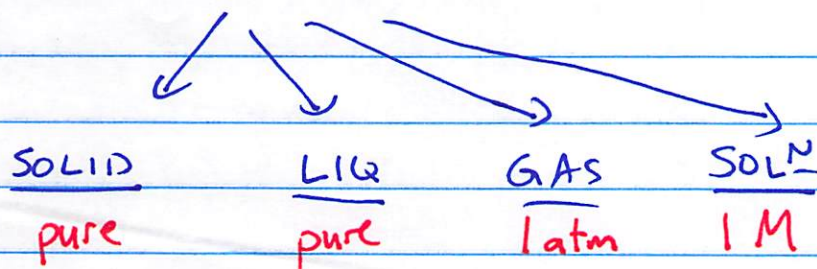


11/7/2018

Determining $\Delta H_{\text{rxn}}^{\circ}$ from standard enthalpies of formation, ΔH_f°

Can calculate $\Delta H_{\text{rxn}}^{\circ}$

$^{\circ}$ = standard conditions.



What's ΔH_f° ?

$\Delta H_{\text{rxn}}^{\circ}$ where we make/form 1 mol of a substance from its elements in their most stable form.

hydrogen: $\text{H}_2(\text{g})$ phosphorus: $\text{P}_4(\text{s})$
chlorine: $\text{Cl}_2(\text{g})$ sulfur: $\text{S}_8(\text{s})$
bromine: $\text{Br}_2(\text{l})$ sodium: $\text{Na}(\text{s})$
iodine: $\text{I}_2(\text{s})$
carbon: $\text{C}(\text{s, graphite})$
 ~~$\text{C}(\text{s, diamond})$~~

ex: $\Delta H_f^{\circ}(\text{CH}_4(\text{g}))$, refers to:

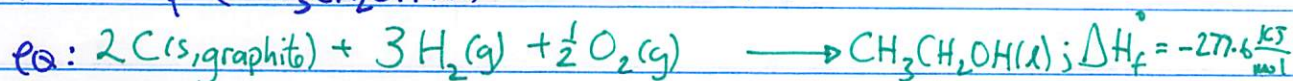
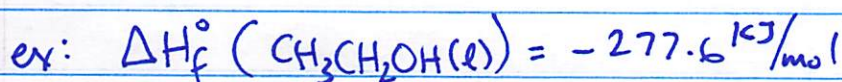


TABLE 6.5 Standard Enthalpies (or Heats) of Formation, ΔH_f° , at 298 K

Formula	ΔH_f° (kJ/mol)	Formula	ΔH_f° (kJ/mol)	Formula	ΔH_f° (kJ/mol)
Bromine		C ₃ H ₈ O(l, isopropanol)	−318.1	Oxygen	
Br(g)	111.9	C ₆ H ₆ (l)	49.1	O ₂ (g)	0
Br ₂ (l)	0	C ₆ H ₁₂ O ₆ (s, glucose)	−1273.3	O ₃ (g)	142.7
HBr(g)	−36.3	C ₁₂ H ₂₂ O ₁₁ (s, sucrose)	−2226.1	H ₂ O(g)	−241.8
Calcium		Chlorine		H ₂ O(l)	−285.8
Ca(s)	0	Cl(g)	121.3	Silver	
CaO(s)	−634.9	Cl ₂ (g)	0	Ag(s)	0
CaCO ₃ (s)	−1207.6	HCl(g)	−92.3	AgCl(s)	−127.0
Carbon		Fluorine		Sodium	
C(s, graphite)	0	F(g)	79.38	Na(s)	0
C(s, diamond)	1.88	F ₂ (g)	0	Na(g)	107.5
CO(g)	−110.5	HF(g)	−273.3	NaCl(s)	−411.2
CO ₂ (g)	−393.5	Hydrogen		Na ₂ CO ₃ (s)	−1130.7
CH ₄ (g)	−74.6	H(g)	218.0	NaHCO ₃ (s)	−950.8
CH ₃ OH(l)	−238.6	H ₂ (g)	0	Sulfur	
C ₂ H ₂ (g)	227.4	Nitrogen		S ₈ (s, rhombic)	0
C ₂ H ₄ (g)	52.4	N ₂ (g)	0	S ₈ (s, monoclinic)	0.3
C ₂ H ₆ (g)	−84.68	NH ₃ (g)	−45.9	SO ₂ (g)	−296.8
C ₂ H ₅ OH(l)	−277.6	NH ₄ NO ₃ (s)	−365.6	SO ₃ (g)	−395.7
C ₃ H ₈ (g)	−103.85	NO(g)	91.3	H ₂ SO ₄ (l)	−814.0
C ₃ H ₆ O(l, acetone)	−248.4	N ₂ O(g)	81.6		

