

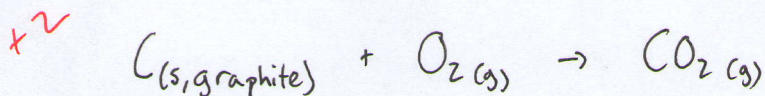
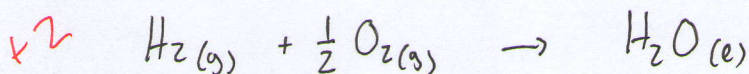
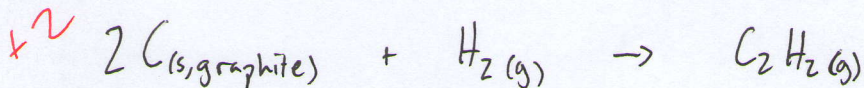
Name Mr. Shank

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Period AP 1, 2, 3**Enthalpy II: Heat of Formation and Hess' Law**

The **standard enthalpy of formation** of a compound can be measured by preparing that compound from its elements in their most stable form in the standard state.

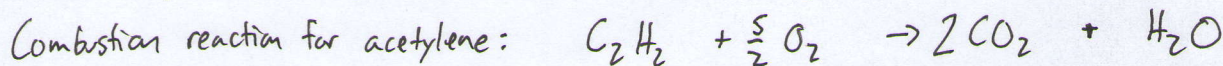
- x1 1. The 'standard state' is defined as (circle one) 1 atm 25 C 1 atm and 25 C
- x1 2. The heat of formation of an element in its standard state is 0 kJ/mol.
3. Write chemical equations for the formation of one mole of each of the following compounds from their elements in their standard state at 25 C. Include the phases of each molecule.

a) CO_2 ($\Delta H_f^\circ = -393.5 \text{ kJ/mol}$)b) H_2O ($\Delta H_f^\circ = -285.8 \text{ kJ/mol}$)c) C_2H_2 

4. Write a **general** equation for calculating the heat of reaction from the heats of formation of reactants and products.

$$\Delta H_{\text{rxn}}^\circ = \sum \Delta H_f^\circ (\text{products}) - \sum \Delta H_f^\circ (\text{reactants})$$

5. The **combustion** of one mole of acetylene (C_2H_2) releases 1,299.4 kJ of heat. Using this and your answers to questions 3 and 4, calculate the heat of formation of acetylene.



$$\Delta H_{\text{rxn}}^\circ = \sum \Delta H_f^\circ (\text{products}) - \sum \Delta H_f^\circ (\text{reactants})$$

$$\Delta H_{\text{rxn}}^\circ = [2 \Delta H_f^\circ (\text{CO}_2) + \Delta H_f^\circ (\text{H}_2\text{O})] - [\Delta H_f^\circ (\text{C}_2\text{H}_2) + \frac{5}{2} \Delta H_f^\circ (\text{O}_2)]$$

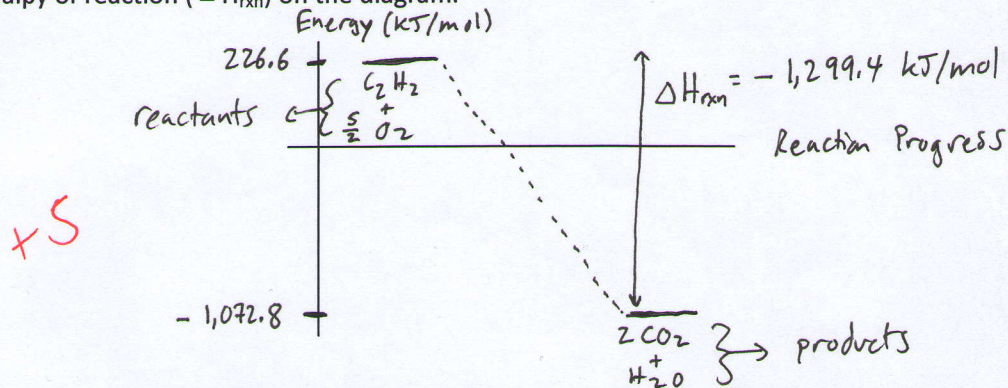
$$-1,299.4 \text{ kJ} = [2(-393.5) \text{ kJ} + 1(-285.8) \text{ kJ}] - [\Delta H_f^\circ (\text{C}_2\text{H}_2) + \frac{5}{2}(0) \text{ kJ}]$$

$$-1,299.4 \text{ kJ} = -1,072.8 \text{ kJ} - \Delta H_f^\circ (\text{C}_2\text{H}_2)$$

$$\Delta H_f^\circ (\text{C}_2\text{H}_2) = +226.6 \text{ kJ/mol}$$

+12

6. On the plot below, draw an energy diagram showing the enthalpy change during acetylene combustion. Clearly label both axes, reactants and products, and all relevant energies. Indicate the enthalpy of reaction (ΔH_{rxn}) on the diagram.



