A Short Compendium of Particularly Delightful Formulas

$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$ $\quad Z = 1 + B(T)\frac{n}{V} + C(T)\left(\frac{n}{v}\right)^2 + D(T)\left(\frac{n}{v}\right)^3 + ...$

$f(x) = f(x_o) + f'(x_o)\frac{(x-x_o)}{1!} + f''(x_o)\frac{(x-x_o)^2}{2!} + f'''(x_o)\frac{(x-x_o)^3}{3!} + ... + f^{(n)}(x_o)\frac{(x-x_o)^n}{n!}$

$V_c = 3b$ $\quad T_c = \frac{8a}{27bR}$ $\quad P_c = \frac{a}{27b^2}$

$dU = dq - P_{ext}dV + F\,dx$ $\quad dw = \gamma\, d\sigma = f\,dx = mg\,dh = \phi\, dq_i$ $\quad w = z_i F \Delta\phi$

$Cp(A) = a(A) + b(A)T + c(A)T^2$ $\quad \Delta C_p = \Delta\left(\frac{dq}{dT}\right) = \Delta\frac{dq}{dt}\frac{dt}{dT}$ $\quad \int\left(\frac{dq}{dt}\right)_p dt = \Delta H$

$\alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$ $\quad \beta = \kappa = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$ $\quad \left(\frac{\partial P}{\partial T}\right)_V = \frac{\alpha}{\kappa}$ $\quad \Delta V = V_o\,\alpha\,\Delta T$

$\Delta V = -V_o\,\kappa\Delta P$ $\quad V - V_o = V_o\,\alpha\,(T - T_o) + V_o\,\alpha^2\frac{(T - T_o)^2}{2}$ $\quad V = V_o\,e^{\alpha(T - T_o)}$

$\left(\frac{\partial U}{\partial T}\right)_P = \left(\frac{\partial U}{\partial T}\right)_V + \left(\frac{\partial U}{\partial V}\right)_T\left(\frac{\partial V}{\partial T}\right)_P$ $\quad C_P - C_V = \left(\left(\frac{\partial U}{\partial V}\right)_T + P\right)\left(\frac{\partial V}{\partial T}\right)_P$ $\quad C_P - C_V = \frac{\alpha^2\,TV}{\kappa}$

$\left(\frac{\partial H}{\partial T}\right)_V = \left(\frac{\partial H}{\partial T}\right)_P + \left(\frac{\partial H}{\partial P}\right)_T\left(\frac{\partial P}{\partial T}\right)_V$ $\quad \mu_{JT} = \left(\frac{\partial T}{\partial P}\right)_H = \frac{-\left(\frac{\partial H}{\partial P}\right)_T}{\left(\frac{\partial H}{\partial T}\right)_P}$ $\quad \left(\frac{\partial H}{\partial P}\right)_T = -\mu_{JT}C_p$

$C_V \ln\left(\frac{T_2}{T_1}\right) = -nR\ln\left(\frac{V_2}{V_1}\right)$ $\quad V_1T_1^{c} = V_2T_2^{c}$ $\quad P_2V_2^{\gamma} = P_1V_1^{\gamma}$ $\quad c = \frac{Cv}{nR}$ $\quad \gamma = \frac{Cp}{Cv}$

$C_V(T_2 - T_1) = -P_2\,(V2 - V1)$ $\quad C_V(T_2 - T_1) = -P_2\left(\frac{nRT_2}{P_2} - \frac{nRT_1}{P_1}\right)$

$\Delta_rH_{T_2} - \Delta_rH_{T_1} = \Delta_rC_p\Delta T$ $\quad \Delta_rH_{T_2} = \Delta_rH_{T_1} + \Delta a(T_2 - T_1) + \frac{\Delta b}{2}(T_2^2 - T_1^2) + \frac{\Delta c}{3}(T_2^3 - T_1^3))$

$\Delta_rH_T = \Delta_rH_o + \Delta aT + \frac{\Delta b}{2}T^2 + \frac{\Delta c}{3}T$

$S = k\ln W$ $\quad \xi = \frac{-w}{q_H} = \frac{q_H + q_L}{q_H}$ $\quad \oint\frac{dq}{T} \leq 0$ $\quad \Delta S \geq \int\frac{dq}{T}$

$dS = \frac{C_V}{T}dT + \frac{P}{T}dV$ $\quad dS = \frac{C_P}{T}dT - \frac{V}{T}dP$ $\quad \Delta S = C_V\ln T_2/T_1$

$dS = \frac{C_V}{T}dT + \frac{nR}{V}dV$ $\quad dS = \frac{C_P}{T}dT - \frac{nR}{P}dP$ $\quad \Delta S = C_P\ln T_2/T_1$

$\Delta S = nR\ln V_2/V_1$ $\quad \Delta S = -nR\ln P_2/P_1$