Foundations of Thermodynamics

$PV=nRT$ $\quad \alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$ $\quad \kappa = \frac{-1}{V}\left(\frac{\partial V}{\partial P}\right)_T$ $\quad \frac{\alpha}{\kappa} = \left(\frac{\partial P}{\partial T}\right)_V$

$\left(P + a\frac{n^2}{V^2}\right)(V - nb) = nRT$ $\quad C_v = \left(\frac{\partial U}{\partial T}\right)_V$ $\quad C_P = \left(\frac{\partial H}{\partial T}\right)_P$

$dU = dq + dw$	$dU = TdS - PdV$	$\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial S}\right)_V$
$H = U + PV$	$dH = TdS + VdP$	$\left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$
$A = U - TS$	$dA = -SdT - PdV$	$\left(\frac{\partial P}{\partial T}\right)_V = \left(\frac{\partial S}{\partial V}\right)_T$
$G = H - TS$	$dG = -SdT + VdP$	$\left(\frac{\partial V}{\partial T}\right)_P = -\left(\frac{\partial S}{\partial P}\right)_T$

$\left(\frac{\partial U}{\partial V}\right)_T = -P + T\left(\frac{\partial P}{\partial T}\right)_V$ $\qquad C_p - C_V = \left(P + \left(\frac{\partial U}{\partial V}\right)_T \right)\left(\frac{\partial V}{\partial T}\right)_P$

$\left(\frac{\partial H}{\partial P}\right)_T = V - T\left(\frac{\partial V}{\partial T}\right)_P = -\mu_{JT} C_P$ $\qquad C_p - C_V = T\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial V}{\partial T}\right)_P = \frac{\alpha^2}{\kappa} VT$

	T	V cst. T	P cst. T
S	$\Delta S = \int \frac{C_P}{T} dT$ @ cst.P $\Delta S = C_P \ln T_2/T_1$	$\Delta S = \int \frac{\alpha}{\kappa} dV$ $\Delta S = nR \ln V_2/V_1$	$\Delta S = -\int \alpha V \, dP$ $\Delta S = -nR \ln P_2/P_1$
A	$\Delta A = -\int S \, dT$ @ cst.V	$\Delta A = -\int P \, dV$ $\Delta A = -nRT \ln V_2/V_1$	$\Delta A = \int PV\kappa \, dP$ $\Delta A = nRT \ln P_2/P_1$
G	$\Delta G = -\int S \, dT$ @ cst.P $\frac{\Delta_r G_2}{T_2} - \frac{\Delta_r G_1}{T_1} = \Delta_r H^\theta \left(\frac{1}{T_2} - \frac{1}{T_1}\right)$	$\Delta G = -\int \frac{1}{\kappa} dV$ $\Delta G = -nRT \ln V_2/V_1$	$\Delta G = \int V \, dP$ $\Delta G = nRT \ln P_2/P_1$