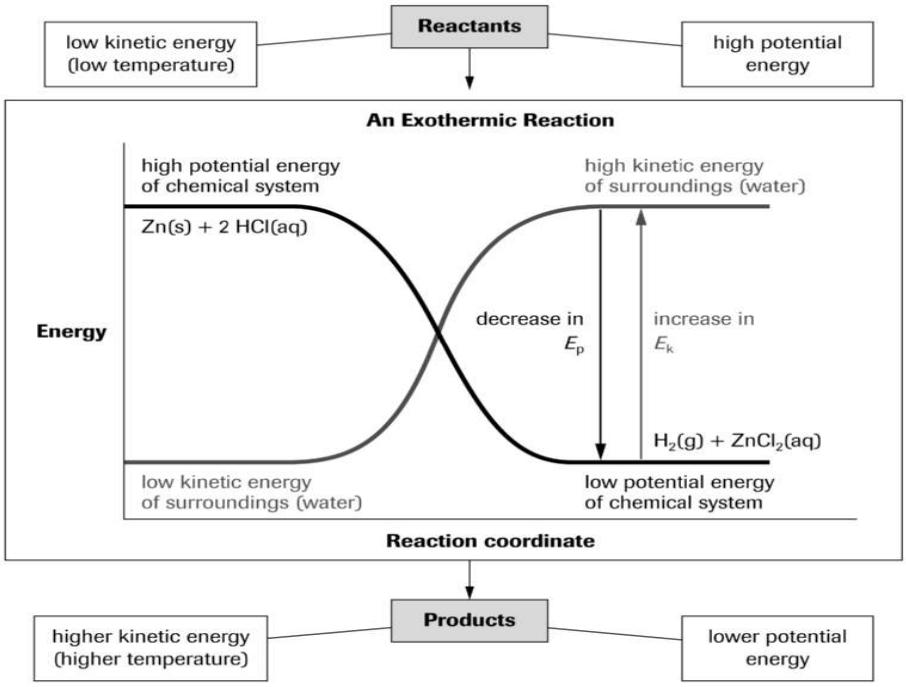
Energy Transfer Concept Diagram

Consider the following reaction: $Zn(s) + 2\,HCl(aq) \rightarrow H_2(g) + ZnCl_2(aq)$



During an exothermic chemical reaction, some of the potential energy is converted to kinetic energy, which then gets transferred.

MOLAR ENTHALPIES

Molar enthalpy of reaction

is the enthalpy change when one mole of a specified chemical undergoing a change in the system at constant pressure.

IUPAC symbol is $\Delta_r H$

Units are (kJ/mol)

If the mass or number of moles of the substance undergoing the change is known, then the energy change of reaction can be found using the following equation:

$\Delta H = n\,\Delta_r H$

Where:

ΔH - change of enthalpy (kJ)

n - chemical amount (mol)

$\Delta_r H$ - molar enthalpy of reaction (kJ/mol)

- If the reaction was combustion use $\Delta H = n\,\Delta_c H$

$Q = mc\Delta t$ (change in E_k)	$\Delta H = n\Delta_r H$ (change in E_p)

Example:

Predict the enthalpy change for the combustion of every 100 g of methane in a natural gas water heater producing water vapour. ($\Delta_c H\,(CH_4) = -802.5$ kJ/mol)

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Watch the video Hess' Law

HESS' LAW – PRINCIPLE OF ADDITIVITY OF REACTION ENTHALPIES

- The enthalpy absorbed or evolved in a given chemical reaction is independent of whether the reaction occurs in one step or in several steps. If the reaction occurs in several steps, the over-all heat of reaction will be the algebraic sum of the heats of the various steps.
- Furthermore, this heat of reaction will be numerically the same as that obtained if the reacting were carried out in one step.
- Thus heats of reaction may be calculated for reactions which do not lend themselves to direct experimental techniques.

Hess' Law
The amount of energy involved in a chemical reaction is the same whether the reaction occurs in one single step or in a series of smaller steps.

Example: -Determine the heat of reaction for the following reaction at SATP.

$C_{(s)} + 2H_2(g) \rightarrow CH_4(g)$ $\Delta H^\circ = ?$

Given the following equations:

1. $H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(l)$ $\Delta H^\circ = -286.0$ kJ
2. $C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H^\circ = -393.5$ kJ
3. $CH_4(g) + 2 O_2(g) \rightarrow CO_2(g) + 2 H_2O(l)$ $\Delta H^\circ = -890.8$ kJ

Rearrange the equations to give the desired reactants and products, altering ΔH° accordingly.

Leave equation 2 unchanged:

$C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H^\circ = -393.5$ kJ

Double equation 1:

$2 H_2(g) + O_2(g) \rightarrow 2 H_2O(l)$ $\Delta H^\circ = -572.0$ kJ

Reverse equation 3:

$CO_2(g) + 2 H_2O(l) \rightarrow 2O_2(g) + CH_4(g)$ $\Delta H^\circ = +890.8$ kJ

Add: $C(s) + 2 H_2(g) \rightarrow CH_4(g)$ $\Delta H^\circ = -74.7$ kJ

Example: Determine ΔH° for:

$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$ $\Delta H^\circ = ?$

1. $3C(s) + 4H_2(g) \rightarrow C_3H_8(g)$ $\Delta H^\circ = -103.8$kJ
2. $C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H^\circ = -393.5$kJ
3. $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g)$ $\Delta H^\circ = -241.8$kJ

Rewrite

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