

Chapter 1

1. Endothermic and Exothermic Reactions

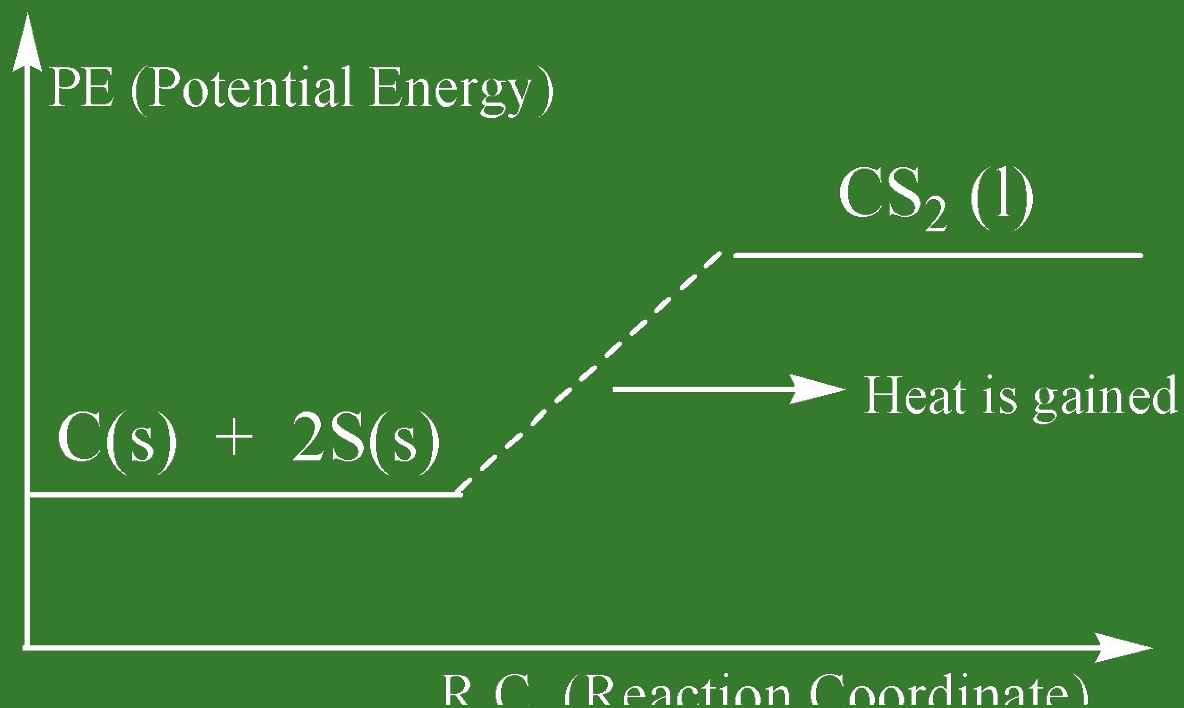
- **Thermo chemistry** is the study of heat changes that accompany chemical reactions and phase changes.
- In chemical reactions energy is either absorbed or released. According to this there are two types of reactions; **endothermic** and **exothermic**.
 - a. Endothermic Reactions**
 - Energy is absorbed by reactants and total potential energy of reactants is smaller than that of products.

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1. Endothermic and Exothermic Reactions



The reaction above is an example for endothermic reactions.

