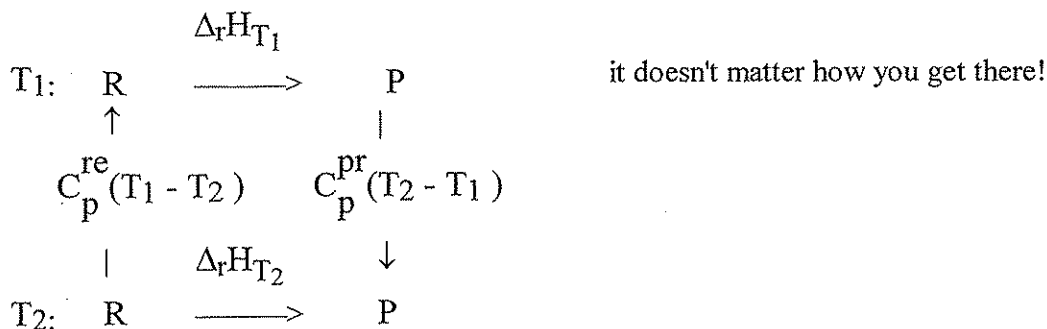


Temperature Dependence of Reaction Enthalpy, $\Delta_r H$



$$\Delta_r H_{T_2} = C_p^{\text{re}}(T_1 - T_2) + \Delta_r H_{T_1} + C_p^{\text{pr}}(T_2 - T_1)$$

$$\Delta_r H_{T_2} = \Delta_r H_{T_1} + (C_p^{\text{pr}} - C_p^{\text{re}})(T_2 - T_1)$$

$$\Delta_r H_{T_2} - \Delta_r H_{T_1} = \Delta_r C_p \Delta T \quad \Delta_r C_p = C_p^{\text{pr}} - C_p^{\text{re}}$$

$$d\Delta_r H = \Delta_r C_p dT \quad \text{Kirchhoff's Law 1858}$$

$$\text{In general} \quad A + B \rightarrow C + D \quad \Delta_r H = H_C + H_D - H_A - H_B$$

$$\left(\frac{\partial \Delta_r H}{\partial T}\right)_P = \left(\frac{\partial H_C}{\partial T}\right)_P + \left(\frac{\partial H_D}{\partial T}\right)_P - \left(\frac{\partial H_A}{\partial T}\right)_P - \left(\frac{\partial H_B}{\partial T}\right)_P$$

$$\left(\frac{\partial \Delta_r H}{\partial T}\right)_P = C_p(C) + C_p(D) - C_p(A) - C_p(B) = \Delta_r C_p$$

$$C_p(A) = a(A) + b(A)T + c(A)T^2 \quad C_p(B) = a(B) + b(B)T + c(B)T^2$$

for the reaction:

$$\Delta_r C_p = (a(C) + a(D) - a(A) - a(B)) + (b(C) + b(D) - b(A) - b(B))T + (c(C) + c(D) - c(A) - c(B))T^2$$

set $\Delta a = a(C) + a(D) - a(A) - a(B)$ etc.

$$\Delta_r C_p = \Delta a + \Delta bT + \Delta cT^2$$

$$d\Delta_r H = \Delta_r C_p dT = (\Delta a + \Delta bT + \Delta cT^2)dT$$

$$\Delta_r H_{T_2} - \Delta_r H_{T_1} = \int_{T_1}^{T_2} (\Delta a + \Delta bT + \Delta cT^2) dT$$

$$\Delta_r H_{T_2} = \Delta_r H_{T_1} + \Delta a(T_2 - T_1) + \frac{\Delta b}{2}(T_2^2 - T_1^2) + \frac{\Delta c}{3}(T_2^3 - T_1^3)$$

$$\text{or let } T_1 \rightarrow 0 \text{ and set } T_2 = T: \quad \Delta_r H_T = \Delta_r H_0 + \Delta aT + \frac{\Delta b}{2}T^2 + \frac{\Delta c}{3}T^3$$

$C_p(\text{rxn})$	$C_p(\text{NH}_3)$	$C_p(\text{H}_2)$	$C_p(\text{N}_2)$
-31.205	25.89	29.07	26.98
0.0308795	3.26E-02	-8.37E-04	5.91E-03
-5.8952E-06	-3.05E-06	2.01E-06	-3.38E-07

T
 $T^2/2$
 $T^3/3$

$H_f^0(298)$ -4.61E+04 0.00E+00 0.00E+00 Joules

$\int(C_p(T)dT)$	$H(\text{NH}_3)$	$H(\text{H}_2)$	$H(\text{N}_2)$
1000	4.117E+04	2.932E+04	2.982E+04
350	1.101E+04	1.015E+04	9.800E+03
298	9.135E+03	8.643E+03	8.300E+03
Delta(1000-298)	3.203E+04	2.068E+04	2.152E+04

$\int(C_p)dt$ H_{rxn}
 $\text{N}_2 + 3\text{H}_2 = 2\text{NH}_3$ -1.950E+04 -1.117E+05

per mole of NH_3 -9.748E+03 -5.586E+04

Textbook= C_p Correction -9.753 -5.59E+04

-21905.91 14068.6384 -1912.87264

-9750.1442
 H_{rxn} -5.59E+04 Joules
 -55.86 kJ