

Tema 3.-Aplicación de la Mecánica Cuántica a Sistemas Sencillos

3.1. La Partícula Libre

3.2. La partícula en una caja mono-, bi- y tridimensional de paredes infinitas

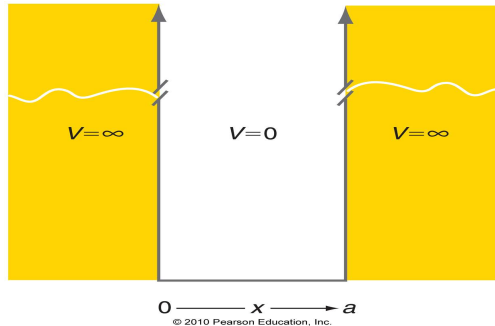
3.3. Barreras y Efecto Túnel

The logo for Cartagena99 features the text 'Cartagena99' in a stylized, teal-colored font. The '99' is significantly larger and more prominent than the 'Cartagena' part. The text is set against a light blue, cloud-like background that tapers off to the right. Below the text, there is a horizontal orange and yellow gradient bar.

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Partícula en una caja unidimensional con barreras infinitas



$$-\frac{\hbar^2}{2m} \frac{d^2\psi(x)}{dx^2} + V(x)\psi(x) = E\psi(x)$$



$$\frac{d^2\psi(x)}{dx^2} = \frac{2m}{\hbar^2} [V(x) - E]\psi(x)$$

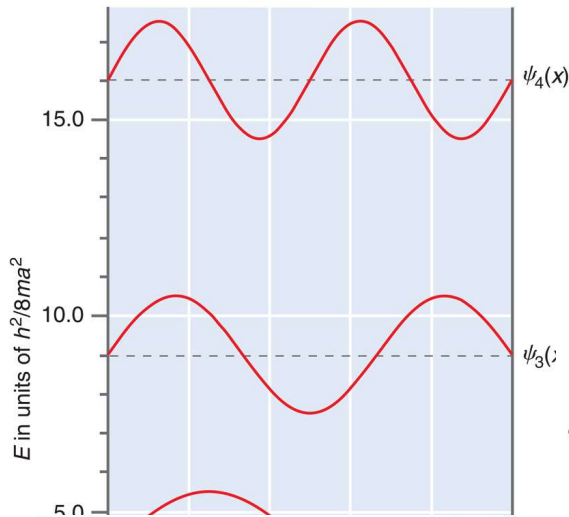
$$\psi(x) = A \sin kx + B \cos kx$$

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Condiciones de contorno

$$\psi(0) = \psi(a) = 0$$

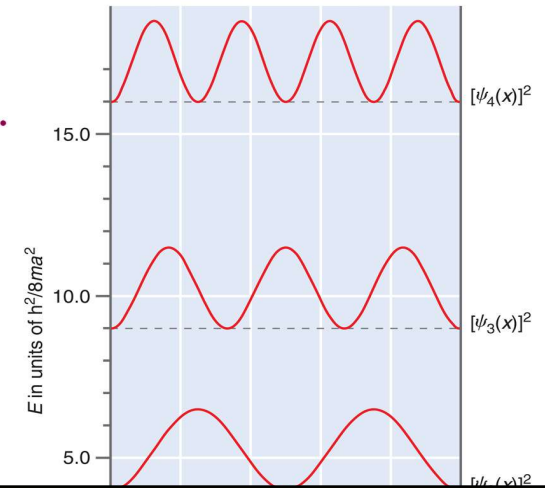


$$\psi_n(x) = A \sin\left(\frac{n\pi x}{a}\right), \text{ for } n = 1, 2, 3, 4, \dots$$

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$$E_n = \frac{\hbar^2}{2m} \left(\frac{n\pi}{a}\right)^2 = \frac{h^2 n^2}{8ma^2}, \text{ for } n = 1, 2, 3, \dots$$

