Initial state

\[ S_{AB} = S_A + S_B \]

The system A is in its ground state, hence

\[ S_A = -1 \cdot \ln 1 = 0 \]

The system B is in the state of the maximal possible energy. This state is a unique one. Hence,

\[ S_B = -1 \cdot \ln 1 = 0 \]

Equilibrium

In the equilibrium each two-level subsystem is distributed between its two states. The probabilities are easily found from the conservation of energy:

\[ \text{total number of two-level systems} \times (0 \cdot w_1 + 3 \cdot w_2) = \text{2NE (energy of the initial state is 2NE)} \]

\[ w_1 + w_2 = 1 \] (As these are probabilities)

Hence, \[ w_2 = 2/3 , \quad w_1 = 1/3 \], and
\[ S_{AB} = 3N \cdot \left( -\frac{1}{3} \ln \frac{1}{3} - \frac{2}{3} \ln \frac{2}{3} \right) = N(3\ln 3 - 2\ln 2). \]

*total number of two-level systems*

**Temperature**. In accordance with Gibbs distribution,

\[ \frac{w_2}{w_1} = e^{-\epsilon/\tau} \Rightarrow e^{\epsilon/\tau} = 2 \]

\[ T = -\frac{\epsilon}{\ln 2} \]