

### ❖ Lowest Energy of the Particle

As we have already discussed that the wave function and energy, both are obtained as the solution of the Schrodinger wave equation for a particle in a one-dimensional box. The general forms of wave-function and energy for various quantum mechanical states are given below.

$$\psi_n = \sqrt{\frac{2}{a}} \text{Sin} \frac{n\pi x}{a} \quad \text{and} \quad E_n = \frac{n^2 h^2}{8ma^2} \quad (505)$$

We can write the expressions for  $\psi_1, \psi_2, \psi_3, \psi_4, \psi_5, \psi_6$  and so on; however, it is also worthy to note that even though the  $n = 0$  is permitted by the boundary condition, we cannot use it because this would make the whole function to collapse to zero.

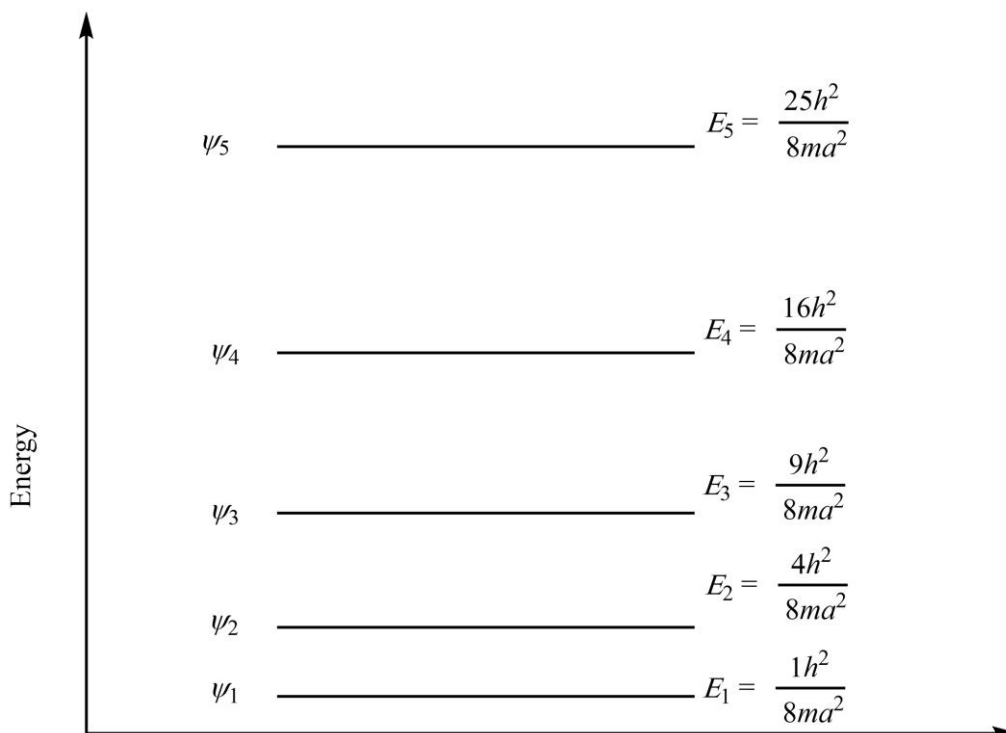


Figure 13. All the energy levels a particle in a one-dimensional box of including the “lowest energy of the particle”.

Hence, the minimum acceptable value of the quantum number  $n$  is 1 rather than 0; which makes the minimum energy of the particle non-zero.

$$E_1 = \frac{h^2}{8ma^2} \quad (506)$$

This non-zero value is popularly called as the zero-point energy and is a function of the mass of the particle and length of the box.

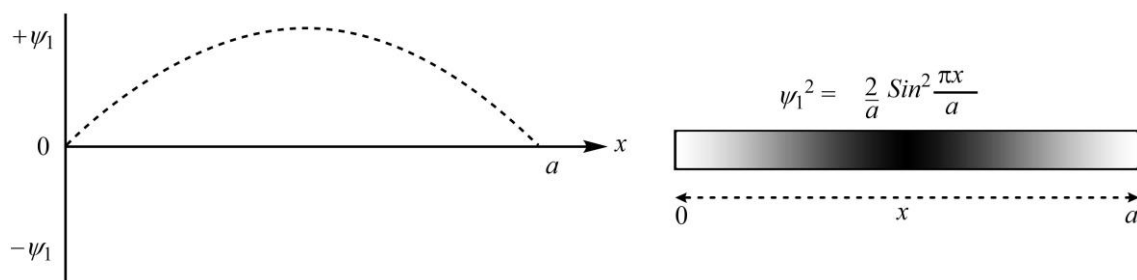


Figure 14. The plot of the wave function (left) and probability for the lowest energy state a particle is trapped in dimensional box.

