Communicating Enthalpy Change for Reactions

- There are 3 main methods of communicating the enthalpy change for both endothermic and exothermic reactions

1. **ΔH Notation**: The enthalpy change/energy term is written as a separate expression at the end of a balanced chemical equation
   - ΔH is always *negative* for an *exothermic* reaction
   - Example:

$$CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(g)} \quad \Delta H = -802.5\,kJ$$

must be combustion in an open system

   - ΔH is always *positive* for an *endothermic* reaction
   - Example:

$$2Fe_2O_{3(s)} + 3C_{(s)} \longrightarrow 4Fe_{(s)} + 3CO_{2(g)} \quad \Delta H = +467.9\,kJ$$

2. **Thermochemical Equation**: A balanced chemical equation that includes the enthalpy change/energy term as a reactant or product
   - *Exothermic*: The enthalpy change/energy terms is always written on the product side because energy is being released
   - Example:

$$CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(g)} + 802.5\,kJ$$

This means for every 1 mol of $CH_{4(g)}$ & 2 mols $O_{2(g)}$, 802.5 kJ of energy is released

   - *Endothermic*: The enthalpy change/energy term is always written on the reactant side because energy is being absorbed
   - Example:

$$2Fe_2O_{3(s)} + 3C_{(s)} + 467.9\,kJ \longrightarrow 4Fe_{(s)} + 3CO_{2(g)}$$

This means for every 2 mols of Fe_2O_3 : 3 mols of $C_{(s)}$, 467.9 kJ of energy is absorbed

- The energy term (ie. the enthalpy change) in a thermochemical equation or ΔH notation is *specific* for the amount/moles of reactants or products in the actual equation
    - Enthalpy change is directly proportional to the amount of substances being consumed or produced in the reaction (ie. if you double the amount of all reactants, the enthalpy doubles as well).

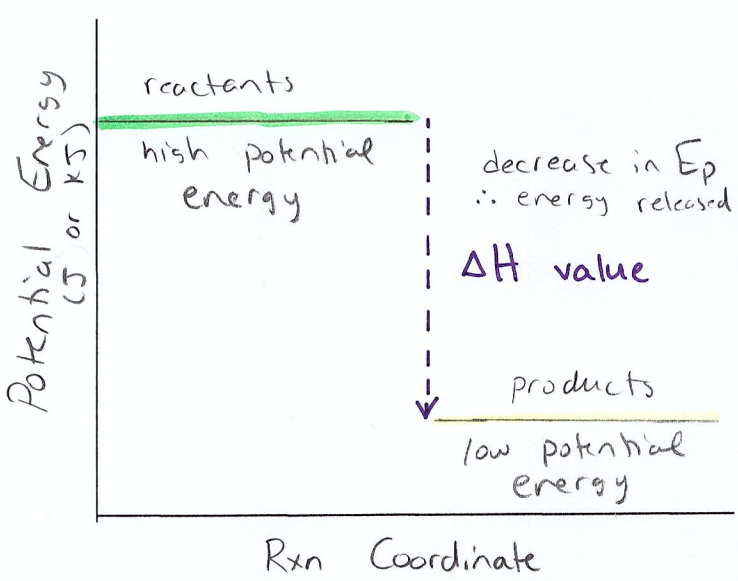
$2CH_{4(g)} + 4O_{2(g)} \rightarrow 2CO_{2(g)} + 4H_2O_{(g)} \quad \Delta H = -1605\,kJ$

