B.Sc chemistry (H). Part-I

Paper - I(A)

Topic :- Thermochemistry :- (Hess's law)

Hess's Law of Constant heat summation :-

ΔE and ΔH are functions of the state of the system, the heat evolved or absorbed in a given reaction must be independent of the manner in which the reaction happens. So, it depends only on the initial and final states of the system and not on the steps in which the change takes place. This generalisation is known as Hess's Law.

Hess's Law :- If a chemical change can be made to take place in two or more different ways wether in one step or two steps or more steps, the amount of total heat change is same no matter by which method the change is brought about.

Let us suppose that a substance A can be changed to Z directly

$$A \longrightarrow Z + Q_1 \qquad \Delta H_1 = -Q_1$$

Where Q_1 is the heat evolved in the direct change.

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when the same change is brought about in stages!-

$A \longrightarrow B + q_1$ $\quad \Delta H_2 = -q_1$

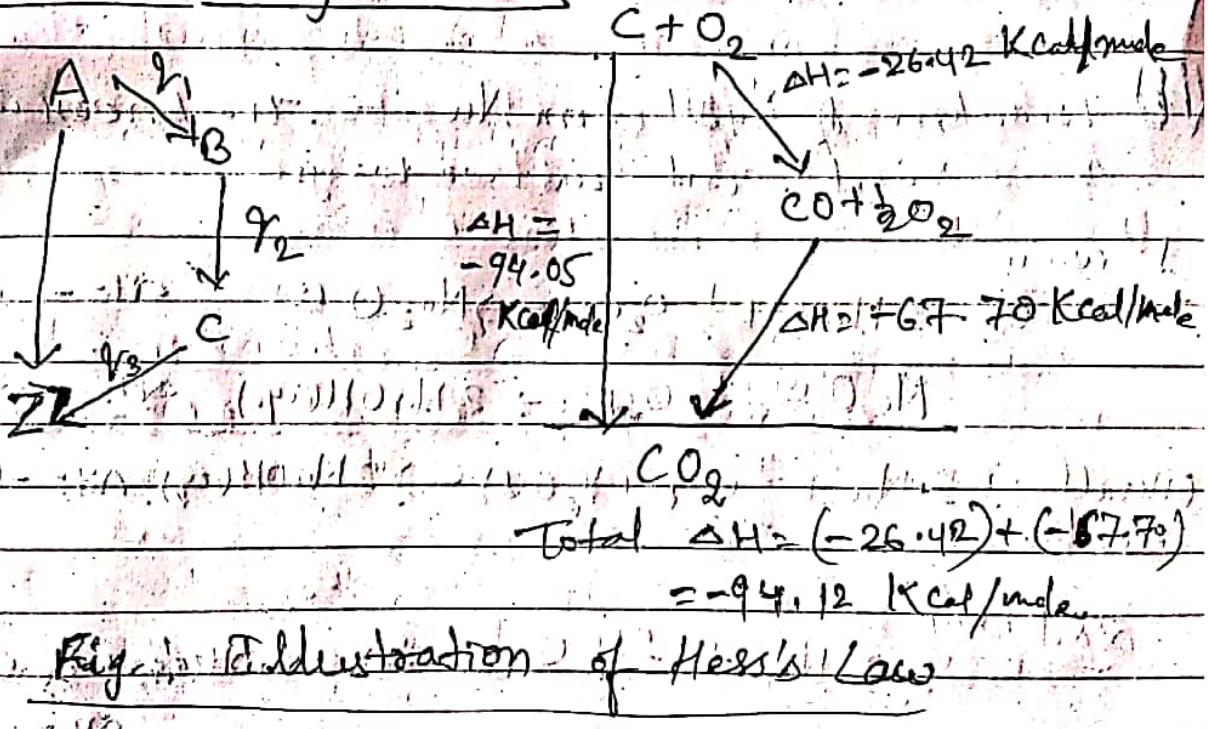
$B \longrightarrow C + q_2$ $\quad \Delta H_3 = -q_2$

$C \longrightarrow Z + q_3$ $\quad \Delta H_4 = -q_3$

The total heat evolved $= q_1 + q_2 + q_3 = Q_2$

According to Hess's Law $Q_1 = Q_2$

⇒ Illustration of Hess's Law!



Total $\Delta H = (-26.42) + (-67.70)$

$= -94.12$ Kcal/mole

Fig.:- Illustration of Hess's Law

(i) Burning of carbon to CO_2 :⇒ Carbon can be burnt directly to carbon dioxide (CO_2) or it may first be changed to carbon monoxide (CO) which may then be oxidised to carbon dioxide (CO_2)

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1st way $C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ $\Delta H = -94.05$ Kcal

2nd way $C_{(s)} + \frac{1}{2} O_{2(g)} \rightarrow CO_{(g)}$ $\Delta H = -26.42$ Kcal

$CO_{(g)} + \frac{1}{2} O_{2(g)} \rightarrow CO_{2(g)}$ $\Delta H = -67.70$ Kcal

overall change in 2nd way $2C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$ $\Delta H = -94.12$ Kcal

From these value this is clear that total heat energy evolved is the same in two cases.

(ii) formation of NaOH from Na :→ The process can be carried out in two ways.

1st way

$2Na_{(s)} + \frac{1}{2} O_{2(g)} \rightarrow Na_2O_{(s)}$ $\Delta H = -100$ kcal

$Na_2O_{(s)} + H_2O_{(l)} \rightarrow 2NaOH_{(aq)}$ $\Delta H = -56$ kcal

overall reaction :- $2Na_{(s)} + \frac{1}{2} O_{2(g)} + H_2O_{(l)} \rightarrow 2NaOH_{(aq)}$ $\Delta H = -156$ Kcal

2nd way

$2Na + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$ $\Delta H = -88$ Kcal

$H_{2(g)} + \frac{1}{2} O_{2(g)} \longrightarrow H_2O_{(l)}$ $\Delta H = -68.5$ Kcal

overall reaction :- $2Na + 2H_2O_{(l)} + \frac{1}{2} O_{2(g)} \rightarrow 2NaOH_{(aq)}$, $\Delta H = -156.5$ Kcal

It may be observed that the total heat evolved in the reaction by two different ways is the same.

It is also clear from above examples, that thermochemical equations may be multiplied, added or subtracted like ordinary algebric equations.

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