2021048 이정빈

1

$PV = nRT$ (3차원)

$\pi A = nRT$ (2차원)

내부에너지 $U = NkT^2\left(\frac{\partial \ln Z}{\partial T}\right)_V$ (3차원)

$U = NkT^2\left(\frac{\partial \ln Z}{\partial T}\right)_A$ (2차원) A=면적

$$Z = \sum e^{-\varepsilon/kT} \qquad \varepsilon = \frac{h^2}{8m}\left(\frac{n_x^2}{a^2} + \frac{n_y^2}{b^2}\right)$$

$$= \sum e^{-\frac{h^2}{8mkT}\cdot\frac{n_x^2}{a^2}} \cdot \sum e^{-\frac{h^2}{8mkT}\cdot\frac{n_y^2}{b^2}}$$

$$= \int_0^\infty e^{-\frac{h^2}{8mkT}\cdot\frac{n_x^2}{a^2}} \int_0^\infty e^{-\frac{h^2}{8mkT}\cdot\frac{n_y^2}{b^2}}$$

$$= \left(\frac{a}{2}\sqrt{\frac{8\pi mkT}{h^2}}\right)\left(\frac{b}{2}\sqrt{\frac{8\pi mkT}{h^2}}\right)$$

$$= \frac{2ab\pi mkT}{h^2} = \frac{2A\pi mkT}{h^2}$$

$$U = NkT^2\left(\frac{\partial \ln Z}{\partial T}\right) = NkT^2\cdot\frac{1}{T} = NkT$$

2 $Z = \sum e^{-\frac{\varepsilon_i}{kT}}$

N
- valency O, $\varepsilon = \Delta H_V$
- valency X, $\varepsilon = \infty$

,

$$Z = \sum_{\text{state}} e^{-\frac{\varepsilon_i}{kT}}$$

$$= e^{-\frac{\Delta H_V}{kT}} + 1$$

$$\frac{n_V}{N} = \frac{e^{\frac{\Delta H_V}{kT}}}{Z} = \frac{e^{-\frac{\Delta H_V}{kT}}}{1 + e^{-\frac{\Delta H_V}{kT}}}$$

$$= \frac{1}{1 + e^{\frac{\Delta H_V}{kT}}}$$

$$\frac{n_V}{N} = \frac{1}{1 + e^{\frac{\Delta H_V}{kT}}}$$

3

macro state 상태는 서로 microstate 로 갈래에 나눠 올 수 있다 microstate 에서는 각각 가역적인 (reversible) 상태 일 수 있지만 이것이 macro state 로 오면서 micro state 의 개별 특성이 보이지 않고 비가역적인 (irreversible) 하나로 묶인 것 같다.

4

(a) $\Omega = \frac{2N!}{N!N!}$ $\Delta S_{thermal} = 0$

$\Delta S_{config} = k \ln \Omega$

$\ln \Omega = 2N \ln 2N - 2N - (N \ln N - N + N \ln N - N)$

$= 2N \ln 2N - 2N \ln N$

$= N \ln 4N^2 - N \ln N^2 = N \ln 4$

$\Delta S_{config} = kN \ln 4 = R \ln 4$

$\Delta S_{total} = \Delta S_{thermal} + \Delta S_{config} = R \ln 4$

(b) $\Delta S_{config} = \ln \left(\frac{3N!}{2N! N!} \right)$

$= 3N \ln 3N - 3N - (2N \ln 2N - 2N + N \ln N - N)$

$= N \ln 27N^3 - N \ln 4N^2 - N \ln N = N \ln \frac{27}{4}$

* A

$\Delta S_{thermal}$ $2R \ln \left(\frac{4}{3} \right)$

* B

$\Delta S_{thermal} = R \ln \left(\frac{2}{3} \right)$

$\Delta S_{total} = \Delta S_{config} + \Delta S_{thermal} = R \ln 8$

(c) $\Delta S_{total} = 2R\ln 2 + 0 + 3R\ln\left(\frac{2}{3}\right) = R\ln\left(\frac{32}{27}\right)$