Formulario di Termodinamica

Legge di Stevino

$$p = \rho g h \qquad \frac{dp}{dz} = \rho g \qquad p = \frac{F}{\Sigma}$$

Calore

$$Q = mc\,\Delta T$$

$$c = \frac{Q}{m\,\Delta T} \qquad \text{calore specifico}$$

$$C = mc = \frac{Q}{\Delta T} \qquad \text{Capacità termica}$$

$$C(T) = \frac{\delta Q}{dT}$$

$$Q = \lambda_f\,\Delta m \Longrightarrow \lambda_f = \frac{Q}{\Delta m}$$

$$\Delta U = Q - W$$

Costanti

$$1 \text{ atm} = 101325 \text{ Pa} = 76 \text{ cm Hg}$$

$$0 \text{ K} = -273.15°\text{C} \qquad 0°\text{C} = 273.15 \text{ K}$$

$$1 \text{ Cal} = 4186.799 \text{ J} \qquad 1 \text{ Cal} = 1000 \text{ cal}$$

$$R = 8.314\,\frac{\text{J}}{\text{mol K}} = 0.0821\,\frac{\text{L atm}}{\text{mol K}}$$

$$k = 1.38065 \cdot 10^{-23} \text{ J K}^{-1} \quad \text{Boltzmann}$$

$$V_0 = 0.022414 \text{ m}^3 \text{ mol}^{-1} = 22.414 \text{ L/mol}$$

- gas monoatomico: $c_V = \frac{3}{2}R\,,\ c_p = \frac{5}{2}R$
- gas biatomico: $c_V = \frac{5}{2}R\,,\ c_p = \frac{7}{2}R$

Gas perfetti

$$pV = nRT \qquad n = \frac{N}{N_A}$$

$$dW = F\,dx = p\,dV$$

$$RT = \frac{2}{3}\overline{U}_k \Longrightarrow \overline{U}_k = \frac{3}{2}\frac{R}{N_A}T = \frac{3}{2}kT$$

Trasformazioni:

- **isoterma**: $T = cost.$ $\quad \Delta U = 0$

  $$W(1 \to 2) = n\,R\,T\,\ln\frac{V_2}{V_1} = Q$$

- **isocora**: $V = cost.$ $\quad W = 0$

  $$\Delta U = Q = n\,c_V\,\Delta T$$

con c_V: calore specifico molare a volume costante

- **isobara**: $p = cost.$

  $$W = nR\,\Delta T$$

  $$Q = n(c_V + R)\Delta T \qquad \text{con } c_p = c_V + R$$

- **Adiabatica reversibile**: $Q = 0$

  $$-W = \Delta U = nc_V\Delta T \qquad V\,T^{\frac{c_V}{R}} = cost.$$

  $$p\,V^\gamma = cost. \qquad \text{con } \gamma = \frac{c_p}{c_V}$$

Ciclo di Carnot

$$W = nR\,\ln\frac{V_B}{V_A}\,(T_2 - T_1) > 0$$

$$\eta = \frac{W}{Q_{\text{assorbito}}} = \frac{T_2 - T_1}{T_2} = 1 - \frac{T_1}{T_2}$$

Teorema di Clausius

$$\oint \frac{\delta Q}{T} \leq 0$$

Entropia

$$\Delta S = \int_A^B \left(\frac{\delta Q}{T}\right)_{\text{Rev}} = k\,\ln\left(\frac{\pi_f}{\pi_i}\right)$$

$$\Delta S = \int_i^f \left(\frac{\delta Q}{T}\right)_{\text{Rev}} > \int_i^f \left(\frac{\delta Q}{T}\right)_{\text{Irr}}$$

Entropie

- **Isoterma reversibile**:

  $$\Delta S = nR\,\ln\frac{V_B + V_A}{V_A}$$

- **Isocora**: $\Delta S = n\,c_V\,\ln\frac{T_B}{T_A}$
- **Isobara**: $\Delta S = n\,c_p\,\ln\frac{T_B}{T_A}$