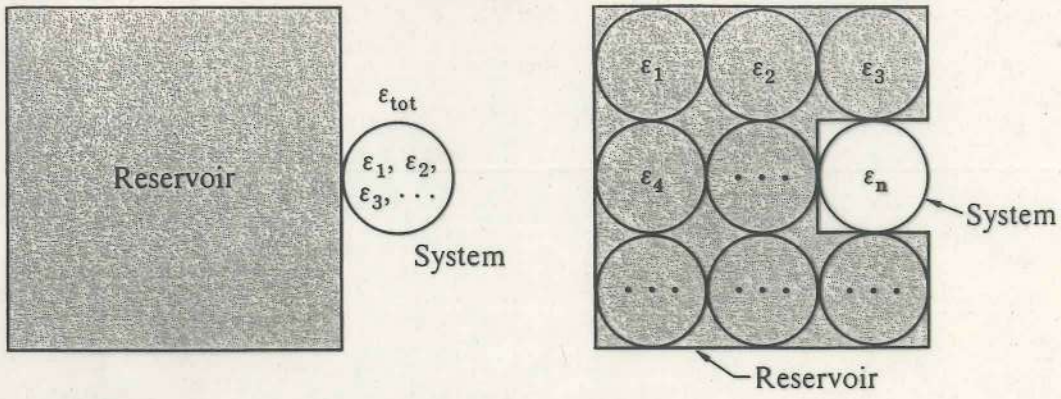


**Figure 6.2** (a) The obvious method of viewing a system of noninteracting particles is shown here. The energy levels each refer to an orbital that is a solution of a single-particle Schrödinger equation. The total energy of the system is

$$\varepsilon_{tot} = \sum N_{\mathbf{n}} \varepsilon_{\mathbf{n}} ,$$

where $N_{\mathbf{n}}$ is the number of particles in the orbital $\mathbf{n}$ of energy $\varepsilon_{\mathbf{n}}$. For fermions $N_{\mathbf{n}} = 0$ or 1. (b) It is much simpler than (a), and equally valid, to treat a single orbital as the system. The system in this scheme may be the orbital $\mathbf{n}$ of energy $\varepsilon_{\mathbf{n}}$. All other orbitals are viewed as the reservoir. The total energy of this one-orbital system is $N_{\mathbf{n}}\varepsilon_{\mathbf{n}}$, where $N_{\mathbf{n}}$ is the number of particles in the orbital. This device of using one orbital as the system works because the particles are supposed to interact only weakly with each other. If we think of the fermion system associated with the orbital $\mathbf{n}$, these are two possibilities: either the system has 0 particles and energy 0, or the system has 1 particle and energy $\varepsilon_{\mathbf{n}}$. Thus, the Gibbs sum consists of only two terms:

$$\mathcal{Z} = 1 + \lambda \exp(-\varepsilon_{\mathbf{n}}/\tau).$$

The first term arises from the orbital occupancy $N_{\mathbf{n}} = 0$, and the second term arises from $N_{\mathbf{n}} = 1$.

of $f$ always lies between zero and one. The Fermi-Dirac distribution function is plotted in Figure 6.3.

In the field of solid state physics the chemical potential $\mu$ is often called the **Fermi level**. The chemical potential usually depends on the temperature. The value of $\mu$ at zero temperature is often written as $\varepsilon_F$; that is,

$$\mu(\tau = 0) \equiv \mu(0) = \varepsilon_F. \tag{5}$$

We call $\varepsilon_F$ the **Fermi energy**, not to be confused* with the Fermi level which

* In the semiconductor literature the symbol $\varepsilon_F$ is often used for $\mu$ at any temperature, and $\varepsilon_F$ is then called the Fermi level.