Formation Reactions:

This reactions starts with elements only as reactants.
The reactants will form compounds as products.

elements ⇒ compound

Ex. $C_{(s)} + 2H_{2(g)}$ --> $CH_{4(g)}$ H_f

The molar enthalpy symbol for a formation reaction is $\mathbf{H_f}$.

Simple Decomposition Reactions:

This reaction starts as a compound, which decomposes into its elements.
(opposite of a formation reaction)

compound ⇒ elements

Ex. $CH_{4(g)}$ --> $C_{(s)} + 2H_{2(g)}$ $\Delta H_{SD} = -\Delta H_f$

The molar enthalpy symbol is $\mathbf{H_{SD}}$.

Combustion Reactions:

The reaction of a substance with excess oxygen to produce an oxide.

Ex. $C_{(s)} + O_{2(g)}$ --> $CO_{2(g)}$ ΔH_c

The molar enthalpy symbol is $\mathbf{H_c}$.

Molar Enthalpies

$\mathbf{H_f}$ - molar enthalpies of formation is the quantity of heat released or absorbed when one mole of a substance forms from its elements.

$\mathbf{H_c}$ - molar enthalpies of combustion is the quantity of heat released or absorbed when one mole of a substance reacts with oxygen.

$\mathbf{H^o}$ - standard molar enthalpy is the quantity of heat released or absorbed when one mole of a substance reacts at SATP

Enthalpy Change

ΔH_r - Enthalpy change is the quantity of heat released or absorbed when a reaction occurs. This may also be called "Heat of Reaction" or "Change in Heat".
⇒ must know the number of moles of a substance reacting to determine the enthalpy change

Molar enthalpy may be determined from the enthalpy change as long as the number of moles (n) are known.

$\Delta H_r = nH_r$

$H_2O_{(s)} \longrightarrow H_2O_{(l)}$ $\Delta H_{fus} = 6.03 kJ$

$H_2O_{(l)} \longrightarrow H_2O_{(s)}$ $\Delta H_{solid} = -6.03 kJ$

H_{fus} H_{solid}

H_{vap} H_{cond}

H_s

$\Delta H_r = nH_r$

Ex. $2SO_{2(g)} + O_{2(g)} \longrightarrow 2SO_{3(g)}$ $\quad SO_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow SO_{3(g)}$

$H^o = -98.79 kJ/mol$

How do we find the change in enthalpy of $SO_{2(g)}$??

$\Delta H_r = nH_r$

$\Delta H_r = (2\,mol)(-98.79\,\frac{kJ}{mol})$

$\Delta H_r = -197.58\,kJ$

$\Delta H_r = nH_r$

$\Delta H_r = (1\,mol)(-98.79\,\frac{kJ}{mol})$

$\Delta H_r = -98.79\,kJ$

$H_r = \Delta H_r / n$

COMMUNICATING ENTHALPY CHANGES

Using ΔH_r notation:
- for chemical reactions not well known, the chemical equation must accompany the enthalpy change. The molar enthalpy of reactic (or change in enthalpy) follows the equation. **For exothermic reactions the $\Delta H_r < 0$.**

Ex. $Mg_{(s)} + 1/2\ O_{2(g)} ==> MgO_{(s)}\ \ \Delta H_r = -601.6kJ$

The Enthalpy Change **(ΔH_r)** may be included as a term in the balanced equation:

$H_2O_{(l)} \longrightarrow H_{2(g)} + \frac{1}{2}O_{2(g)}\ \ \Delta H = 285.8\ kJ$

(i) In endothermic reactions - energy is reported as a reactant and is transformed in the reaction.

Ex. $H_2O_{(l)} + 285.8kJ \Rightarrow H_{2(g)} + 1/2O_{2(g)}$

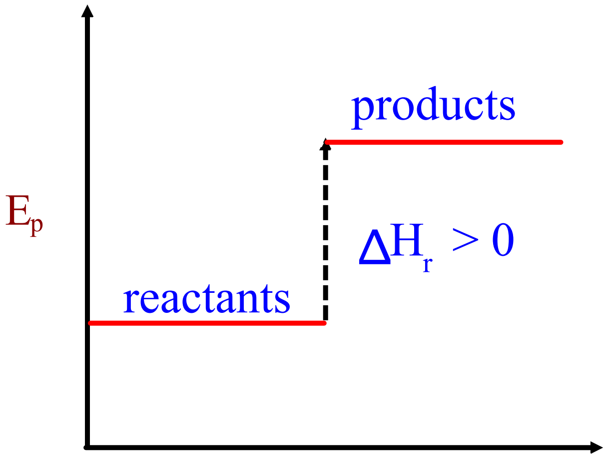
(ii) In exothermic reactions - energy is reported as a product since it is being produced. $Mg_{(s)} + \frac{1}{2}O_{2(g)} \longrightarrow MgO_{(s)}\ \ \Delta H_r = -601.6kJ$

