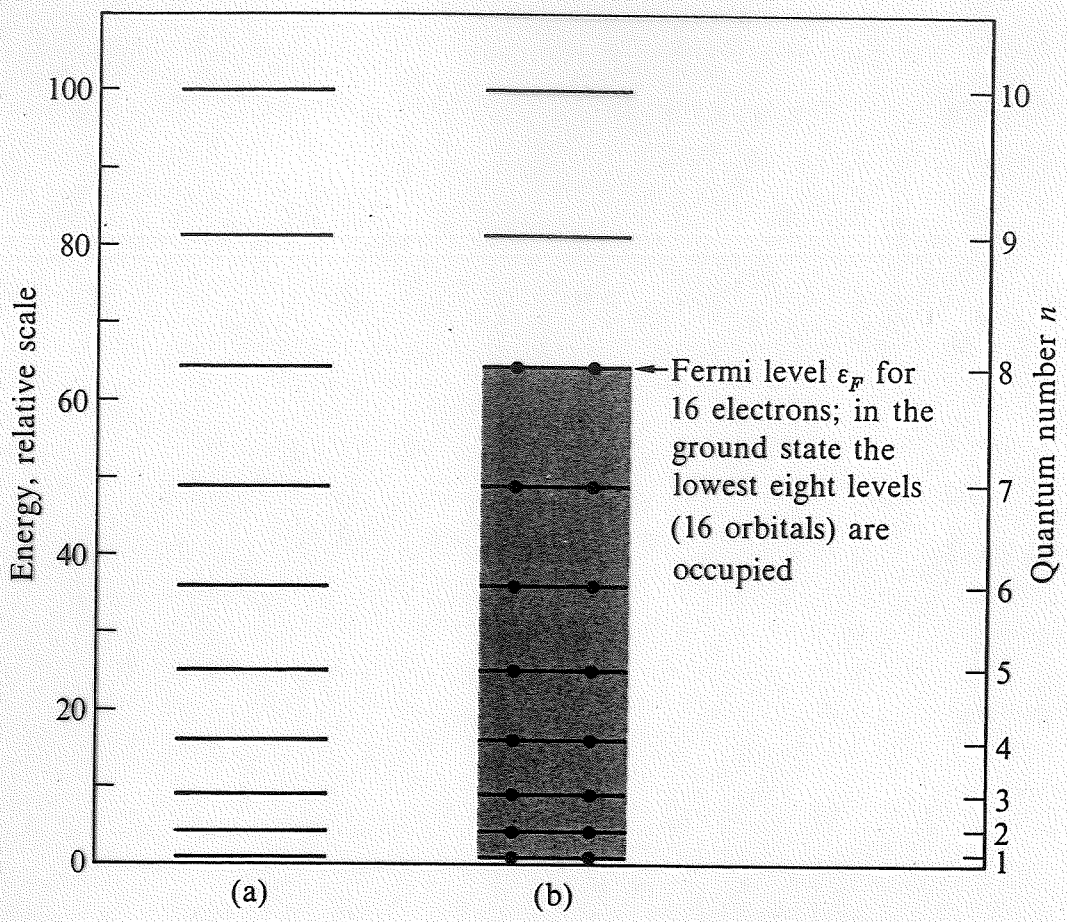

Figure 7.1 (a) The energies of the orbitals $n = 1, 2, \ldots, 10$ for an electron confined to a line of length L. Each level corresponds to two orbitals, one for spin up and one for spin down. (b) The ground state of a system of 16 electrons. Orbitals above the shaded region are vacant in the ground state.

of the ground state of the system at absolute zero. Suppose that it is necessary to accommodate N noninteracting electrons in a length L in one dimension. What orbitals will be occupied in the ground state of the N electron system? In a one-dimensional crystal the quantum number of a free electron orbital of form $\sin(n\pi x/L)$ is a positive integer n, supplemented by the spin quantum number $m_s = \pm\frac{1}{2}$ for spin up or spin down.

If the system has 8 electrons, then in the ground state the orbitals with $n = 1, 2, 3, 4$ and with $m_s = \pm\frac{1}{2}$ are filled, and the orbitals of higher n are empty. Any other arrangement gives a higher energy. To construct the ground state we fill the orbitals starting from $n = 1$ at the bottom, and we continue filling higher orbitals with electrons until all N electrons are accommodated. The orbitals that are filled in the ground state of a system of 16 electrons are shown in Figure 7.1.