LECTURE NOTES FOR GENERAL CHEMISTRY ©2007 MM

CHAPTER 6 THERMOCHEMISTRY

ENDOTHERMIC: ΔH POSITIVE: $H_{PRODUCTS} > H_{REACTANTS}$

EXOTHERMIC: ΔH NEGATIVE: $H_{PRODUCTS} < H_{REACTANTS}$

H IS ENTHALPY

AT CONSTANT PRESSURE HEAT FLOW: $Q_p =$

$$Q_p = H_{PRODUCTS} - H_{REACTANTS} = \Delta H$$

ENTHALPY IS A STATE FUNCTION

ENTHALPY IS FIXED WHEN "STATE" (T, P) IS SPECIFIED

ENTHALPY OF A SUBSTANCE CHANGES WITH TEMP

$$H \text{ OF } 1g\ H_2O(l) \text{ AT } 100°C - H \text{ OF } 1g\ H_2O(l) \text{ AT } 0°C = 418J$$

ALSO, PHASE CHANGES

$$H \text{ OF } 1g\ H_2O(l) \text{ AT } °C - H \text{ OF } 1g\ H_2O(s) \text{ AT } 0°C = 333J$$

$$H \text{ OF } 1g\ H_2O(g) \text{ AT } 100°C - H \text{ OF } 1g\ H_2O(l) \text{ AT } 0°C = 2257J$$

1 MOL (18g) H_2O HAS 18X H OF 1g H_2O (EXTENSIVE)

THERMOCHEMICAL EQUATIONS

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

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

1) (DOUBLE THESE COEFFICIENTS, MUST DOUBLE ΔH)

2) ΔH FOR REVERSE REACTION IS EQUAL, BUT OPPOSITE SIGN OF FORWARD REACTION

3) ΔH IS INDEPENDENT OF # OF STEPS OVERALL (STATE FUCTION)

$Sm_{(s)} + 2\,Cl_{2\,(g)} \rightarrow SmCl_4$

THIS REACTION MIGHT TAKE 2 STEPS

$$Sm_{(s)} + Cl_{2(g)} \rightarrow SmCl_{2\,(s)} \quad \Delta H = -349.8\ KJ$$
$$SmCl_{2}(s) + Cl_2(g) \rightarrow SmCl_4(s) \quad \Delta H = -195.4\ KJ$$

$$Sm(s) + 2Cl_2(g) \rightarrow SmCl_4(s) \quad \Delta H = -545.2\ KJ$$

HESS'S LAW

ΔH FOR A REACTION IS THE SAME NO MATTER HOW MANY STEPS IT TAKES

ΔH IN STOICHIOMETRY

$$H_{2}(g) + Cl_{2}(g) \rightarrow 2\,HCl_{(g)} \quad \Delta H = -184.6\ KJ$$

UNIT RELATIONSHIPS

$1\ MOL\ H_2 = -184.6\ KJ$

$1\ MOL\ Cl_2 = -184.6\ KJ$

$2\ MOL\ HCl = -184.6\ KJ$

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

$$75.0\,g\,HCl \times \frac{1\,MOL\,HCl}{36.46\,g\,HCl} \times \frac{-184.6\ KJ}{2\ MOL\ HCl} = 380\ KJ$$

CALORIMETRY

THE HEAT CAPACITY (C) OF A SYSTEM IS THE QUANTITY OF HEAT REQUIRED TO CHANGE THE TEMP OF A SYSTEM BY $1^{\circ}C$

UNITS ARE $J/^{\circ}C$ 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.

$J = 1015$

$°C = 100° - 25° = 75°C$

$c = \frac{1015\ J}{75°C} = 14\ J/°C$

MORE USEFUL IS THE SPECIFIC HEAT

SPECIFIC HEAT IS THE HEAT CAPACITY OF 1g OF SUBSTANCE

THE SPECIFIC HEAT OF H_2O = $4.18 \frac{J}{g \cdot °C}$

IF THE IRON BLOCK ABOVE HAD A MASS OF 31g, SPECIFIC HEAT = $\frac{14\ J}{31g \cdot °C} = 0.45 \frac{J}{g \cdot °C}$

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 ?

$$\begin{array}{r} 24.30\ °C \\ -21.80\ °C \\ \hline 2.50\ °C \end{array}$$

SO, WATER TEMP GOES UP BY 2.50°C

$7.45 \frac{KJ}{°C} \times 2.50°C = 18.6\ KJ$ NEEDED

$\frac{18.6\ KJ}{1.23g\ \text{FUEL}} = 15.1\ KJ/g$ FUEL

CHAPTER 6

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