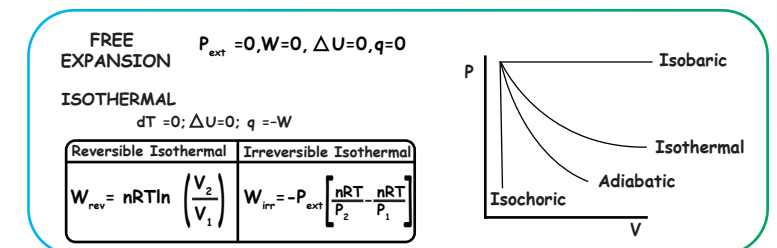
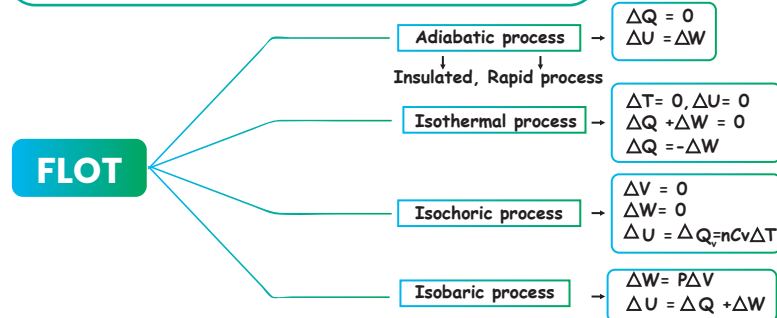
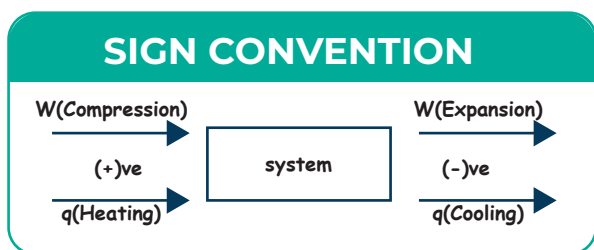


FIRST LAW OF THERMODYNAMICS

(Based on Law of conservation of energy)

$$\Delta U = \Delta q + \Delta W$$



Spontaneity

ENTHALPY

$$\Delta H = \Delta U + \Delta n_g RT$$

$$\Delta n_g = 0, \Delta H = \Delta U$$

$$\Delta n_g > 0, \Delta H > \Delta U$$

$$\Delta n_g < 0, \Delta H < \Delta U$$

All exothermic process are spontaneous

ENTROPY

$S_{\text{gas}} > S_{\text{liquid}} > S_{\text{solid}}$

ENTROPY CHANGE

1) Isothermal
 $\Delta S = nR \ln \frac{V_2}{V_1} = nR \ln \frac{P_1}{P_2}$

2) Isochoric ($P \propto T$)
 $\Delta S = nC_v \ln \frac{T_2}{T_1} = nC_v \ln \frac{P_2}{P_1}$

3) Isobaric
 $\Delta S = nC_p \ln \frac{T_2}{T_1} = nC_p \ln \frac{V_2}{V_1}$

$\Delta S_{\text{total}} > 0$, Spontaneous
 $\Delta S_{\text{total}} = 0$, Equilibrium
 $\Delta S_{\text{total}} < 0$, Non-spontaneous

GIBBS FREE ENERGY

$$\Delta G = \Delta H - T \Delta S$$

$$\Delta G < 0 \text{ Or } (-)\text{ve, Spontaneous}$$

$$\Delta G > 0 \text{ Or } (+)\text{ve, Non-spontaneous}$$

$$\Delta G = 0, \text{ Equilibrium}$$

Equilibrium Temperature

$$T_e = \frac{\Delta H}{\Delta S}$$

THERMODYNAMICS

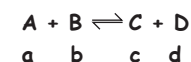
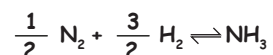
Chemical Thermodynamics and Energetics

1) Heat of Reaction (ΔH_{rxn})

$$\Delta H_{\text{rxn}} = \Delta H_{\text{products}} - \Delta H_{\text{reactants}}$$