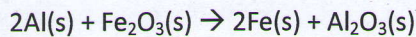
7. With respect to the enthalpy of reaction, what is the relationship between the bond enthalpies and heats of formation of the reactants and products?

$\Delta H_{rxn}^{\circ} = \sum \Delta H(\text{bonds broken}) - \sum \Delta H(\text{bonds formed})$

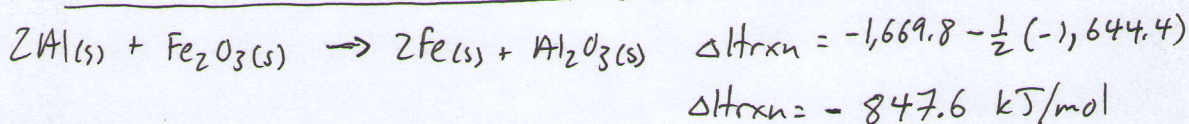
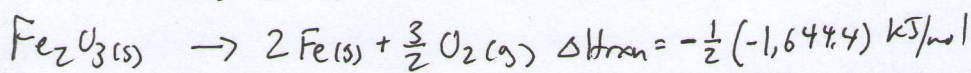
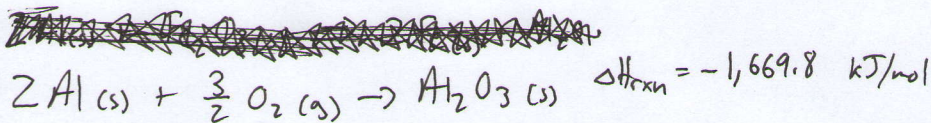
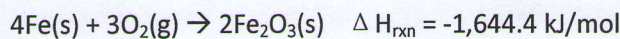
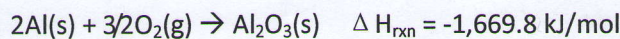
The enthalpy of reaction is equal to the heat of forming the bonds in the products minus the heat of breaking the bonds in the reactants.

$\Delta H_{rxn} = \sum \Delta H_f^{\circ}(\text{products}) - \sum \Delta H_f^{\circ}(\text{reactants})$

8. Calculate the reaction enthalpy (ΔH_{rxn}) for the thermite reaction



given that



9. Thermite welding is commonly used to repair broken train tracks. How many grams of iron(III) oxide (Fe_2O_3) are needed to completely melt 500g of iron (Fe) initially at a temperature of 25 C?

$s(\text{Fe}) = 0.46 \text{ J/g} \cdot \text{C}$

Melting Point (Fe) = 1536 C

$\Delta H_{fus}(\text{Fe}) = 15.19 \text{ kJ/mol}$

$q_{\text{total}} = q_{\text{heat Fe}} + q_{\text{melt Fe}}$

$= m_{\text{Fe}} s_{\text{Fe}} \Delta T + n_{\text{Fe}} \Delta H_{\text{fus}}$

$= (500\text{g})(0.46 \text{ J/g} \cdot \text{C})(1,536\text{C} - 25\text{C}) + \left(\frac{500\text{g Fe} \times 1 \text{ mol Fe}}{55.85\text{g Fe}} \right) \left(\frac{15.19 \text{ kJ}}{\text{mol Fe}} \right)$

$= 347.530 \text{ kJ} + 135.989 \text{ kJ}$

$q_{\text{total}} = 483.52 \text{ kJ}$

$483.52 \text{ kJ} \times \frac{\text{mol rxn}}{847.6 \text{ kJ}} =$

$0.570 \text{ mol rxn} \times \frac{1 \text{ mol Fe}_2\text{O}_3}{1 \text{ mol rxn}} =$

$0.570 \text{ mol Fe}_2\text{O}_3 \times \frac{159.7 \text{ g Fe}_2\text{O}_3}{1 \text{ mol Fe}_2\text{O}_3} =$

$91.03 \text{ g Fe}_2\text{O}_3$