that an orbital of a free particle can be characterized by three positive integral quantum numbers $n_x$, $n_y$, $n_z$. The energy is

$$\varepsilon = \frac{\hbar^2}{2M}\left(\frac{\pi}{L}\right)^2 (n_x{}^2 + n_y{}^2 + n_z{}^2). \tag{1}$$

The multiplicities of the levels are indicated in the figure. The three orbitals with $(n_x, n_y, n_z)$ equal to (4,1,1), (1,4,1), and (1,1,4) all have $n_x{}^2 + n_y{}^2 + n_z{}^2 = 18$; the corresponding energy level has the multiplicity 3.

$\boxed{\varepsilon_s(N)}$

To describe the statistical properties of a system of $N$ particles, it is essential to know the set of values of the energy $\varepsilon_s(N)$, where $\varepsilon$ is the energy of the quantum state $s$ of the $N$ particle system. Indices such as $s$ may be assigned to the quantum states in any convenient arbitrary way, but two different states should not be assigned the same index.

It is a good idea to start our program by studying the properties of simple model systems for which the energies $\varepsilon_s(N)$ can be calculated exactly. We choose as a model a simple binary system because the general statistical properties found for the model system are believed to apply equally well to any realistic physical system. This assumption leads to predictions that always agree with experiment. What general statistical properties are of concern will become clear as we go along.

↓ gauzak kalkulatzeko oinarria

## BINARY MODEL SYSTEMS

N separate distinct

$\pm m$ ($\uparrow\downarrow$) •••

The binary model system is illustrated in Figure 1.3. We assume there are $N$ separate and distinct sites fixed in space, shown for convenience on a line. Attached to each site is an elementary magnet that can point only up or down, corresponding to magnetic moments $\pm m$. To understand the system means to count the states. This requires no knowledge of magnetism: an element of the system can be any site capable of two states, labeled as yes or no, red or blue, occupied or unoccupied, zero or one, plus one or minus one. The sites are numbered, and sites with different numbers are supposed not to overlap in physical space. You might even think of the sites as numbered parking spaces in a car parking lot, as in Figure 1.4. Each parking space has two states, vacant or occupied by one car.

Whatever the nature of our objects, we may designate the two states by arrows that can only point straight up or straight down. If the magnet points up, we say that the magnetic moment is $+m$. If the magnet points down, the magnetic moment is $-m$.