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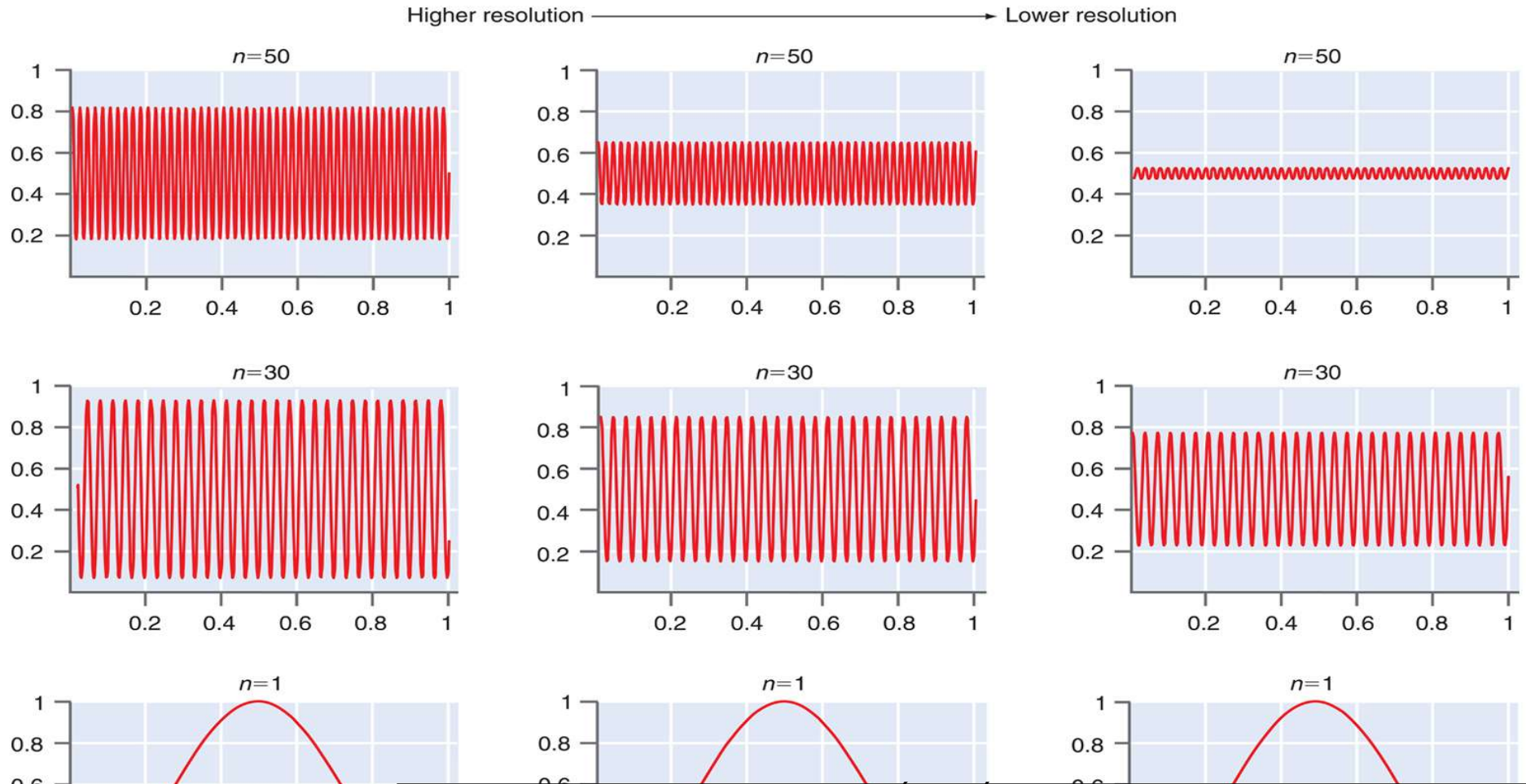


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Principio de Correspondencia de Born: el límite del comportamiento clásico



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Partícula en una caja tridimensional

$$V(x, y, z) = 0 \text{ for } 0 < x < a; \ 0 < y < b; \ 0 < z < c$$

$$= \infty \text{ otherwise}$$

$$-\frac{\hbar^2}{2m} \left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2} \right) \psi(x, y, z) = E\psi(x, y, z)$$

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$$\psi(x, y, z) = X(x)Y(y)Z(z)$$

