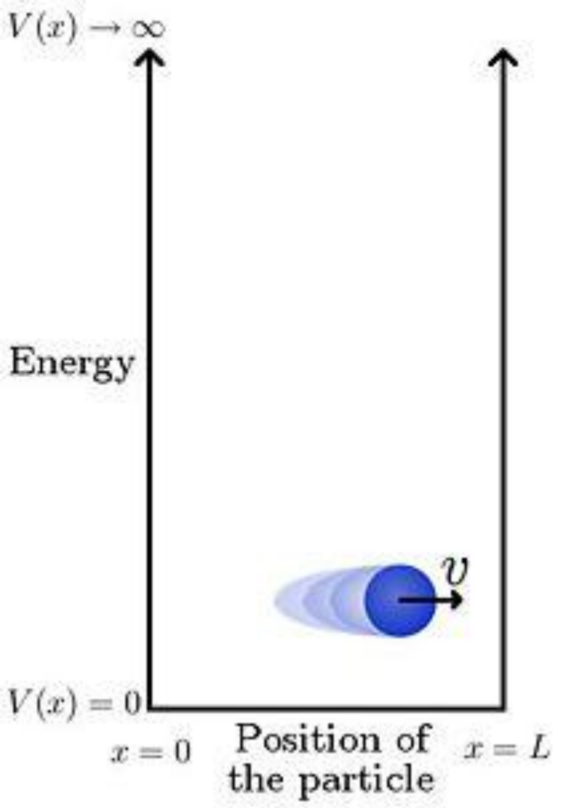
WAVE PROPERTIES OF PARTICLES

1. De Broglie waves.
2. Waves of what?
3. Describing a wave.
4. Phase and group velocities.
5. Particle diffraction.
6. Particle in a box.
7. Uncertainty principle I.
8. Uncertainty principle II.
9. Applying the uncertainty principle.

PARTICLE IN A BOX

The wave nature of a moving particle leads to some remarkable consequences ← particle restricted in a box.



We assume:
- walls of the box are infinitely hard so that the particle does not lose energy.
- the velocity is small so we can ignore relativistic corrections.

What happens from a wave point of you?

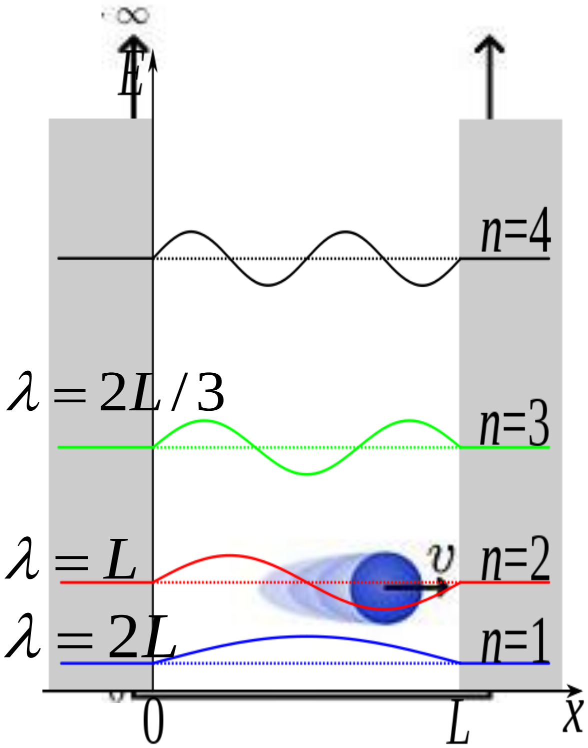
Standing waves are formed like in a stretched string.

PARTICLE IN A BOX

Wave variable must be 0 at the walls.

The de Broglie waves of the particle in the box are determined by the width L of the box.

The longest wavelength $\lambda = 2L$.
The next $\lambda = L$, then $\lambda = 2L/3$, and so forth.



