LECTURE NOTES FOR GENERAL CHEMISTRY © 2007
CHAPTER C THERMOCHEMISTRY

ENDOTHERMIC: $\Delta H$ POSITIVE: $H_{\text{products}} > H_{\text{reactants}}$

EXOTHERMIC: $\Delta H$ NEGATIVE: $H_{\text{products}} < H_{\text{reactants}}$

$H$ IS ENTHALPY

AT CONSTANT PRESSURE, HEAT FLOW: $Q_p = H_{\text{products}} - H_{\text{reactants}} = \Delta H$

ENTHALPY IS A STATE FUNCTION

ENTHALPY IS FIXED WHEN “STATE” $(T, P)$ IS SPECIFIED

ENTHALPY OF A SUBSTANCE CHANGES WITH TEMP

$H$ OF 1 g $H_2O(l)$ AT 100°C – $H$ OF 1 g $H_2O(l)$ AT 0°C = 418 J

ALSO, PHASE CHANGES

$H$ OF 1 g $H_2O(s)$ AT 0°C – $H$ OF 1 g $H_2O(s)$ AT 0°C = 333 J

$H$ OF 1 g $H_2O(g)$ AT 100°C – $H$ OF 1 g $H_2O(g)$ AT 0°C = 2257 J

1 mol (18 g) $H_2O$ HAS 18X $H$ OF 1 g $H_2O$ (EXTENSIVE)

THERMOCHEMICAL EQUATIONS

$H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O$ $\Delta H = -285.8 \text{ KJ (EVO)}$

$HgO(s) \rightarrow Hg(l) + \frac{1}{2} O_2(g)$ $\Delta H = 90.7 \text{ KJ (ENDO)}$

1) (DOUBLE THESE COEFFICIENTS, MUST DOUBLE $\Delta H$)

2) $\Delta H$ FOR REVERSE REACTION IS EQUAL, BUT OPPOSITE SIGN OF FORWARD REACTION

3) $\Delta H$ IS INDEPENDENT OF # OF STEPS OVERALL (STATE FUNCTION)
\[ \text{Sm}(s) + 2 \text{Cl}_2(g) \rightarrow \text{SmCl}_4 \]

**THIS REACTION MIGHT TAKE 2 STEPS**

\[ \text{Sm}(s) + \text{Cl}_2(g) \rightarrow \text{SmCl}_2(s) \quad \Delta H = -349.8 \text{ KJ} \]
\[ \text{SmCl}_2(s) + \text{Cl}_2(g) \rightarrow \text{SmCl}_4(s) \quad \Delta H = -195.4 \text{ KJ} \]
\[ \text{Sm}(s) + 2\text{Cl}_2(g) \rightarrow \text{SmCl}_4(s) \quad \Delta H = -545.2 \text{ KJ} \]

**Hess's Law**

\( \Delta H \) FOR A REACTION IS THE SAME NO MATTER HOW MANY STEPS IT TAKES.

**\( \Delta H \) IN STOICHIOMETRY**

\[ \text{H}_2(g) + \text{Cl}_2(g) \rightarrow 2 \text{HCl}(g) \quad \Delta H = -184.6 \text{ KJ} \]

**UNIT RELATIONSHIPS**

\[ 1 \text{ mol H}_2 = -184.6 \text{ KJ} \]
\[ 1 \text{ mol Cl}_2 = -184.6 \text{ KJ} \]
\[ 2 \text{ mol HCl} = -184.6 \text{ KJ} \]

**WHAT IS THE ENTHALPY CHANGE WHEN 75.0 g HCl IS FORMED?**

\[ 75.0 \text{ g HCl} \times \frac{1 \text{ mol HCl}}{36.46 \text{ g HCl}} \times \frac{-184.6 \text{ KJ}}{2 \text{ mol HCl}} = 380 \text{ KJ} \]

**Calorimetry**

THE HEAT CAPACITY (\( C \)) OF A SYSTEM IS THE QUANTITY OF HEAT REQUIRED TO CHANGE THE TEMPERATURE OF A SYSTEM BY 1°C. UNITS ARE J/°C OR J/K
HEAT CAPACITY

CALCULATE THE HEAT CAPACITY OF AN IRON BLOCK THAT REQUIRES 1015 J TO WARM FROM 25°C TO 100°C.

\[ \begin{align*}
J &= 1015 \\
^\circ C &= 100^\circ C - 25^\circ C = 75^\circ C \\
C &= \frac{1015 \, J}{75^\circ C} = 14 \, \frac{J}{^\circ C}
\end{align*} \]

MORE USEFUL IS THE SPECIFIC HEAT

SPECIFIC HEAT IS THE HEAT CAPACITY OF 1 g OF SUBSTANCE

THE SPECIFIC HEAT OF \( H_2O \) = 4.18 \( \frac{J}{g \cdot ^\circ C} \)

IF THE IRON BLOCK ABOVE HAD A MASS OF 31 g, SPECIFIC HEAT = \( \frac{145}{31 \, g \cdot ^\circ C} = 0.45 \, \frac{J}{g \cdot ^\circ C} \)

MEASURING HEATS OF REACTION

A 1.23 g SAMPLE OF FUEL IS BURNED IN A BOMB CALORIMETER WITH A HEAT CAPACITY OF 7.45 KJ/°C. THE TEMP RISES FROM 21.80 TO 24.30°C.

WHAT IS THE HEAT OF COMBUSTION OF FUEL IN KJ/g?

\[ \frac{24.30^\circ C - 21.80^\circ C}{250^\circ C} \]

7.45 KJ °C \( \times \) 2.50°C = 18.6 KJ NEEDED

\[ \frac{18.6 \, KJ}{1.23 \, g \, \text{fuel}} = 15.1 \, KJ/g \text{ fuel} \]
CHAPTER 6

TOPICS

CONSERVATION OF ENERGY AND THE FIRST LAW

WORK WITH EXOTHERMIC AND ENDOThERMIC: $\Delta H^+$ AND $\Delta H^-$

USE ENTHALPY IN STOICHIOMETRIC CALCULATIONS

WORK WITH HEAT CAPACITY

WORK WITH SPECIFIC HEAT

DO CALORIMETRIC CALCULATIONS

WORK WITH HESS'S LAW, SUMMING $\Delta H$ FOR MULTISTEP REACTIONS

QUESTIONS

25, 27, 29

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51, 53

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