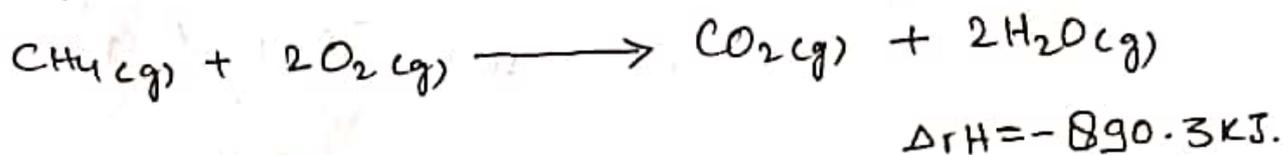


## Enthalpy changes of chemical Reactions: Reaction Enthalpy:

The enthalpy of reaction is defined as -  
The enthalpy change in a reaction when the number of moles of reactants react completely to give the product as given by the balanced chemical equation.

For example, the enthalpy change for the reaction of one mole of methane with two moles of water is oxygen to form one mole of  $\text{CO}_2$  and two moles of water is  $-890.3 \text{ kJ}$ .

Thus,



## Enthalpy changes of Reactions: In a reaction

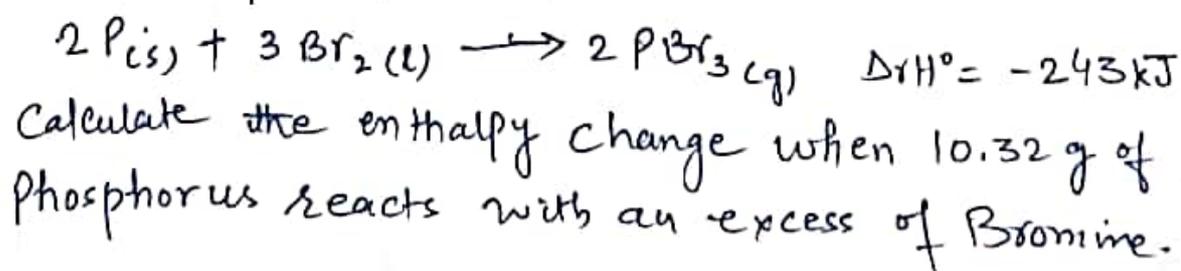
Reactants  $\longrightarrow$  Products

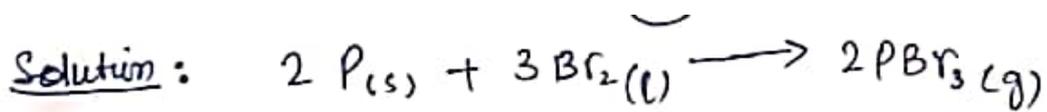
Enthalpy change of a reaction  $\Delta_r H$  is given by

$$\Delta_r H = \left[ \text{Sum of enthalpies of products} \right] - \left[ \text{Sum of enthalpies of reactants} \right]$$

$$\Delta_r H = \sum \alpha_i H_{\text{product}} - \sum \beta_i H_{\text{reactants}}$$

Ques. Red Phosphorus <sup>reacts</sup> with liquid bromine as:





$$\Delta_r H^\circ = -243 \text{ kJ mol}^{-1}$$

Molar mass of phosphorus =  $31 \text{ g mol}^{-1}$

$$\text{Mass of P} = 10.32 \text{ g}$$

$$\text{Moles of P} = \frac{10.32}{31} = 0.333 \text{ mol}$$

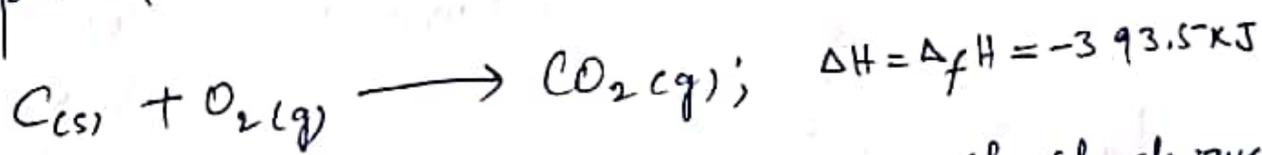
Enthalpy change for 2 moles of P =  $-243 \text{ kJ}$

$$\text{_____} \quad | \quad \text{_____} = -\frac{243}{2} \text{ kJ}$$

$$\text{_____} \quad 0.333 \quad \text{_____} = -\frac{243}{2} \times 0.333$$

$$= -40.46 \text{ kJ.}$$

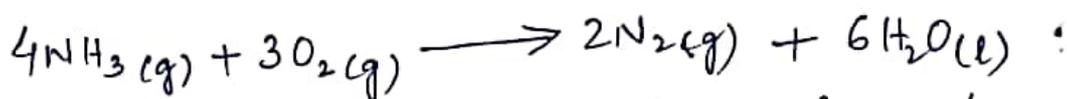
Enthalpy of formation: The enthalpy change when 1 mole of a substance is formed from its elements in their most stable forms is called enthalpy of formation. For example, the formation of  $CO_2$  ~~and~~ ~~may~~ be expressed as:



It may be noted that these equations should always be written as for one mole of the substance to be formed.

(18)

Que. Calculate the enthalpy change in the reaction:



at 298K given that the enthalpy of formation at 298K for  $\text{NH}_3(\text{g})$  and  $\text{H}_2\text{O}(\text{l})$  are  $-46.0$  and  $-286.0 \text{ kJ mol}^{-1}$  respectively.

Solution.:  $\Delta_r H^\circ$  for the reaction,



$$\Delta_r H^\circ = \Delta_f H^\circ(\text{product}) - \Delta_f H^\circ(\text{reactants})$$

$$\Delta_r H^\circ = \{6\Delta_f H^\circ[\text{H}_2\text{O}(\text{l})] + 2\Delta_f H^\circ[\text{N}_2(\text{g})]\} - \{4\Delta_f H^\circ[\text{NH}_3(\text{g})] + 3\Delta_f H^\circ[\text{O}_2(\text{g})]\}$$

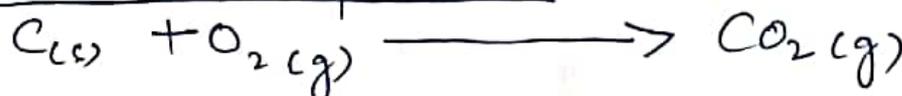
$$\Delta_r H^\circ = \{6 \times (-286) + 0\} - \{4 \times (-46) + 0\}$$

$$\Delta_r H^\circ = -1716 + 184$$

$$\Delta_r H^\circ = -1532 \text{ kJ}$$

Enthalpy of Combustion: The enthalpy change when 1 mole of a substance is completely burnt in excess of oxygen or air is called enthalpy of combustion. for example.

① Combustion of Carbon



$$\Delta H = \Delta_c H = -393.5 \text{ kJ}$$

② Combustion of methane.



$$\Delta H = \Delta_c H = -890.3 \text{ kJ}$$