third response: compressibility

$\Delta V \Leftrightarrow \Delta P$

$\beta = \frac{1}{V}\frac{\Delta V}{\Delta P}$ depends on path

$\beta_T = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T \quad ; \quad \beta_S = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_S$

isothermal   isoentropic

introduce rec.

$B_T = -V\left(\frac{\partial P}{\partial V}\right)_T \quad ; \quad B_S = -V\left(\frac{\partial P}{\partial V}\right)_S$

Gibbs Distribution: applications

$\boxed{w_n^{(a)} = e^{-\alpha^{(a)} - \beta E_n}} \quad ; \quad \boxed{\sum_n w_n^{(a)} = 1}$

fixed part. number $N = \text{const}$

$w_{nN}^{(a)}$ prob. multiplicative; petit ensemble

$\ln w_{nN}^{(a)} = -\alpha^{(a)} - \beta E_{nN}^{(a)} - \gamma N^{(a)}$

grand ensemble

$\boxed{w_{nN}^{(a)} = e^{-\alpha^{(a)} - \beta E_{nN}^{(a)} - \gamma N^{(a)}}}$

Normalize $\boxed{\sum_N \sum_n w_{nN}^{(a)}}$

in thermo

$\frac{1}{T} = \frac{\partial S}{\partial E}$

connect β to T

$S(\beta) = -k_B \sum_n w_n(\beta) \ln w_n(\beta)$

$\bar{E}(\beta) = \sum_n w_n(\beta) E_n$

$\frac{\partial S}{\partial E} = \frac{\left(\frac{\partial S}{\partial \beta}\right)}{\left(\frac{\partial E}{\partial \beta}\right)} = \frac{1}{T}$

provided $\beta = \frac{1}{k_B T}$

Connect $w_n(\alpha,\beta) = F, T$

$F = E - TS$ def

$= \sum_n E_n e^{-\alpha - \beta E_n} - k_B T \sum_n e^{-\alpha - \beta E_n}(\alpha + \beta E$

$\boxed{F = -k_B T \alpha}$

$w_n = e^{-\beta F - \beta E_n}$

$\boxed{w_n = e^{\frac{F - E_n}{k_B T}}}$