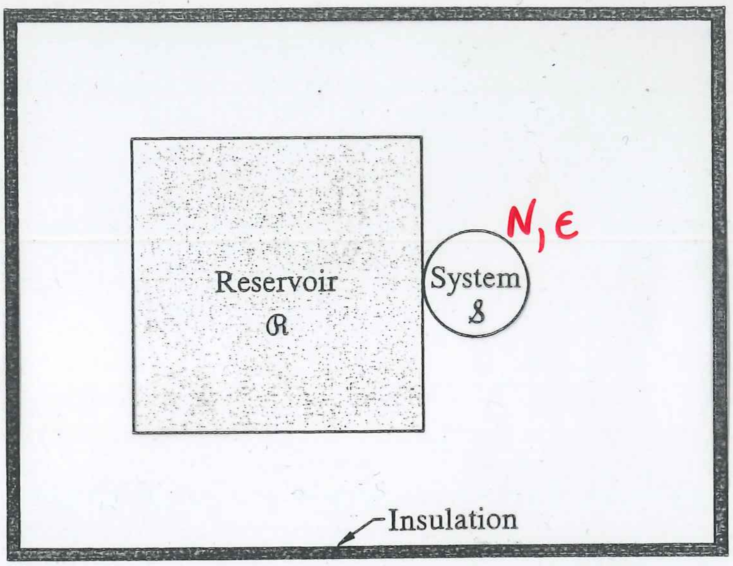
N_0, U_0



$\varepsilon_s(N)$?

Figure 5.8 A system in thermal and diffusive contact with a large reservoir of energy and of particles. The total system $\mathcal{R} + \mathcal{S}$ is insulated from the external world, so that the total energy and the total number of particles are constant. The temperature of the system is equal to the temperature of the reservoir, and the chemical potential of the system is equal to the chemical potential of the reservoir. The system may be as small as one atom or it may be macroscopic, but the reservoir is always to be thought of as much larger than the system.

Let $P(N,\varepsilon_s)$ denote the probability that the system has N particles and is in a particular state s. This probability is proportional to the number of accessible states of the reservoir when the state of the system is exactly specified. That is, if we specify the state of $\mathcal{S}$, the number of accessible states of $\mathcal{R} + \mathcal{S}$ is just the number of accessible states of $\mathcal{R}$:

$$g(\mathcal{R} + \mathcal{S}) = g(\mathcal{R}) \times 1. \tag{41}$$

The factor 1 reminds us that we are looking at the system $\mathcal{S}$ in a single specified state. The $g(\mathcal{R})$ states of the reservoir have $N_0 - N$ particles and have energy $U_0 - \varepsilon_s$. Because the system probability $P(N,\varepsilon_s)$ is proportional to the number of accessible states of the reservoir,

$$P(N,\varepsilon_s) \propto g(N_0 - N, U_0 - \varepsilon_s). \tag{42}$$

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