

Particle in a Box

Physics

The simplest bound system, and why it is the model for everything else.

A particle confined to a box has energies fixed by the box length and the quantum number.

$$E_n = n^2 h^2 / (8mL^2), n = 1, 2, 3 \dots$$

Smaller box

Inverse square in L.

Higher energies

Ground state

Zero-point energy.

$n = 1$, never zero

Heavier particle

Lower energies

THE COMMON MISTAKE

✗ **Expecting a ground state of zero energy**

✓ **The minimum is $n = 1$, not $n = 0$**

$n = 0$ would mean ψ is zero everywhere — no particle at all. Confinement forces a non-zero minimum energy.

This model explains quantum dot colours: smaller dots have larger level gaps and emit bluer light.