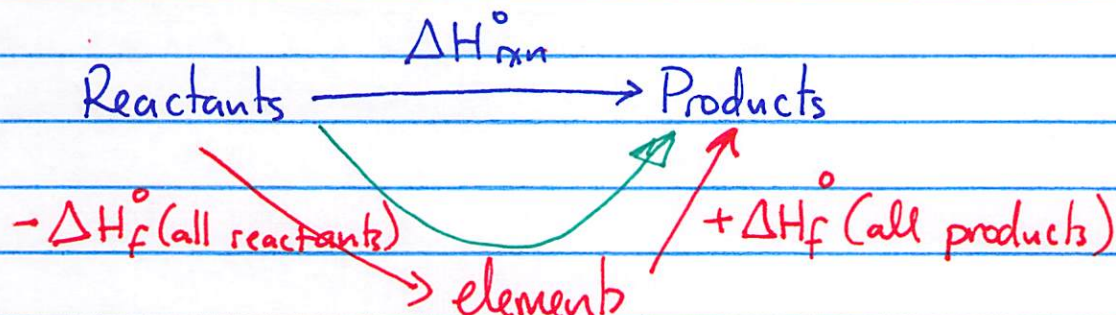
Table 6-5 lists ΔH_f° @ 298.15K (25 °C)

- Appendix III

ΔH_f° (most stable form of element) = 0

- Can calculate any ΔH_{rxn}° from ΔH_f° !

How?

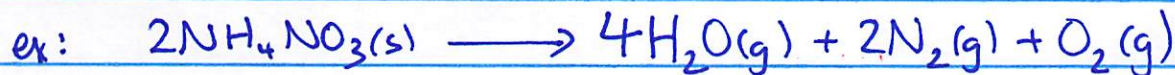


Can write as:

$$\Delta H_{rxn}^\circ = \sum_p n_p \cdot \Delta H_f^\circ (\text{products}) - \sum_r n_r \cdot \Delta H_f^\circ (\text{reactants})$$

#mol of each products #mol ea. reactant

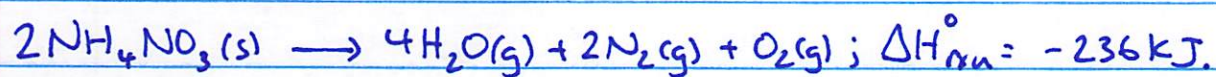
Sigma/Sum



$$\Delta H_{rxn}^\circ = \left[4\text{mol} \times \Delta H_f^\circ (\text{H}_2\text{O}(\text{g})) + 2\text{mol} \times \Delta H_f^\circ (\text{N}_2(\text{g})) + 1\text{mol} \times \Delta H_f^\circ (\text{O}_2(\text{g})) \right] - \left[2\text{mol} \times \Delta H_f^\circ (\text{NH}_4\text{NO}_3(\text{s})) \right]$$

$$= \left[4\cancel{\text{mol}} \times -241.8 \frac{\text{KJ}}{\cancel{\text{mol}}} \right] - \left[2\cancel{\text{mol}} \times -365.6 \frac{\text{KJ}}{\cancel{\text{mol}}} \right] = -236 \text{ KJ}$$

exothermic!



What's q_p is 20.2g NH_4NO_3 reacts?

$$20.2\text{g } \text{NH}_4\text{NO}_3 \times \frac{1 \text{ mol } \text{NH}_4\text{NO}_3}{80.05\text{g } \text{NH}_4\text{NO}_3} \times \frac{-236 \text{ kJ}}{2 \text{ mol } \text{NH}_4\text{NO}_3} = -29.8 \text{ kJ}$$

so, 29.8 kJ of heat
was given off

MAS 436.