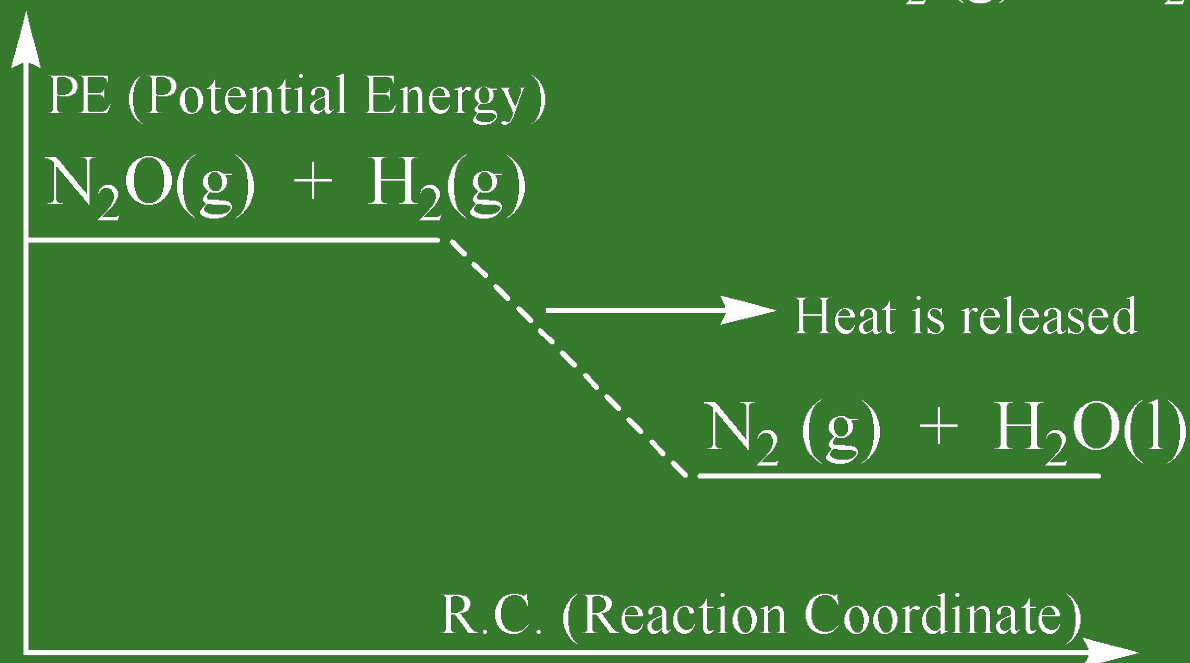


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1. Endothermic and Exothermic Reactions

