E|\psi\rangle = \hat{H}|\psi\rangle$$

$$\underset{\text{Constant}}{\downarrow} \qquad \underset{\text{time Independent}}{\downarrow}$$

$$\hat{H} = -\frac{\hbar^2}{2m}\nabla^2 + V(r)$$

Time dependent: $i\hbar \frac{d}{dt}(|\psi(t)\rangle) = \hat{H}|\psi(t)\rangle$

$$\hat{H} = -\frac{\hbar}{2m}\nabla^2 + V(r,t)$$

3) Applications of S.W.E:

1). Particle in a 1-D box etc..

2) Quantum Tunneling

3) Energy levels of electrons in the atoms, basically to predict the atomic structure of matter in general.

4) Heisenbergs Uncertainty principle (H.U.P).

Position & Momentum

$$\Delta x \, \Delta P \geq \frac{\hbar}{2} \left(= \frac{h}{4\pi}\right)$$

Energy time

$$\Delta E \, \Delta t \geq \frac{\hbar}{2} \left(= \frac{h}{4\pi}\right)$$

Δx, ΔP, ΔE, Δt - Standard deviations of x, P, E, t respectively.

5) Applications of H.U.P:

i) Non-existence of electrons in nucleus

ii) Existence of protons in nucleus.

iii) Ground State energy of atomic electron in H atom

iv) Zero point energy of a particle in an one dimensional potential box.

Wave function Meaning:

aka Interpretation of the Wave function (ψ).

ψ - itself got no "physical ~~Interpreta~~ Interpretation".

But $|\psi|^2$ = a real number, has a physical Interpretation.

$\Rightarrow$ Existence is Waving.

For a normalized ψ $\Rightarrow$