

Formulae for Final

$$k = 1.381 \cdot 10^{-23} \text{ J/K} = 8.617 \cdot 10^{-5} \text{ eV/K} \quad h = 6.626 \cdot 10^{-34} \text{ Js} = 4.136 \cdot 10^{-15} \text{ eVs}$$

$$c = 2.998 \cdot 10^8 \text{ m/s} \quad N_A = 6.022 \cdot 10^{23}$$

$$\Delta U = Q + W_{\text{on}} \quad \text{where } W_{\text{on}} = - \int p \, dV$$

$$C = \frac{Q}{\Delta T} \quad C_V = T \left(\frac{\partial S}{\partial T} \right)_V = \left(\frac{\partial U}{\partial T} \right)_{V,N} \quad C_p = T \left(\frac{\partial S}{\partial T} \right)_p$$

$$pV = NkT \quad pV^\gamma = \text{const.}, \text{ where } \gamma = (f + 2)/f$$

$$U = \frac{f}{2} NkT$$

$$\epsilon = \frac{W_{\text{by}}}{Q_h} \quad \text{COP} = \frac{Q_c}{W_{\text{on}}} \quad p = \frac{NkT}{(V-bN)} - a \frac{N^2}{V^2}$$

$$G = \mu N \quad \frac{dp}{dT} = \frac{\Delta S}{\Delta V} = \frac{L}{T\Delta V}$$

$$H = U + pV \quad F = U - TS \quad G = U - TS + pV$$

$$dU = T \, dS - p \, dV + \mu \, dN$$

$$\Omega = \binom{q + N - 1}{q} \quad \Omega = \binom{N}{n} = \frac{N!}{n!(N-n)!}$$

$$\ln N! \approx N \ln N - N \quad \ln(1+x) \approx x$$

$$S = k \ln \Omega \quad \frac{1}{T} = \left(\frac{\partial S}{\partial U} \right)_{N,V}$$

$$\bar{X} = \sum_s X(s) P(s)$$

$$\text{canonical: } P(s) = \frac{e^{-E(s)/(kT)}}{Z} \quad \text{grand-canon.: } P(s) = \frac{e^{-(E(s) - \mu N(s))/(kT)}}{\mathcal{Z}}$$

$$\bar{n}_{\text{FD}} = \frac{1}{e^{(\epsilon - \mu)/(kT)} + 1} \quad \bar{n}_{\text{BE}} = \frac{1}{e^{(\epsilon - \mu)/(kT)} - 1} \quad \bar{n}_{\text{PI}} = \frac{1}{e^{(hf)/(kT)} - 1}$$

$$D(v) = \left(\frac{m}{2\pi kT} \right)^{3/2} 4\pi v^2 e^{-mv^2/(2kT)}$$

$$F = -kT \ln Z$$

$$Z_{\text{idealgas}} = \frac{1}{N!} \left(\frac{V Z_{\text{int}}}{v_Q} \right)^N \quad \text{where } v_Q = \left(\frac{h}{\sqrt{2\pi m kT}} \right)^3 \quad S = Nk \left[\ln \left(\frac{V}{N} \left(\frac{4\pi m U}{3N h^2} \right)^{3/2} \right) + \frac{5}{2} \right]$$

$$\int_{-\infty}^{\infty} e^{-ax^2} dx = \sqrt{\frac{\pi}{a}} \quad \int_{-\infty}^{\infty} x^2 e^{-ax^2} dx = \frac{\sqrt{\pi}}{2} a^{-3/2} \quad \int_{-\infty}^{\infty} x^4 e^{-ax^2} dx = \frac{3}{4} \sqrt{\frac{\pi}{a^5}}$$

$$\sum_{n=0}^{\infty} x^n = \frac{1}{1-x} \quad \cosh(x) = \frac{e^x + e^{-x}}{2} \quad \sinh(x) = \frac{e^x - e^{-x}}{2} \quad \tanh(x) = \frac{\sinh(x)}{\cosh(x)}$$

$$\frac{d \tanh(x)}{dx} = \frac{1}{\cosh^2(x)}$$

$$\text{power} = L = \sigma \epsilon A T^4 \quad \text{where } \sigma = 5.67 \times 10^{-8} \frac{\text{W}}{\text{m}^2 \text{K}^4}$$

$$\text{sphere: } A = 4\pi R^2 \quad V = \frac{4\pi}{3} R^3$$