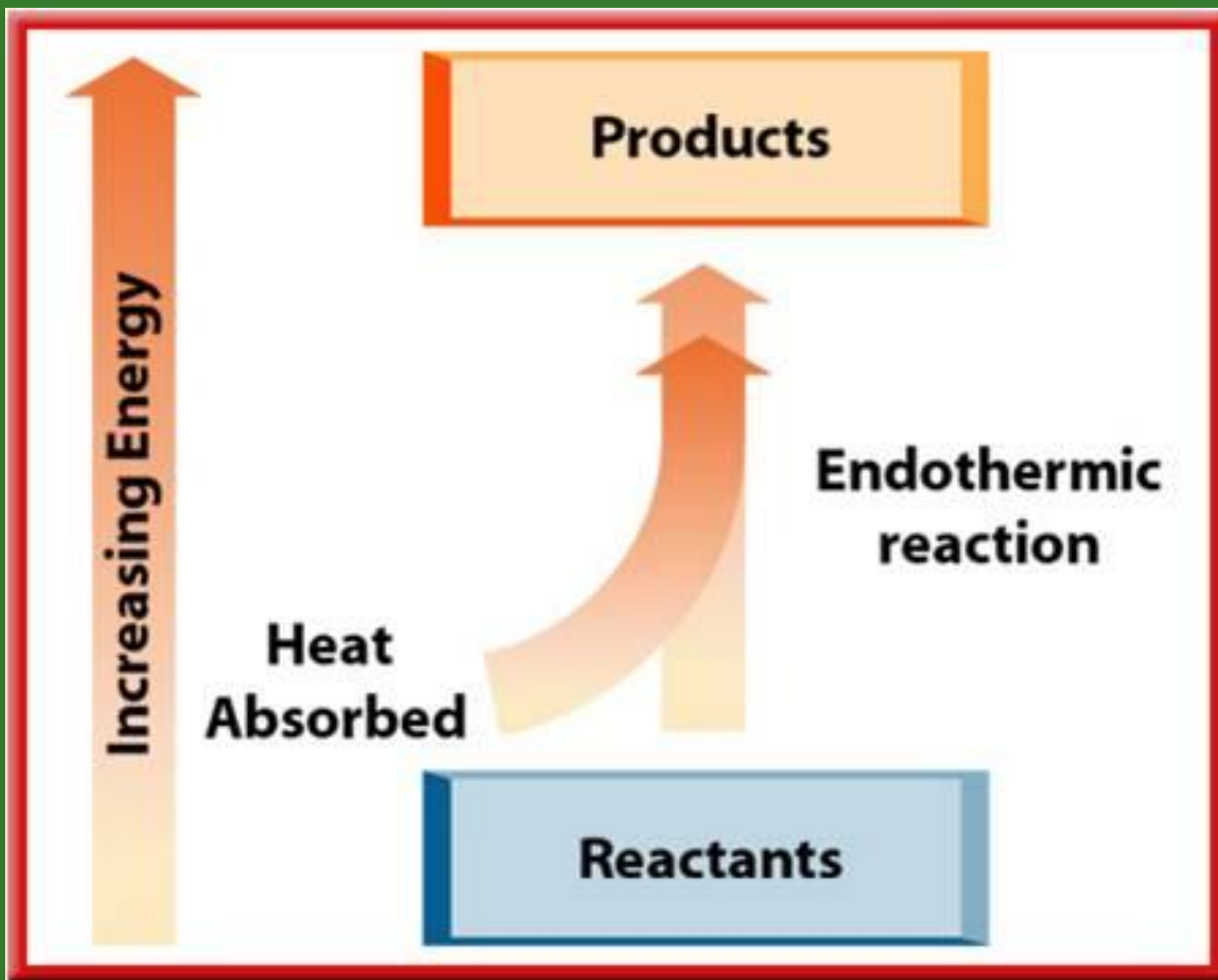
b. *Exothermic Reactions*

- Energy is released by reactants and total potential energy of reactants is greater than that of products.



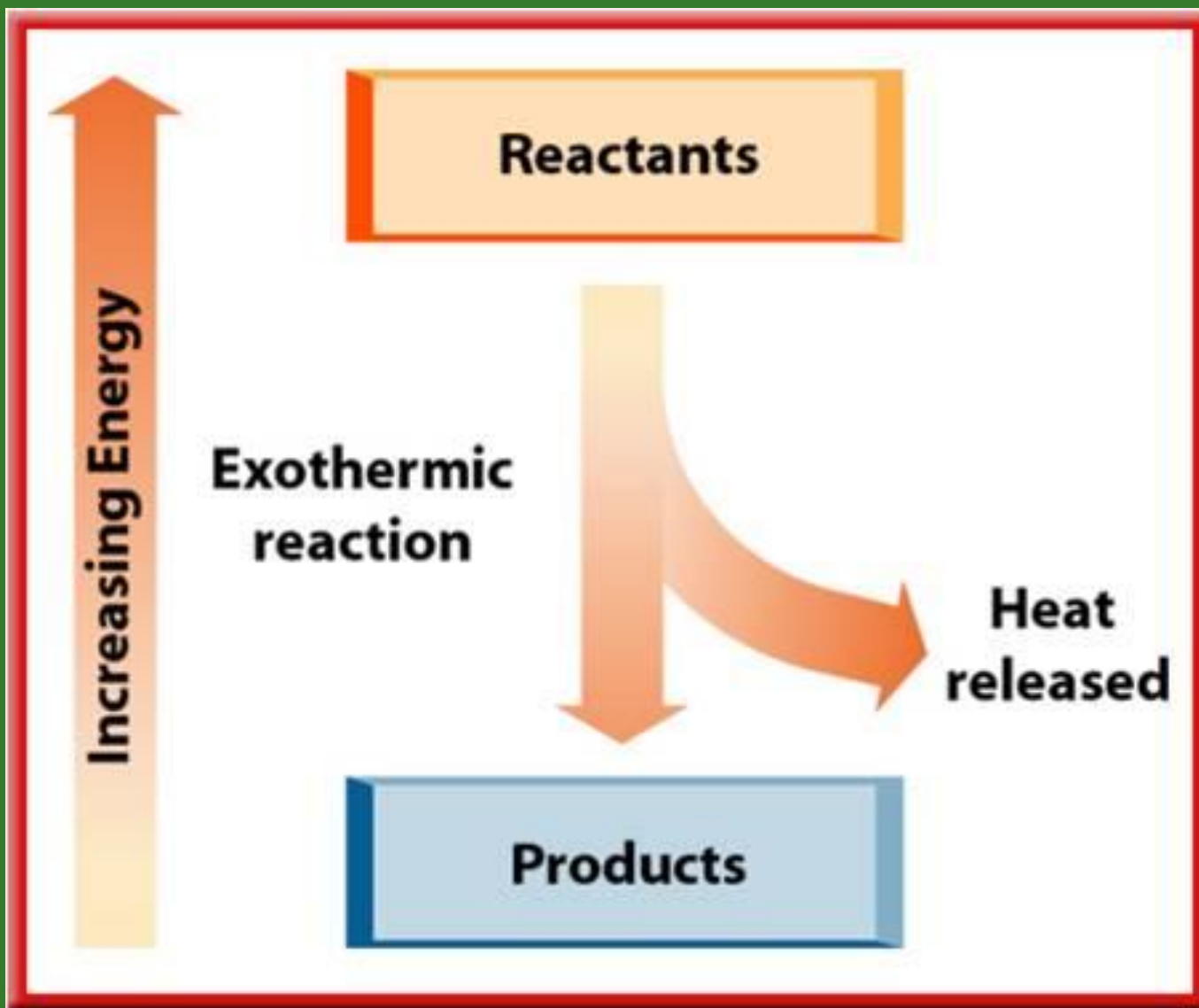
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1. Endothermic and Exothermic Reactions