Factorización de la función de ondas

$$-\frac{\hbar^2}{2m} \frac{d^2X(x)}{dx^2} = E_x X(x); \quad -\frac{\hbar^2}{2m} \frac{d^2Y(y)}{dy^2} = E_y Y(y); \quad -\frac{\hbar^2}{2m} \frac{d^2Z(z)}{dz^2} = E_z Z(z)$$

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$$\psi_{n_x n_y n_z}(x, y, z) = N \sin \frac{n_x \pi x}{a} \sin \frac{n_y \pi y}{b} \sin \frac{n_z \pi z}{c}$$

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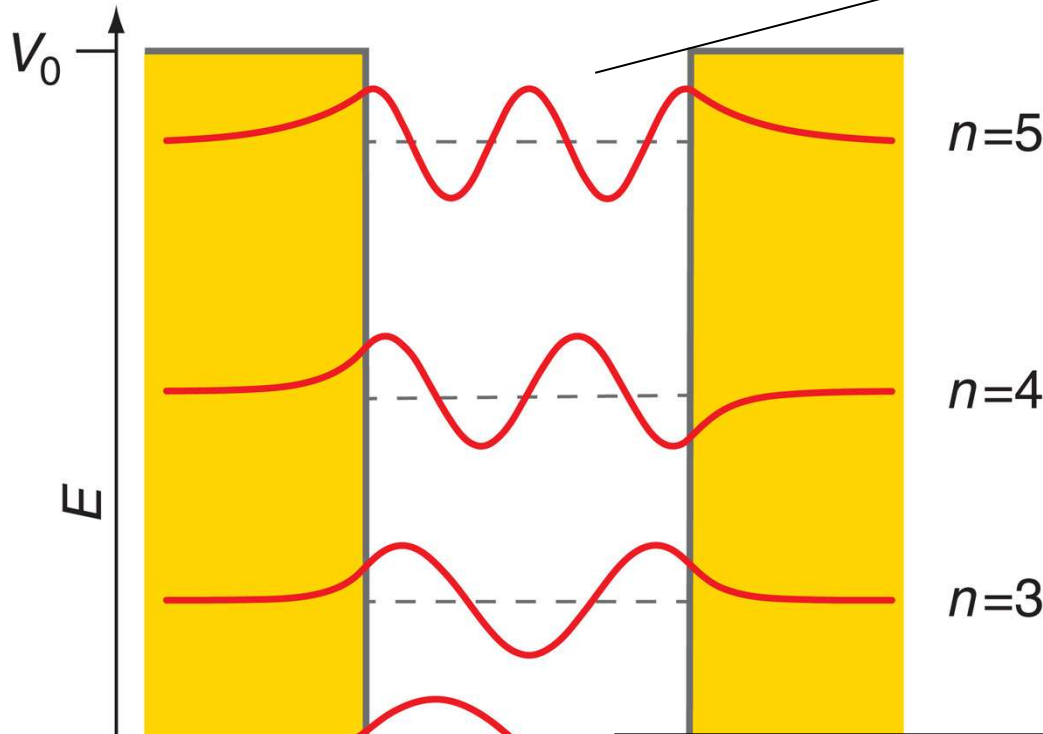
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Partícula en una caja unidimensional con barreras finitas

$$V(x) = 0, \quad \text{for } -a/2 < x < a/2$$

$$V(x) = V_0, \quad \text{for } x \geq a/2, x \leq -a/2$$

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$$\frac{d^2\psi(x)}{dx^2} = -\frac{2mE}{\hbar^2}\psi(x)$$

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$$\psi_n(x) = A \sin\left(\frac{n\pi x}{a}\right), \quad \text{for } n = 1, 2, 3, 4, \dots$$

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$$\frac{d^2\psi(x)}{dx^2} = \frac{2m(V_0 - E)}{\hbar^2}\psi(x)$$

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$$\psi(x) = A e^{-\kappa x} + B e^{+\kappa x} \quad \text{for } \infty \geq x \geq a/2 \quad \text{and}$$