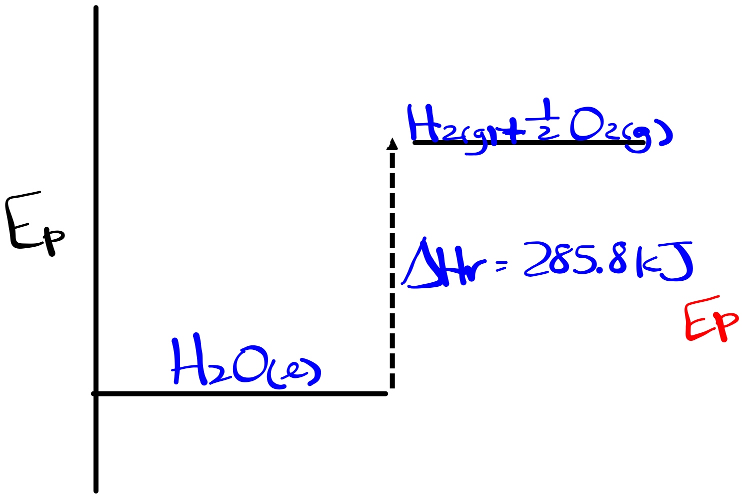
Ex. $Mg_{(s)} + 1/2\ O_{2(g)} \Rightarrow MgO_{(s)} + 601.6kJ$

POTENTIAL ENERGY DIAGRAMS

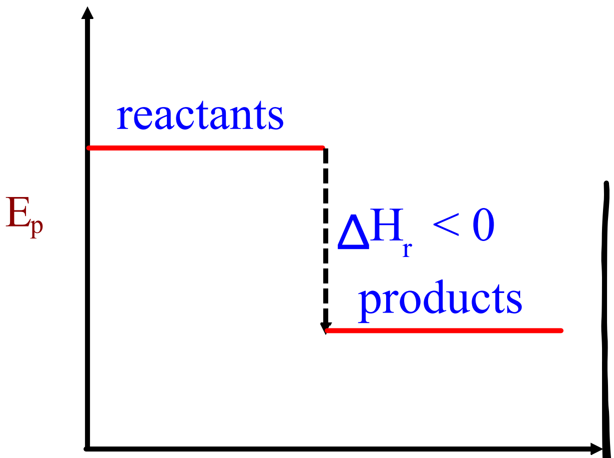
- may be used to express enthalpy change (ΔH_r)
- shows the potential energy of the reactants and products of a chemical reaction.
- shows the difference between the initial and final energies as the enthalpy change. (ΔH_r)

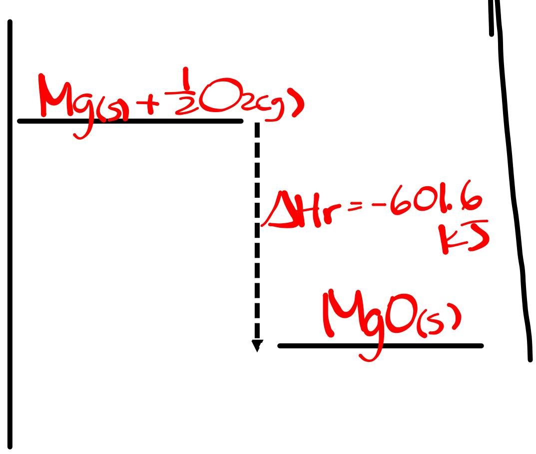
Endothermic Rxn





Exothermic Rxn





see Fig 11-8 p 373 (also 11-15,16,17)

For each of the following reactions:

(a) rewrite the equation including the enthalpy change as a term

(b) draw a potential energy diagram

(i) $C_6H_{12}O_{6(s)} + 6O_{2(g)} \longrightarrow 6CO_{2(g)} + 6H_2O_{(l)}$ $\Delta H^o = -2802.7kJ$

(ii) $CO_{2(g)} \longrightarrow C_{(s)} + O_{2(g)}$ $\Delta H_r = 393.5kJ$

(ii) $H_2O_{(l)} \longrightarrow H_{2(g)} + \frac{1}{2}O_{2(g)}$ $\Delta H^o = 285.8\ kJ$