

Some useful expressions

$$dU = TdS - pdV \Rightarrow \left(\frac{\partial S}{\partial T}\right)_V = \frac{1}{T} \left(\frac{\partial U}{\partial T}\right)_V = \frac{C_V}{T}$$

$$dH = TdS + Vdp \Rightarrow \left(\frac{\partial S}{\partial T}\right)_p = \frac{1}{T} \left(\frac{\partial H}{\partial T}\right)_p = \frac{C_p}{T}$$

$$\left(\frac{\partial U}{\partial V}\right)_T = T \left(\frac{\partial S}{\partial V}\right)_T - p = T \left(\frac{\partial p}{\partial T}\right)_V - p$$

$$\left(\frac{\partial H}{\partial p}\right)_T = T \left(\frac{\partial S}{\partial p}\right)_T + V = -T \left(\frac{\partial V}{\partial T}\right)_p + V$$

If you know  $G(T, p)$  you know everything

$$S = -\left(\frac{\partial G}{\partial T}\right)_p \quad \text{and} \quad V = \left(\frac{\partial G}{\partial p}\right)_T$$

$$H = G + TS \quad \Rightarrow \quad H = G - T \left(\frac{\partial G}{\partial T}\right)_p$$

$$U = H - PV \quad \Rightarrow \quad U = G - T \left(\frac{\partial G}{\partial T}\right)_p - p \left(\frac{\partial G}{\partial p}\right)_T$$

$$A = U - TS \quad \Rightarrow \quad A = G - p \left(\frac{\partial G}{\partial p}\right)_T$$

$$C_p = T \left(\frac{\partial S}{\partial T}\right)_p \quad \Rightarrow \quad C_p = -T \left(\frac{\partial^2 G}{\partial T^2}\right)_p$$