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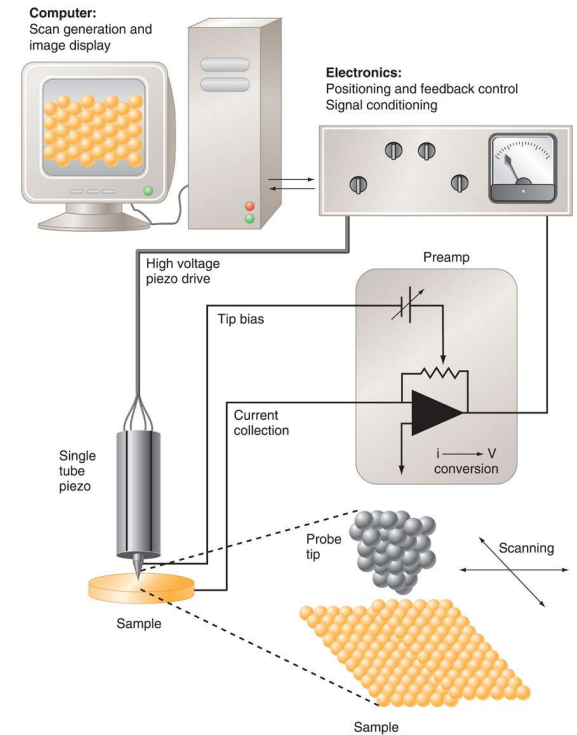
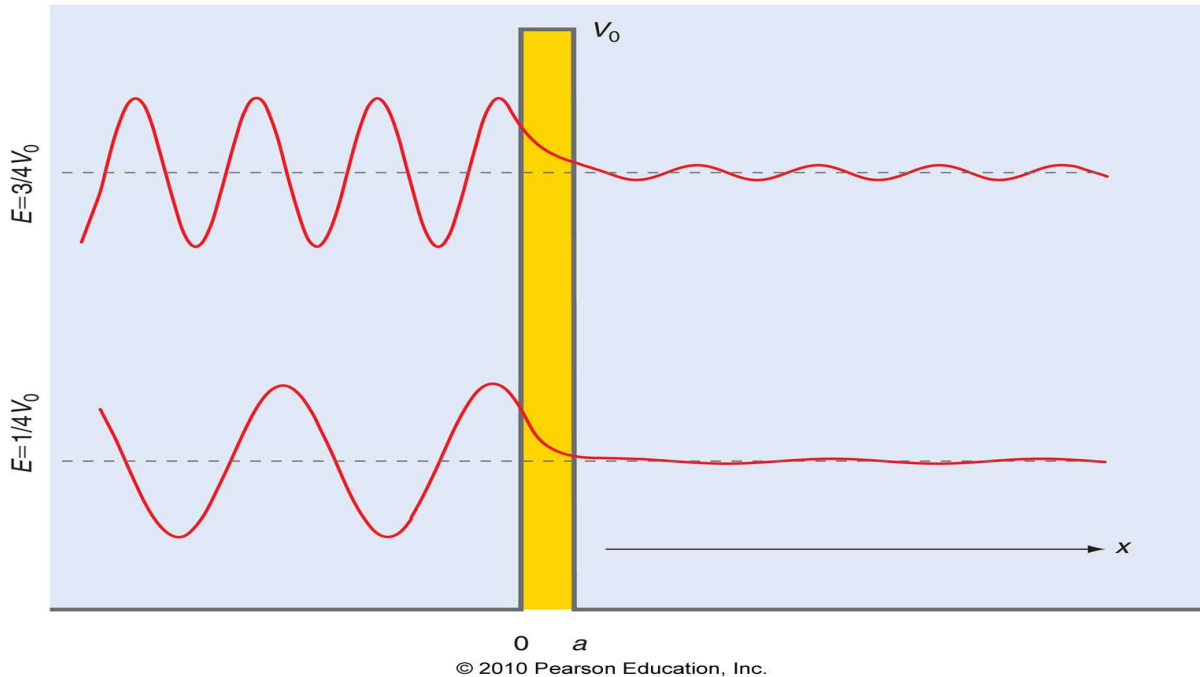
$-a/2 \quad x \quad a/2$

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Efecto Túnel

Microscopio de efecto túnel de barrido (STM, Scanning Tunneling Microscope)

Barrera de altura finita



$$V(x) = 0, \quad \text{for } x < 0$$

$$V(x) = V_0, \quad \text{for } 0 \leq x \leq a$$

Imagen STM de la superficie (111) de Si



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