Hence, in order to create the lowest energy, the particle must occupy the whole box without any node, having the highest probability at the center.



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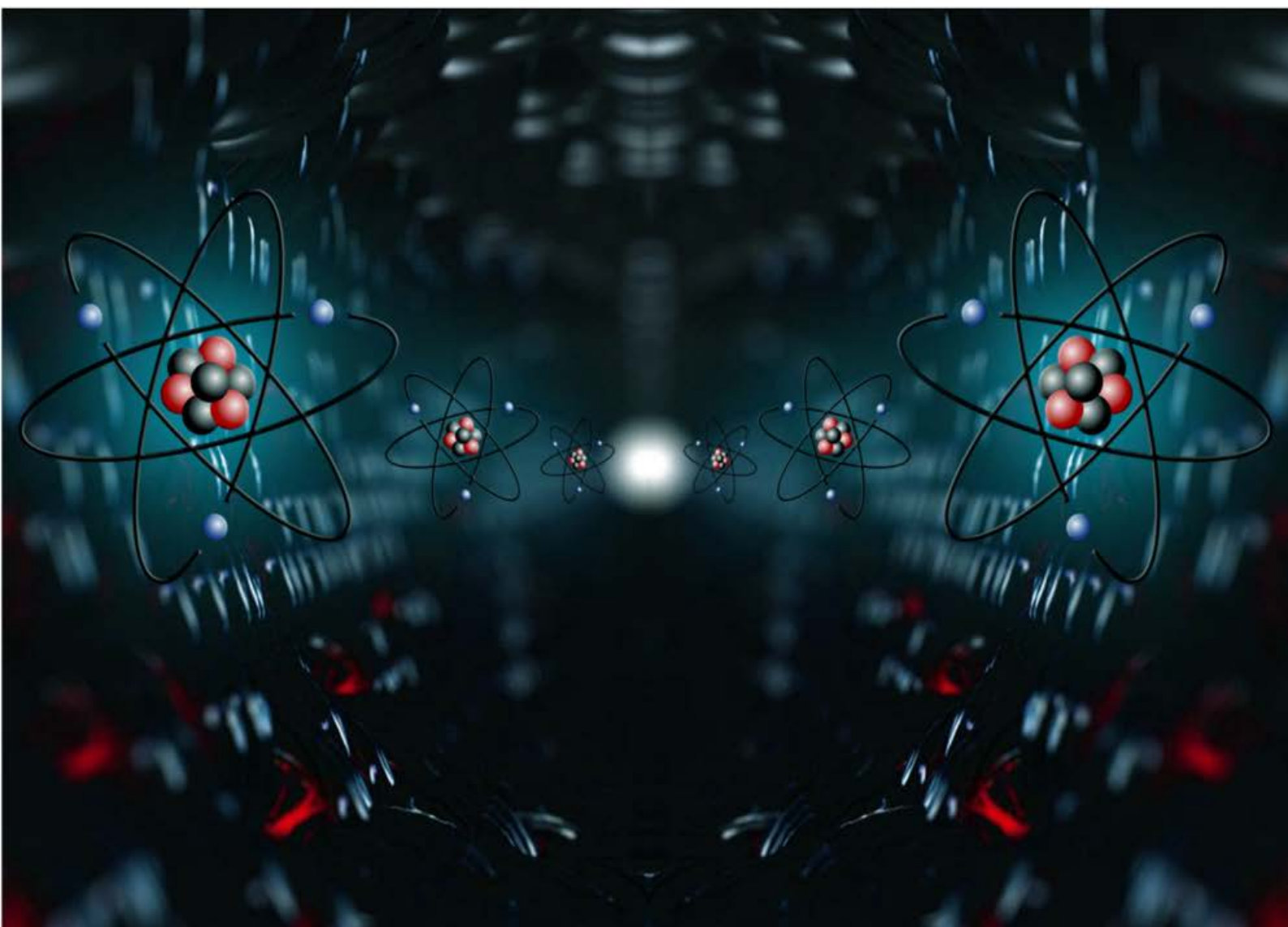
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# A TEXTBOOK OF PHYSICAL CHEMISTRY

**Volume I**

**MANDEEP DALAL**



*First Edition*

**DALAL INSTITUTE**

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