<u>The de Broglie wavelengths of trapped particle</u>

$$\lambda_n = \frac{2L}{n}, \quad n = 1,2,3,\ldots$$

PARTICLE IN A BOX

$$\lambda_n = \frac{2L}{n}, \quad n = 1,2,3,...$$

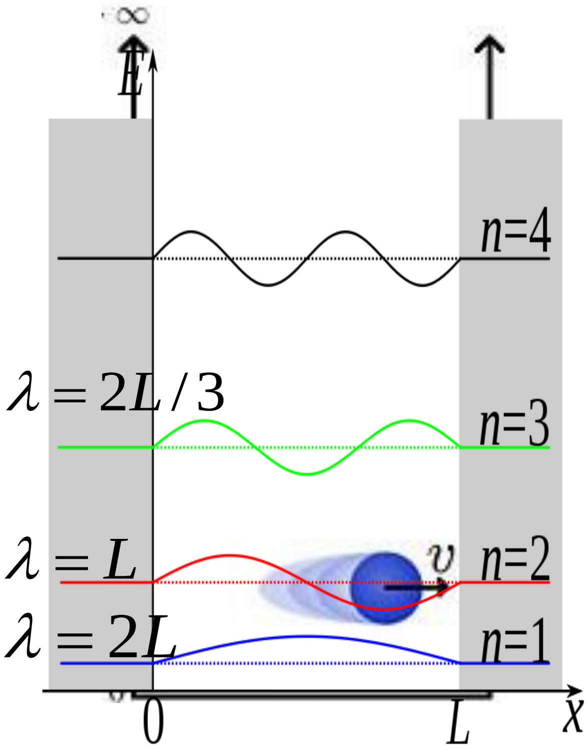
de Broglie wavelength are restricted by the width of the box.

Since mυ = h/λ, the momentum is limited by L too..

→KE is also limited by L

$$KE = \frac{1}{2}m\upsilon^2 = \frac{(m\upsilon)^2}{2m} = \frac{h^2}{2m\lambda^2}$$

$$E_n = \frac{n^2h^2}{8mL^2}, \quad n = 1,2,3,..$$

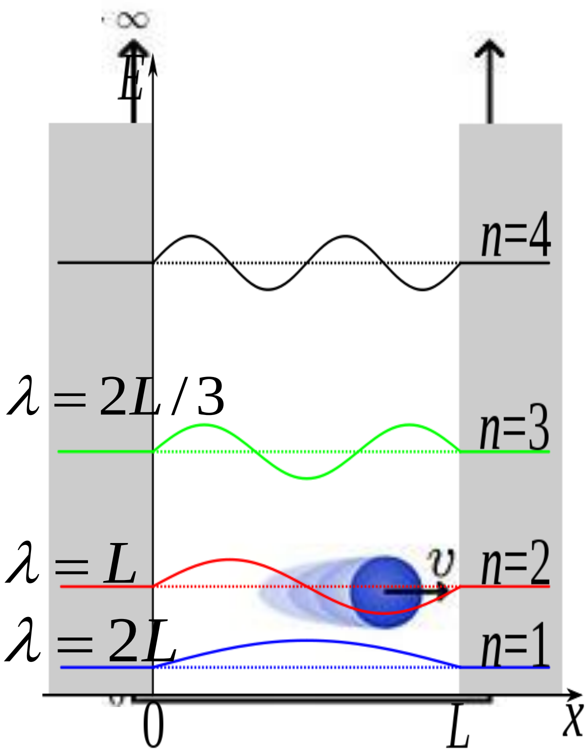


PARTICLE IN A BOX

$$E_n = \frac{n^2 h^2}{8mL^2} \quad , \quad n = 1,2,3,..$$

Each permitted energy is called an **energy level**.

n that specifies an energy level E_n is called its **quantum number**.



<u>We can draw three general conclusions:</u>

1. A trapped particle has specific energies.
2. A trapped particle can't have 0 energy ($\lambda = h/ m\upsilon$).
3. Quantization of energy is conspicuous only when *m* and *L* are small.

PARTICLE IN A BOX

Remember…

Explanation of why the energy of a trapped particle in quantized.