Warm-Up!

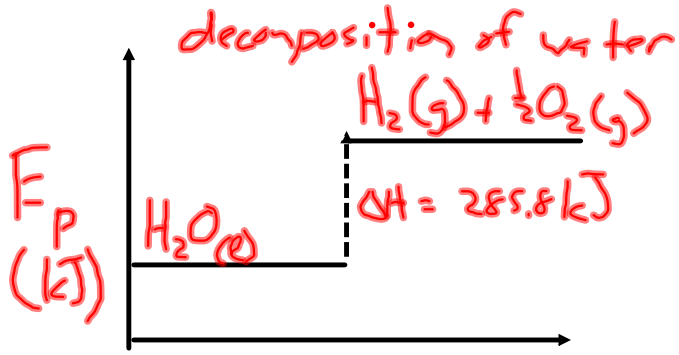
For the following reaction:
(a) rewrite the equation including the enthalpy change as a term
(b) draw a potential energy diagram

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

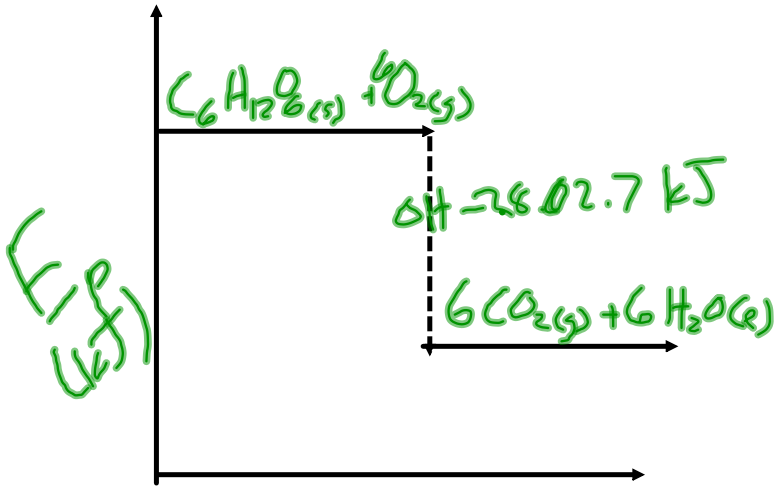
$C_6H_{12}O_{6(s)} + 6O_{2(g)} \rightarrow 6CO_{2(g)} + 6H_2O_{(l)} + 2802.7kJ$

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

$H_2O_{(l)} + 285.8kJ \rightarrow H_{2(g)} + \frac{1}{2}O_{2(g)}$



Combustion of glucose



Predicting Energy Changes using Hess's Law

Hess's Law - (Heat of Summation)

- allows for the determination of the enthalpy change of a reaction with direct use of calorimetry.

Rules:

- if a chemical equation is reversed, then the sign of the ΔH_r changes
- if the coefficients of a chemical equation are altered by multiplying or dividing by a constant factor, then the ΔH_r is altered in the same way

Ex. $C_{(s)} + O_{2(g)} \Rightarrow CO_{2(g)}$ $\Delta H = -393.5$ kJ

Ex: $C + O_2 \rightarrow CO_2$ $\Delta H = -393.5kJ$

① $CO_2 \rightarrow C + O_2$ $\Delta H = +393.5\ kJ$

② $2C + 2O_2 \rightarrow 2CO_2$ $\Delta H = -787.0\ kJ$

Example

$H_2O\,(g) + C\,(s) \rightarrow CO\,(g) + H_2\,(g)$

$\Delta H = ?$

Steps (found using calorimetry):

① $H_2\,(g) + 1/2\,O_2\,(g) \rightarrow H_2O\,(g) \quad \Delta H = -242.0\ kJ$

② $2CO\,(g) \rightarrow 2\,C\,(s) + O_2\,(g) \quad \Delta H = +221.0\ kJ$

rev ①

$H_2O_{(g)} \rightarrow H_2(g) + \frac{1}{2}O_2(g) \qquad \Delta H = 242.0\ kJ$

rev ② ÷ 2

$C(s) + \frac{1}{2}O_2(g) \rightarrow CO(g) \qquad \Delta H = -110.5\ kJ$

+

$H_2O_{(g)} + C(s) + \frac{1}{2}O_2(g) \rightarrow H_2(g) + \frac{1}{2}O_2(g) + CO(g)$

$\Delta H = 131.5\ kJ$

Calculate the heat released by the burning of sulfur in oxygen given the following steps:

$$2S(s) + 3O_2(g) \rightarrow 2SO_3(g) \qquad \Delta H = ?$$

Evidence:

① Step 1 $\quad S(s) + O_2(g) \rightarrow SO_2(g) \quad \Delta H = -297\ kJ$

② Step 2 $\quad 2SO_2(g) + O_2(g) \rightarrow 2SO_3(g) \quad \Delta H = -198\ kJ$

① x2

$2S(s) + 2O_2(g) \rightarrow 2SO_2(g) \quad \Delta H = -594\ kJ$

②

$+ \quad 2SO_2(g) + O_2(g) \rightarrow 2SO_3(g) \quad \Delta H = -198\ kJ$

$2S(s) + 3O_2(g) \rightarrow 2SO_3(g) \quad \Delta H = -792\ kJ$

Worksheet

$$6\,C_{(s)} + 6\,H_{2\,(g)} + 3\,O_{2\,(g)} \rightarrow C_6H_{12}O_{6\,(s)} \qquad \Delta H^\circ = ?$$

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

$H_{2\,(g)} + \frac{1}{2}O_{2\,(g)} \rightarrow H_2O_{(l)}$ $\Delta H^\circ = -285.8\,kJ$

$C_{(s)} + O_{2\,(g)} \rightarrow CO_{2\,(g)}$ $\Delta H^\circ = -393.5\,kJ$