Predicting Enthalpy Changes-Hess's Law

Not every reaction of interest can be studied by means of calorimetry.

Example: The rusting of iron

- products may vary. Example: The formation of carbon monoxide

$$C(s) + O_2 \rightarrow CO_2(g)$$

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In the event we want to determine an enthalpy change for a reaction, we can use predetermined reaction values.

This principle is known as Hess's Law of summation

$$\Delta H_{NET} = \Delta H_1 + \Delta H_2 + \Delta H_3 + ...$$

$$\Delta H_{NET} = \sum_{n=1}^{\infty} \Delta H_{RW}$$

Characteristics of Enthalpy Changes

- 1. If a reaction is reversed, the sign of ΔH is also reversed.
- If $H_2(g) + 1/2 O_2(g) \rightarrow H_2O(g)$ $\Delta H=-285.5 \text{ kJ}$ then the reverse is:

$$H_2O(g) \rightarrow H_2(g) + 1/2 O_2(g)$$

 $\Delta H = +285.5 \text{ kJ}$

- Ž. The magnitude of ∆H is directly proportional to the quantities of reactants and products in a reaction.
- If you <u>multiply the equation by a</u> <u>number</u>, you multiply the heat by that number:

1
 2 H₂O(g) → 2 H₂(g) + O₂(g) 1 1 1 1 2 2 H = +571.0 kJ

EX

a) Find the enthalpy change for the formation of butane. ⊿#=?

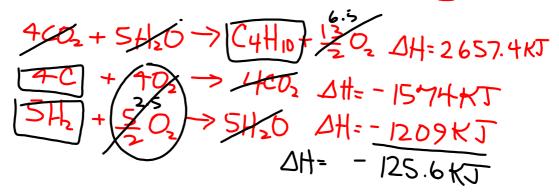
Given:

$$\begin{array}{l} C_4 H_{10(g)} \ + \ 13/2 \ O_2 \ -> \ 4 C O_{2(g)} \ + \ 5 H_2 O_{(g)} \ \Delta H_{rxn} = -2657.4 KJ \\ C_{(s)} \ \ + \ \ O_{2(g)} \ \ -> \ C O_{2(g)} \ \Delta H_{rxn} = \ -393.5 KJ \\ H_{2(g)} \ \ + \ \ 1/2 \ O_{2(g)} \ -> \ H_2 O_{(g)} \ \Delta H_{rxn} = \ -241.8 \ KJ \end{array}$$

Step 1: Write the net reaction if it is not given:

Step 2: Manipulate the given equations so they will add to yield the net equation.

$$\begin{array}{l} . \ C_4 H_{10(g)} + 13/2 \ O_2 -> 4 C O_{2(g)} + 5 H_2 O_{(g)} \ \Delta H_{rxn} = -2657.4 \text{KJ Fip} \\ . \ C_{(s)} + O_{2(g)} -> C O_{2(g)} \ \Delta H_{rxn} = -393.5 \text{KJ} \times 4 \\ . \ H_{2(g)} + 1/2 \ O_{2(g)} -> H_2 O_{(g)} \ \Delta H_{rxn} = -241.8 \ \text{KJ} \times 5 \end{array}$$



Step 3: Cancel and add the remaining reactants and products

Step 4: Add the component enthalpy changes to obtain the net enthalpy change

Step 5: Determine molar enthalpy, if required

DH=?

reactions to use

$$C_{(s)}$$
 diamond + $O_{2(g)}$ -----> $CO_{2(g)}$

C (s) graphite +
$$O_{2(g)}$$
 ----> $CO_{2(g)}$

$$\frac{C_{(s)d} + B_2 \rightarrow CO_2}{C_{(s)g} + B_2} \Delta H = -395.4KJ$$

$$2O_2 \rightarrow C_{(s)g} + D_2 \Delta H = 393.5KJ$$

$$\Delta H = -1.9KJ$$