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2. Enthalpy Change of Reactions (ΔH)

- Enthalpy (H) is the heat content of a substance at constant pressure.
- The change in enthalpy for a reaction is called the enthalpy of reaction (ΔH).

$$\Delta H = \sum H_{\text{products}} - \sum H_{\text{reactants}}$$

- If $\sum H_{\text{products}} > \sum H_{\text{reactants}}$, then $\Delta H > 0$ so the reaction is endothermic. Similarly,
- If $\sum H_{\text{products}} < \sum H_{\text{reactants}}$, then $\Delta H < 0$ so the reaction is exothermic.

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2. Enthalpy Change of Reactions (ΔH)

Enthalpy Changes for Exothermic and Endothermic Reactions

Type of reaction	Sign of ΔH_{rxn}
Exothermic	Negative
Endothermic	Positive

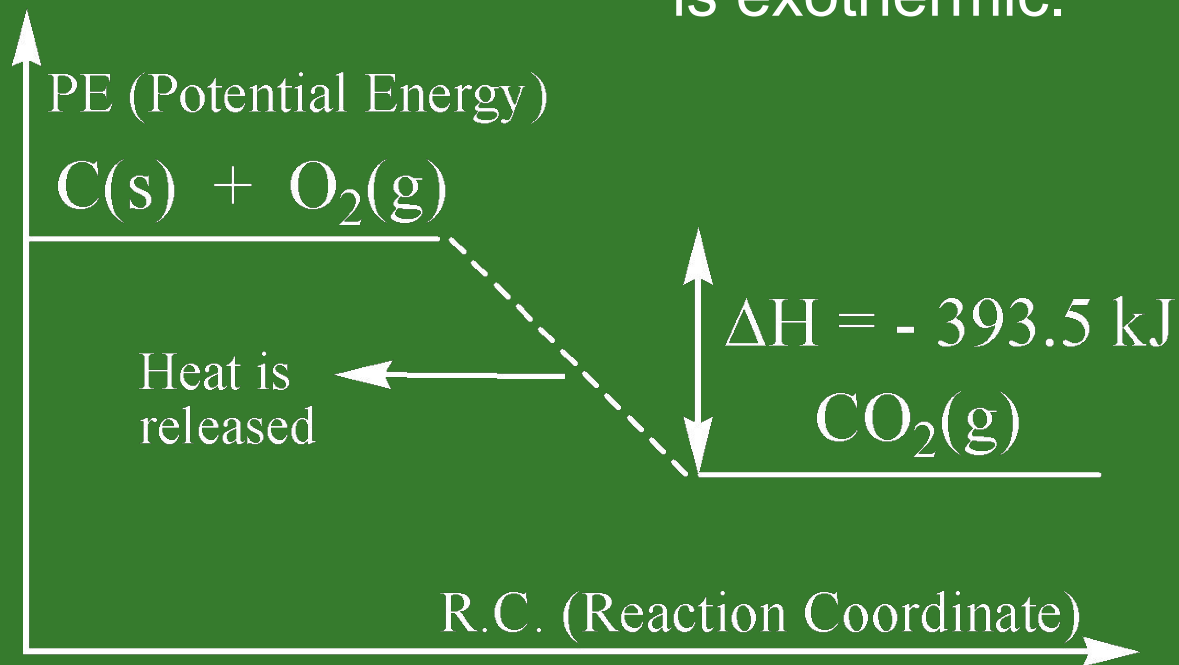
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2. Enthalpy Change of Reactions (ΔH)

