6.3 the dependence of the Gibbs and helmholtz energies on P and T

- the Gibbs-helmholtz equation can be written as

$$(7)\quad \left(\frac{\partial[G/T]}{\partial[1/T]}\right)_P = \left(\frac{\partial[G/T]}{\partial T}\right)_P \left(\frac{\partial T}{\partial[1/T]}\right) = \frac{-H}{T^2}(-T^2) = H$$

- the preceding equation also applies to the change in G and H associated with a process such a chemical reaction.

- Replacing G by ΔG and integrating equation (7) at constant P

$$\int_{T_1}^{T_2} d\left(\frac{\Delta G}{T}\right) = \int_{T_1}^{T_2} \Delta H\, d\left(\frac{1}{T}\right) \quad (8)$$

$$\frac{\Delta G(T_2)}{T_2} = \frac{\Delta G(T_1)}{T_1} + \Delta H(T_1)\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

- it has been assumed in the second equation that ΔH is independent of T over the temperature interval of interest

- If this is not the case, the integral must be evaluated numerically, using tabulated values of ΔH_f° and expressions of $C_{p,m}$ for the temperature-dependent reactants and products.

idea diagram:

$$\int_{T_1}^{T_2} d\left(\frac{\Delta G}{T}\right) = \int_{T_1}^{T_2} \Delta H\, d(1/T)$$

$$\underbrace{\frac{\Delta G(T_2)}{T_2} = \frac{\Delta G(T_1)}{T_1}}_{\Delta T \text{ in terms of Gibbs free energy}} + \overbrace{\Delta H(T_1)\left(\frac{1}{T_2} - \frac{1}{T_1}\right)}^{\Delta T \text{ in terms of entropy}}$$