Equally impossible is a perpetual motion machine of the second kind, as it is called, in which heat is extracted from part of the environment and delivered to another part of the environment, the difference in temperature thus established being used to power a heat engine that delivers mechanical work available for any purpose at no cost to us. In brief, we cannot propel a ship by cooling the surrounding ocean to extract the energy necessary to propel the ship. The spontaneous transfer of energy from the low temperature ocean to a higher temperature boiler on the ship would decrease the total entropy of the combined systems and would thus be in violation of the law of increase of entropy.

SUMMARY

1. The fundamental assumption is that a closed system is equally likely to be in any of the quantum states accessible to it.

2. If $P(s)$ is the probability that a system is in the state s, the average value of a quantity X is

$$\langle X \rangle = \sum_s X(s)P(s).$$

3. An ensemble of systems is composed of very many systems, all constructed alike.

4. The number of accessible states of the combined systems 1 and 2 is

$$g(s) = \sum_s g_1(s_1)g_2(s - s_1) \, ,$$

where $s_1 + s_2 = s$.

5. The entropy $\sigma(N,U) \equiv \log g(N,U)$. The relation $S = k_B \sigma$ connects the conventional entropy S with the fundamental entropy σ.

6. The fundamental temperature τ is defined by

$$1/\tau \equiv (\partial \sigma / \partial U)_{N,V}.$$

The relation $\tau = k_B T$ connects the fundamental temperature and the conventional temperature.

7. The law of increase of entropy states that the entropy of a closed system tends to remain constant or to increase when a constraint internal to the system is removed.