2) Heat of Formation

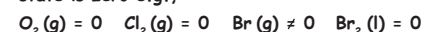
Heat Change in formation of 1 mole of substance at 298 K and 1 atm Pressure (standard enthalpy of formation)



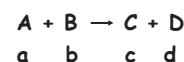
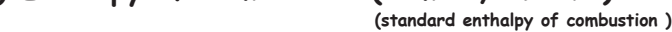
$$\Delta H_{\text{reaction}} = \text{Heat of formation of products} - \text{Heat of formation of reactants}$$

$$= (c + d) - (a + b)$$

Standard enthalpy of formation (298 K, 1 atm) of element at its standard state is zero e.g.,



3) Enthalpy of Combustion (1 mole, 298 K)

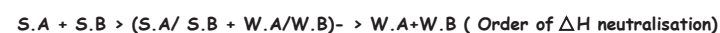
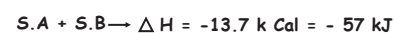


Enthalpy of combustion:

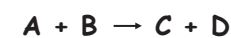
$$\Delta H_{\text{reaction}} = \text{Heat of combustion of reactants} - \text{Heat of combustion of products}$$

$$= (a + b) - (c + d)$$

4) Heat of Neutralisation ($\Delta H = (-)\text{ve}$)



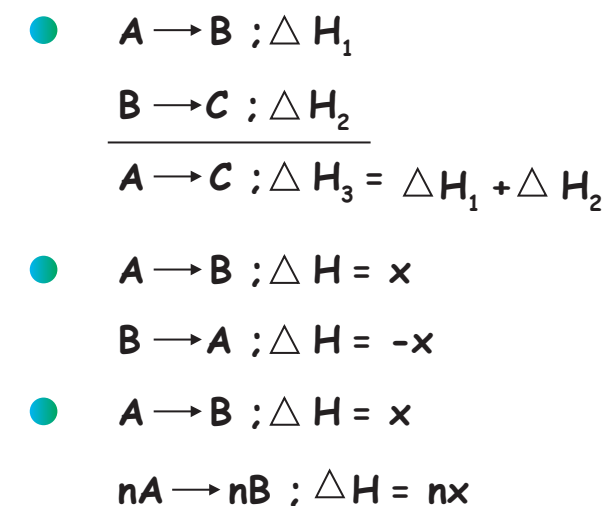
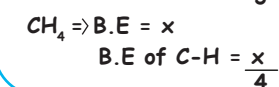
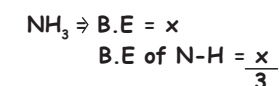
BOND ENERGY



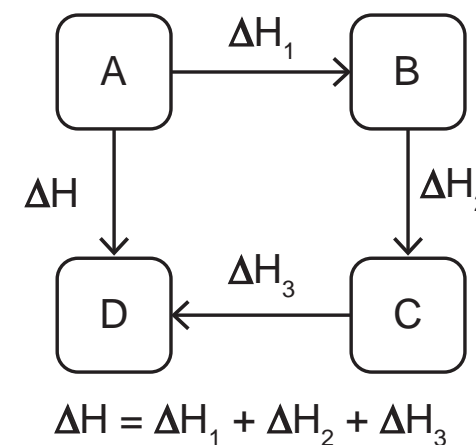
Bond energy: $\begin{matrix} a & b & c & d \end{matrix}$

$$\Delta H_{\text{reaction}} = \text{Bond energy of reactants} - \text{Bond energy of products}$$

$$= (a + b) - (c + d)$$



HESS' LAW OF CONSTANT HEAT SUMMATION



ΔH	ΔS	$\Delta G = \Delta H - T \Delta S$	Spontaneity.
(-)	(+)	Always Negative	Spontaneous at all temp
(+)	(-)	Always Positive	Non-spontaneous at all temperature.
(+)	(+)	+ve @ low temp. -ve @ high temp.	Non spontaneous at low temperature Spontaneous at high temperature
(-)	(-)	-ve @ low temp. +ve @ high temp.	Spontaneous at low temperature, $T < T_e$ Non spontaneous at high temperature