CONCEPT MAP

THERMODYNAMICS

First law

The energy of an isolated system is constant, $\Delta U = q + W$

Internal energy (U or E) : The energy stored within a substance.

$\Delta U = U_P - U_R$

Enthalpy (H) : The energy stored within the substance that is available for conversion into heat.

$H = U + PV$

Enthalpy change,

$\Delta H = \Delta U + P\Delta V$

Enthalpy of

- change of reaction ($\Delta_r H°$)
- combustion ($\Delta_c H°$)
- formation ($\Delta_f H°$)

$\Delta_r H° = \Sigma \Delta_f H_p° - \Sigma \Delta_f H_r°$

- neutralisation ($\Delta_{net} H$)
- solution ($\Delta_{sol} H$)
- atomization ($\Delta_a H°$)
- hydration ($\Delta_{hyd} H$)
- hydrogenation ($\Delta H_{hydrogenation}$)
- allotropic transformation ($\Delta H_{transform}$)
- fusion ($\Delta_{fus} H$)
- sublimation ($\Delta_{sub} H$)
- vaporisation ($\Delta_{vap} H$)
- Lattice enthalpy

$\Delta H_f^\circ = S + \frac{1}{2}D + I.E. + E.A. + U$

Heat capacity (C) : Amount of heat required to raise the temperature of the system through 1°C.

$C = q/\Delta T$

Heat capacity at constant volume (C_V)

$C_V = dU/dT$

Heat capacity at constant pressure (C_P)

$C_P = dH/dT$

Relationship

$C_P - C_V = R$

(for 1 mole of an ideal gas)

Specific heat (c) : Amount of heat required to raise the temperature of 1 g of the substance through 1°C.

$q = mc\Delta T$

Hess law : If a chemical reaction can be made to take place in a number of ways in one or in several steps, the total enthalpy change is always the same.

Second law

The entropy of the universe is continuously increasing.

Entropy : Measure of randomness or disorder of the system.

$\Delta S = \Sigma S_p - \Sigma S_r$

$\Delta S = q_{rev}/T$

Gibbs free energy (ΔG) is the net energy available to do useful work.

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

Spontaneity

Spontaneous process

ΔH = negative

ΔS = positive

ΔG = negative

$\Delta S_{total} = \Delta S_{system} + \Delta S_{surr} > 0$

Non-spontaneous process

ΔH = positive

ΔS = negative

ΔG = positive

Equilibrium

$\Delta S_{total} = 0$

$\Delta_r G = 0$

$\Delta_r G° = -RT \ln K$

Third law

The entropy of all perfectly crystalline solids may be taken as zero at the absolute zero of temperature.