OR

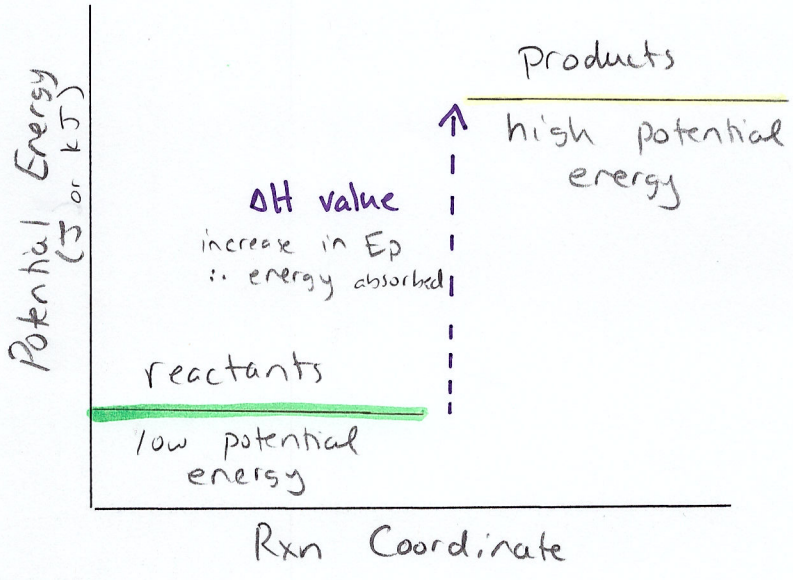
$6Fe_2O_{3(s)} + 9C_{(s)} + 1403.7\,kJ \rightarrow 12Fe_{(s)} + 9CO_{2(g)}$

3. **Potential Energy Diagram:** a graphical representation of the change in potential energy as a chemical reaction progresses
    - Looks like a "*step-down*" for *exothermic* reactions
    - Looks like a "*step-up*" for an *endothermic* reaction

EXOTHERMIC REACTION



ENDOTHERMIC REACTION



*****Now try pg. 346 #3-4 & pg. 350 #2, 5*****

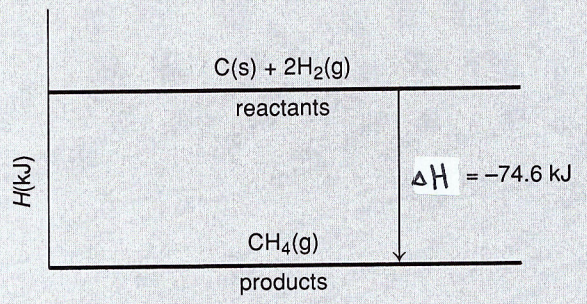
Answers to Questions for Comprehension

Student Textbook page 346

Q3. (a) $C(s) + 2H_2(g) \rightarrow CH_4(g) + 74.6\ kJ$

(b) $C(s) + 2H_2(g) \rightarrow CH_4(g)$ $\Delta H = -74.6\ kJ$

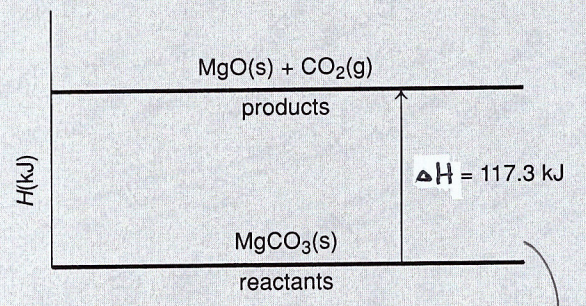
(c)



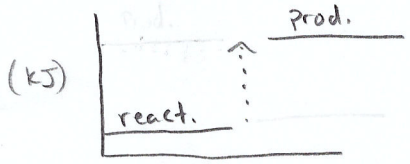
Q4. (a) $MgCO_3(s) + 117.3\ kJ \rightarrow MgO(s) + CO_2(g)$

(b) $MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$ $\Delta H = 117.3\ kJ$

(c)



same diagram as



(kJ)

b/c products are still higher in enthalpy than the reactants

Section 9.1 Review Answers

Student Textbook page 350

2. If a reaction is endothermic, more energy is consumed in breaking bonds than is released when bonds are formed.

3. (a) $Ag(s) + \frac{1}{2}Cl_2(g) \rightarrow AgCl(s)$ $\Delta H = -127.0\ kJ$

(b) $C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g)$ $\Delta H = -1322.9\ kJ$

(c) $NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$ $\Delta H_{sol} = -44.2\ kJ$

5. In exothermic reactions, the potential energy of the products is less than the potential energy of the reactants. If the potential energy of the system decreases, the ΔH is negative and the energy of the surroundings increases. Therefore, the reaction is exothermic.