$$\alpha_L = \frac{1}{L}\frac{\mathrm{d}L}{\mathrm{d}T} \qquad \beta = \alpha_V = \frac{1}{V}\frac{\mathrm{d}V}{\mathrm{d}T} \qquad \beta = \alpha_V = 3\alpha_L$$

$$\Delta L \approx L_0 \alpha_L \Delta T \qquad \Delta V \approx V_0 \alpha_V \Delta T \qquad \frac{t}{^\circ\mathrm{C}} = \frac{T}{\mathrm{K}} - 273.0$$

$$\frac{\mathrm{d}Q}{\mathrm{d}t} = \dot{Q} = -\kappa A \frac{\mathrm{d}T}{\mathrm{d}x} \qquad \frac{\mathrm{d}Q}{\mathrm{d}t} = \dot{Q} = -\frac{\kappa A}{L}\Delta T$$

$$C = \frac{\mathrm{d}Q}{\mathrm{d}T} \qquad Q = mc\Delta T \qquad Q = \pm \Delta m L$$

$$Q = nc\Delta T \qquad Q = \pm \Delta n L$$

$$\Delta U = \Delta Q - \Delta W \qquad \mathrm{d}U = \mathrm{d}Q - P\mathrm{d}V \qquad \mathrm{d}U = T\mathrm{d}S - P\mathrm{d}V$$

$$\mathrm{d}S = \frac{\mathrm{d}Q_{\text{rev}}}{T} \qquad \Delta S = \int_{\text{rev}} \frac{\mathrm{d}Q}{T}$$

$$PV = nRT \qquad U = U(T) = nc_V T \qquad \mathrm{d}U = nc_V \mathrm{d}T$$

$$\mathrm{d}V = 0 \Rightarrow \qquad \mathrm{d}Q = \mathrm{d}U = nc_V \mathrm{d}T$$

$$\mathrm{d}P = 0 \Rightarrow \qquad \mathrm{d}Q = \mathrm{d}U + P\mathrm{d}V = nc_P \mathrm{d}T \qquad c_P - c_V = R$$

$$\mathrm{d}Q = 0 \Rightarrow \mathrm{d}U = -P\mathrm{d}V \Rightarrow \qquad \begin{cases} TV^{\gamma-1} & = \text{constante} \\ PV^{\gamma} & = \text{constante} \end{cases} \qquad \gamma = c_P/c_V$$

$$\mathrm{d}T = 0 \Rightarrow \mathrm{d}Q = P\mathrm{d}V \qquad \Delta Q = \Delta W = nRT\ln\left(V_\mathrm{f}/V_\mathrm{i}\right)$$

$$\eta = \frac{W}{Q_\mathrm{q}} = 1 - \frac{Q_\mathrm{f}}{Q_\mathrm{q}} \qquad K = \mathrm{CoD} = \frac{Q_{\mathrm{f,q}}}{W} = \frac{Q_{\mathrm{f,q}}}{Q_\mathrm{q} - Q_\mathrm{f}} \qquad \eta \leq \eta_{\text{rev}} = 1 - \frac{Q_\mathrm{f}^{\text{rev}}}{Q_\mathrm{q}^{\text{rev}}} = 1 - \frac{T_\mathrm{f}}{T_\mathrm{q}}$$

$$\frac{U}{N} = \langle K_{\text{trans}} \rangle + \langle K_{\text{rot}} \rangle + \langle E_{\text{vib}} \rangle \qquad U = \tfrac{1}{2} f N k T = \tfrac{1}{2} f n R T \qquad c_V = \tfrac{1}{2} f R$$

$$\langle K_{\text{trans}} \rangle = \tfrac{3}{2} kT \qquad v_{\text{rqm}} = \sqrt{\langle v^2 \rangle} = \sqrt{\frac{3kT}{m}} = \sqrt{\frac{3P}{\rho}} \qquad \lambda = \bar{\ell} = \frac{V}{N}\frac{1}{\sqrt{2}\sigma} = \frac{1}{\sqrt{2} n \pi d^2}$$

$$R = 8{,}314\ \mathrm{J/(mol \cdot K)} \quad N_\mathrm{A} = 6{,}023 \times 10^{23}\ \mathrm{mol^{-1}} \quad k = R/N_\mathrm{A} = 1{,}38 \times 10^{-23}\ \mathrm{J/K}$$

$$\mathrm{cal} = 4{,}20\ \mathrm{J} \qquad \mathrm{L} = 10^3\ \mathrm{cm^3} = 10^{-3}\ \mathrm{m^3}$$