Example 1



$\Delta H = - 393.5 \text{ kJ} < 0$ then the reaction is exothermic.



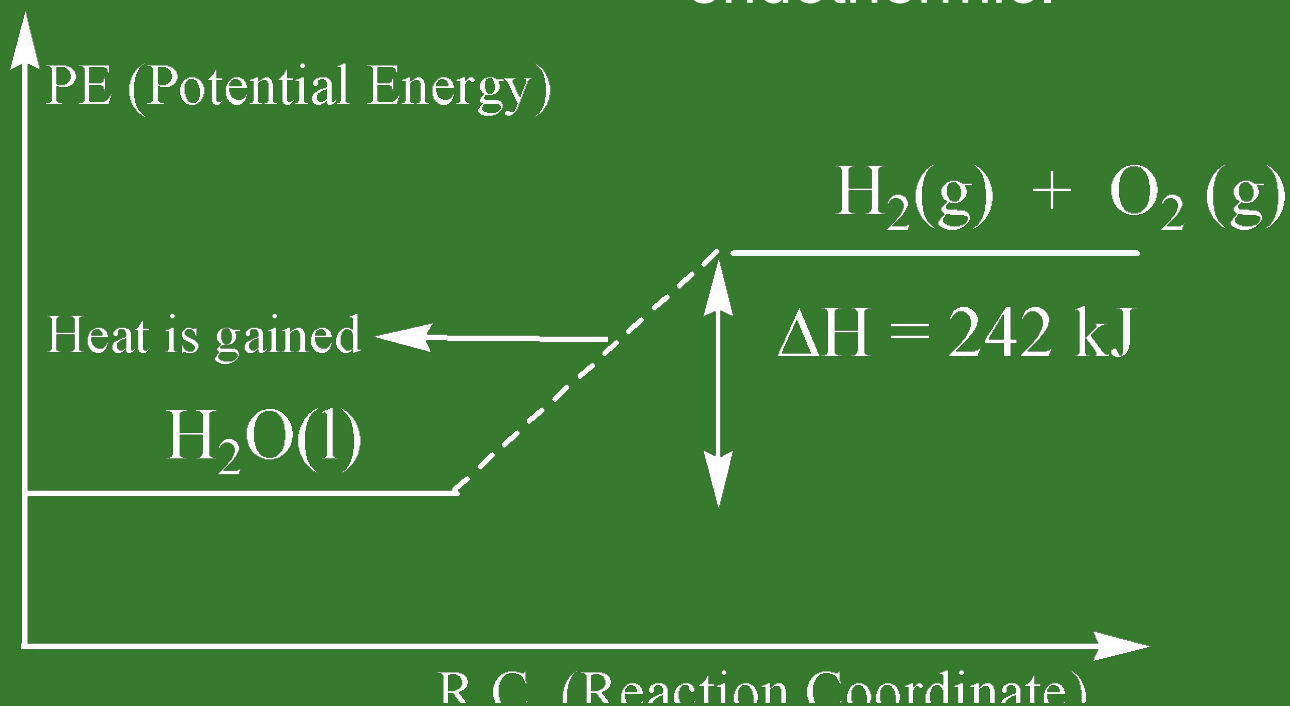
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2. Enthalpy Change of Reactions (ΔH)

Example 2



$\Delta H = 242 \text{ kJ} > 0$ then the reaction is endothermic.



