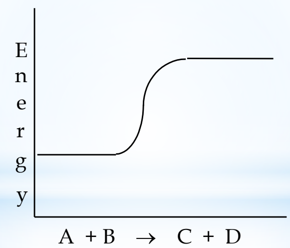
* Enthalpy & Thermodynamics

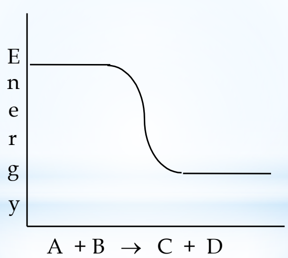
* Endothermic - energy is absorbed, surrounding temperature decreases

A + B + Energy → C + D



* Exothermic - energy is released (given off), surrounding temperatures increases

A + B → C + D + Energy



* Enthalpy (H)

* Heat released or absorbed during a constant pressure process
* ΔH_{rxn} = change in enthalpy during a reaction
  * reflects the differences in the potential energies associated with bonds in the reactants compared to bonds in the products

* Example:

2H atoms → H_2 molecule + energy ΔH_{rxn}

* The total PE of the nuclei and electrons in the H_2 molecules is less than the total PE of the nuclei and electrons in the two separate H atoms
* Also, if the same amount of energy is added to a H_2, it can break the molecule into 2 separate H atoms

* How can the enthalpy of a reaction be calculated?
  * Enthalpy of a *free element* is *zero*, at STP
    * STP = Standard Temperature (25°C = 278 K) & Standard Pressure (1 atm)
  * Enthalpy of a *compound* can be found in tables (p. 1100 – Appendix C)

*Heat of Formation

*change in enthalpy when one mole of a compound is produced from free elements

ΔH_f°

change enthalpy formation STP

- Ex: water ΔH_f° = - 286 kJ/mol exothermic (-ΔH)

  for the reaction: $H_2 + ½O_2 \rightarrow H_2O$

More Examples

*H_3PO_3

$\frac{3}{2}H_2 + P + \frac{3}{2}O_2 \rightarrow H_3PO_3$ ΔH_f° = -964 kJ/mol

*$NaHCO_3$

$Na + \frac{1}{2}H_2 + C + \frac{3}{2}O_2 \rightarrow NaHCO_3$ ΔH_f° = -947.7 kJ/mol

*There will **always** be a coefficient of '1' on the product side (compound) in all heat of formation equations

*Heat of Reaction

ΔH = change in enthalpy for a reaction

$$\Delta H^\circ_{rxn} = H^\circ_{products} - H^\circ_{reactants}$$

endothermic - ΔH is positive

exothermic - ΔH is negative

Ex: Calculate the heat of reaction for:

$$2\,H_2O_{(l)} \rightarrow 2\,H_{2(g)} + O_{2(g)}$$

-286kJ/mol 0 0

ΔH = ???

$$\Delta H^\circ = [2(0) + 0] - 2(-286)$$
$$= 0 - (-572)$$
$$= 572 \text{ kJ}$$

Ex: Calculate the heat of reaction for:

$$2\,NaClO_3(s) \rightarrow 2\,NaCl(s) + 3\,O_2(g)$$

-358 kJ/mol -411 0

ΔH = ???

$$\Delta H^\circ = [2(-411) + 0] - 2(-358)$$
$$= 822 - (-716)$$
$$= -106 \text{ kJ}$$

*Thermochemical Equation

shows both the balanced equation and the ΔH

$$2\,NaClO_3(s) \rightarrow 2\,NaCl(s) + 3\,O_2(g)$$

ΔH = -106 kJ

*A chemical reaction would include only the top line!!

Ex: How much energy is released if 18 g of $NaClO_3$ decomposes by the reaction shown above?

More Examples (p.206 #45)

$Ag^{+}_{(aq)} + Cl^{-}_{(aq)} \rightarrow AgCl_{(s)} \quad \Delta H = -65.5\ kJ$

a) Calculate ΔH when 0.45 mol AgCl produced.

b) Calculate ΔH when 9.00 g AgCl produced.

c) Calculate ΔH when 9.25×10^{-4} mol AgCl dissolves.