$2PbS + 3O_2 \rightleftharpoons 2PbO + 2SO_2$, $\Delta H_{298} = -845.2\ kJ$

$2(-94.1) \quad 0 \quad 2x \quad 2(-297.1)$

Heat of reaction at 298K is (-845.2 kJ)

X ; KJ be the unknown heat content

$\Delta H_{298} = -845.2 = 2X - 594.1 - (-188.2 + 0)$

$= 2X - 594.1 + 188.2$

$\therefore x = -219.7\ KJ/mol$ of PbO

Heat of Combustion of a Substance

The enthalpy change when 1 mole of the substance (element or compound) is completely burnt in oxygen

Example

$Mg + \frac{1}{2}O_2 \rightleftharpoons MgO \qquad \Delta H_{298} = -602.5\ kJ$

$C + O_2 \rightleftharpoons CO_2 \qquad \Delta H_{298} = -393.7\ kJ$

Heat of Transformation (or L_t)

The change in enthalpy when 1 mole of a substance undergoes a specific physical change. This general term can be given the symbol (L_t), but is commonly described according to the transformation

Latent heat of fusion L_f → solid to liquid

= = evaporation L_e → liquid → gas

Heat of Solution

When one substance dissolves in another there will be a change in enthalpy. This is called the heat of solution.

Example

The reduction of haematite to magnetite, by carbon monoxide and finally the reduction of magnetite to iron

$\frac{3}{2}C + \frac{3}{2}O_2 \rightleftharpoons \frac{3}{2}CO_2 \qquad \Delta H = -591.6\ kJ$

$\frac{3}{2}CO_2 + \frac{3}{2}C \rightleftharpoons 3CO, \qquad \Delta H = +258.6\ kJ$

$Fe_2O_3 + \frac{1}{3}CO \rightleftharpoons \frac{2}{3}Fe_3O_4 + \frac{1}{3}CO_2 \qquad \Delta H = -17.6\ kJ$

$\frac{2}{3}Fe_3O_4 + \frac{8}{3}CO \rightleftharpoons 2Fe + \frac{8}{3}CO_2 \qquad \Delta H = -10.5\ kJ$

It will be seen that if all these eqns. are added together we have the overall reaction & according to Hess's law], the ∆H of the overall reaction will be the sum of the heats of reaction of the stages

∆H for the overall reaction = 258.6 − (591.6 + 17.6 + 10.5)

= −361.1 kJ

Example

Calculate the heat formation of $[Al_4C_3]$, when the heat reaction equal (−1035.4) k cal

O_2	CO_2	Al_2O_3	Al_4C_3
0	94.5 −	400 −	X

$Al_4C_3 + 6O_2 \longrightarrow 2Al_2O_3 + 3CO$

X 6*0 −2*400 −3*94.5

$\Delta H_{298} = 3\Delta HCO_2 + 2\Delta HAl_2O_3 - \Delta HAl_4C_3$

$-1035.4 = -282.2 - 800 - 0 - \Delta HAL_4C_3$

$\Delta H Al_4C_3 = -1082.2 + 1035.4 = -46.8$ k Cal.

Example

Calculate the standard heat of the reaction at (298k & 1 atm) for the reaction

$3FeO + 2Al \rightleftharpoons Al_2O_3 + 3Fe$

for each molecular for the following: Al_2O_3 & Fe & FeO & Al and for each gram for [iron], if given

ΔH°_{298}, FeO = −63.3 kcal/mole

ΔH°_{298}, Al_2O_3 = −400 kcal/mole

The atomic weight for Fe = 56

Sol-

$\Delta H^\circ_{298} = \Sigma \Delta H^\circ_{298} P - \Sigma \Delta H^\circ_{298} R$

$= \Delta H_{298} Al_2O_3 + 3\Delta H_{298} Fe - 3\Delta H_{298} FeO - 2\Delta H_{298} Al$

$\Delta H_{298} = \Delta H_{298} Al_2O_3 + 3\Delta H_{298} FeO$

$= -400 - 3[-63.3]$

$= -210.1$ K Cal The standard heat of reaction

for one molecular from Al_2O_3 heat of reaction = −210.1 kcal/mole.

for 3 molecular fro Fe = = = $= \frac{-210.1}{3} = -70.3$ kcal/mole.

For 3 molecular from FeO the heat reaction $= -\frac{210.1}{3} = 70.3$ kcal/molecular

$=$ 2 $=$ $=$ Al $=$ $=$ $=$ $= -\frac{210.1}{2} = 105.05$ kcal/molecular

for Iron for each gram $= -\frac{70.03}{56}$

$= -1.255$ kcal/gram for Fe.

Example

The Standard

Calculate heat formation for lead oxide from Pb & O_2 at temp. 227 C° for the following formation :-

ΔH_{298} $PbO_{(s)} = -524$ kcal/mol

$C_{p,PbO_{(s)}} = 10.6 + 4 \times 10^{-3} T$ cal/deg/mole

$C_{p,Pb_{(s)}} = 5.63 + 2.33 \times 10^{-3} T$ cal/deg/mole

$C_{p,O_{(g)}} = 7.16 + 1.0 \times 10^{-3} T - 0.4 \times 10^{5} T^{-2}$ Cal/deg mol

Soln.

$Pb + O_2 \rightleftharpoons PbO$

$\Delta H_{298} = -524000$ Cal

$$\Delta H^{\circ}_{500(2,1)} = \Delta H^{\circ}_{298(2,1)} + \int_{298}^{500} [C_{p(P)} - C_{p(R)}]\, dT$$

$$= \Delta H_{298} + \int_{298}^{500} \left[(C_{p,PbO} - C_{p,Pb(s)} - \tfrac{1}{2} C_{p\,O}\right] dT$$

$$= -52400 + \int_{298}^{500} [(10.6 + 4 \times 10^{-3} T) - (5.63 + 2.33 \times 10^{-3} T) - \tfrac{1}{2}(7.16 + 1 \times 10^{-3} T$$

$$- 0.4 \times 10^{5} T^{-2})]\, dT$$