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2. Enthalpy Change of Reactions (ΔH)

Standard Heat of Formation (ΔH°_f)

- The heat change when 1 mole compound is produced from its elements in their most stable states (under 1 atm pressure and at 25°C is called as **standard heat of formation**, and shown by ΔH°_f .
- ΔH°_f of the free atoms (K, Fe, Na, S, P, Cu...etc) and free simple molecules (O_2 , N_2 , Cl_2 , P_4 , ...etc) are accepted as zero.

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2. Enthalpy Change of Reactions (ΔH)

Heat of a reaction, ΔH° can be calculated by using ΔH°_f values.

$$\Delta H^\circ = \sum H^\circ_{f(\text{products})} - \sum H^\circ_{f(\text{reactants})}$$

Example 3

Find the heat of the reaction (ΔH°)



by using ΔH°_f of the compounds given

$$\Delta H^\circ_{f(\text{SO}_2)} = -297 \text{ kJ/mol}, \Delta H^\circ_{f(\text{SO}_3)} = -396 \text{ kJ/mol}$$

$$\Delta H^\circ_{f(\text{O}_2)} = 0 \text{ kJ/mol}$$

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2. Enthalpy Change of Reactions (ΔH)

Solution

$$\Delta H^\circ = \sum H^\circ_{f(\text{products})} - \sum H^\circ_{f(\text{reactants})}$$

$$\Delta H^\circ = \Delta H^\circ_{f(\text{SO}_3)} - [\Delta H^\circ_{f(\text{SO}_2)} + \frac{1}{2} \Delta H^\circ_{f(\text{O}_2)}]$$

$$\Delta H^\circ = (-396) - [(-297) + \frac{1}{2} \times (0)]$$

$$\Delta H^\circ = -99 \text{ kJ}$$

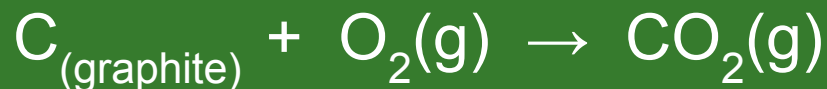
Example 4

When 2.4 g of graphite burnt with O_2 completely, 78.70 kJ heat is released. What is the molar enthalpy of the formation of CO_2 ?

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2. Enthalpy Change of Reactions (ΔH)

Solution



2.4 g C releases 78.70 kJ

12 g (1mol) C releases x

$$x = 393.5 \text{ kJ}$$

$$\Delta H^\circ = \sum H^\circ_{\text{f}(\text{products})} - \sum H^\circ_{\text{f}(\text{reactants})}$$

$$\Delta H^\circ = \Delta H^\circ_{\text{f}(\text{CO}_2)} - [\Delta H^\circ_{\text{f}(\text{C})} + \Delta H^\circ_{\text{f}(\text{O}_2)}]$$

$$-393.5 = \Delta H^\circ_{\text{f}(\text{CO}_2)} - [(0) + (0)]$$

$$\Delta H^\circ_{\text{f}(\text{CO}_2)} = -393.5 \text{ kJ}$$

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2. Enthalpy Change of Reactions (ΔH)

Example 5

The combustion reaction of propane is



If $\Delta H^\circ_{\text{f}(\text{CO}_2)}$ and $\Delta H^\circ_{\text{f}(\text{H}_2\text{O})}$ values are -393.5 kJ/mol and -286 kJ/mol respectively find $\Delta H^\circ_{\text{f}(\text{C}_3\text{H}_8)}$?

Example 6



If $\Delta H^\circ_{\text{f}(\text{Fe}_2\text{O}_3)}$, $\Delta H^\circ_{\text{f}(\text{CO})}$ and $\Delta H^\circ_{\text{f}(\text{CO}_2)}$ values are -826 kJ/mol , -110.5 kJ/mol and -393.5 kJ/mol respectively find ΔH° for the reaction.