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Class \Rightarrow B.Sc. Part I Subsidiary
 Subject \Rightarrow Chemistry
 Chapter \Rightarrow 2 (Group A) Thermochemistry
 Topic \Rightarrow Hess's Law of constant heat summation

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Hess's Law of constant heat summation

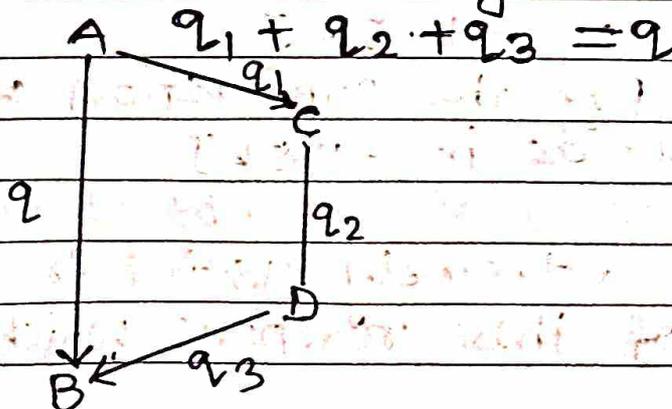
Hess's law states that the amount of heat evolved or absorbed in a process, including a chemical change, is the same whether the process takes place in one or several steps.

Suppose in a process, the system changes from state A to state B in one step and the heat exchanged in this change is q

Now suppose the system changes from state A to state B in three steps involving a change from A to C, C to D and finally from D to B.

If q_1 , q_2 and q_3 are the heats exchanged in the first, second and third step respectively.

Then according to Hess's Law,



(2)

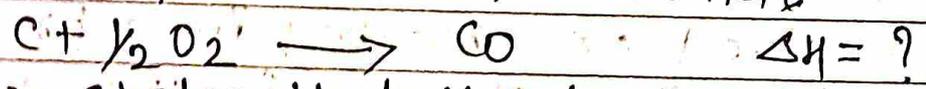
This generalisation means, in effect, that the enthalpy of reaction depends only on the initial reactants and final products and not at all on the intermediate products that may be formed.

Applications of Hess's law

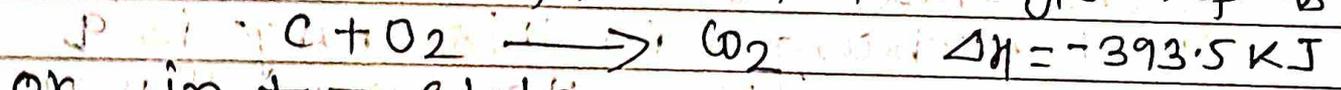
1. Calculation of enthalpy of reactions. \Rightarrow

Hess's law makes it possible to calculate enthalpies of many reactions which cannot be determined experimentally.

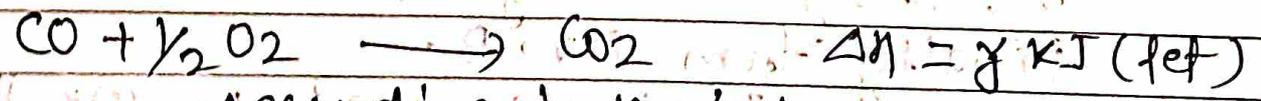
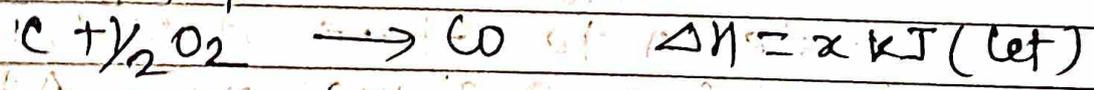
e.g. It is extremely difficult to measure the heat evolved when carbon burns in oxygen to form carbon monoxide.



Hess's law states that the heat evolved in the combustion of 1 mole of carbon is the same (393.5 kJ) (i.e. $\Delta H = -393.5$ kJ) whether the reaction takes place in a single step as



or, in two steps:



According to Hess's law

$$x + y = -393.5 \text{ kJ}$$

$$\text{or } x = -393.5 - y$$

$$= -393.5 - (-282.0) \quad (\text{measure } y \text{ value})$$

$$= -111.5 \text{ kJ}$$

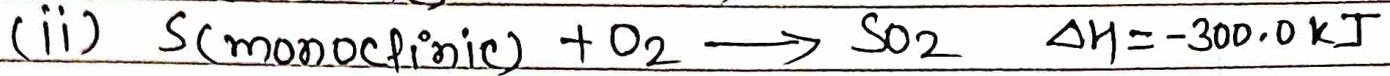
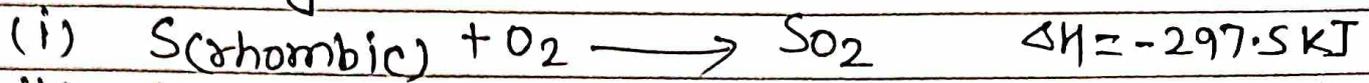
Thus ΔH for the combustion of carbon to give carbon monoxide is -111.5 kJ

2. Determination of enthalpy of slow reactions. \Rightarrow

Hess law is extremely useful in determining enthalpies of those reactions which take place

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extremely slowly,
e.g.



Subtracting (i) from (ii) and transposing, we get,



Thus, transformation of one mole of rhombic sulphur into monoclinic sulphur is accompanied by absorption of 2.5 kJ of heat.