March

2020

AIM

- What is enthalpy?

AGENDA

- YOYO
- Enthalpy notes
- Practice

YOYO

- Take note sheet and start the YOYO.

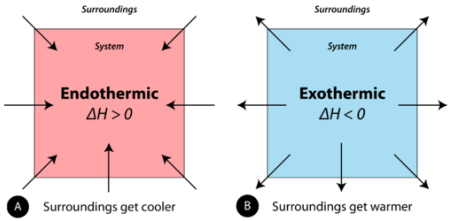
HOMEWORK

- Follow the calendar on the website.

1

Heat of Reaction

- **<u>The amount of heat energy lost or gained throughout the reaction</u>**
- $\Delta H_{\text{heat of reaction}} = H_{\text{products}} - H_{\text{reactants}}$
- ΔH = **<u>enthalpy</u>**



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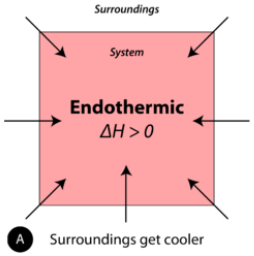
Endothermic Reactions

- Heat is **<u>absorbed</u>** by **<u>reactants</u>**
  - Energy is stored in chemical bonds of the products
  - **<u>ΔH is (+)</u>**
  - **<u>A + B + Energy → C + D</u>**



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Endothermic Example A +B → C

- If H_A = 40 kJ and H_B = 20 kJ, then the reactants have a total or 60 kJ
- If H_C = 110 kJ, then 50 kJ of heat must have been absorbed by the reactants.
  - (110-60 = 50kJ)
  - Rewritten: A + B + 50 kJ →C
- Total energy on both sides are equal (law of conservation of energy)

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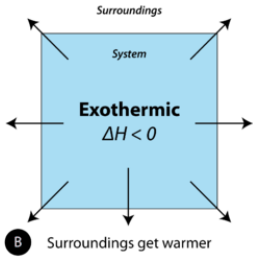
Exothermic Reactions

- Heat is **released** as a **product**
  - **ΔH is (-)**
  - More stable reaction
  - Spontaneous
  - **A + B → C + D + Energy**
    - Energy is written as a product



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Exothermic Example A + B → C

- If H_A = 60 kJ and H_B = 40 kJ, then the reactants have a total of 100 kJ
- If H_C = 30 kJ, then 70 kJ of heat must be released as a product
  - (100-30 = 70)
  - Rewritten: A + B → C + 70 kJ
- Total energy on both sides are equal (law of conservation of energy)

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Table I: Heat of Reaction at 101.3 kPa and 298 K

- The ΔH values are based on molar quantities represented in the equations. A minus sign indicates an exothermic reaction
- Two ways to write + ΔH
  - $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$ [ΔH +182.6 kJ]
  - 182.6 kJ + $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$
- Two ways to write - ΔH
  - $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(l)}$ [ΔH -890.4 kJ]
  - $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(l)}$ + 890.4 kJ

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Question: What if the reaction is the opposite of what it says on Table I?

- What is the ΔH of the following reaction? Is this exothermic or endothermic?
  - $2H_2O_{(l)} \rightarrow 2H_{2(g)} + O_{2(g)}$
  - Table I says: $2H_{2(g)} + O_{2(g)} \rightarrow$ $2H_2O_{(l)}$ [ΔH = -571.6]
- Answer: **+571.6 kJ (endothermic)**
  - *** For reverse reactions, switch the signs of ΔH**

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Sample Problem: #1

- Given the reaction $2CO_{(g)} + O_{2(g)} \rightarrow 2CO_{2(g)}$ $\Delta H = -556.0$ kJ
  - How much heat would be released is 4 moles of carbon monoxide were consumed by oxygen?

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Sample Problem #2:

- Given the reaction $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$ [$\Delta H = -571.6$]
  - Calculate ΔH for the following reaction: $H_{2(g)} + \frac{1}{2} O_{2(g)} \rightarrow H_2O_{(l)}$

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Enthalpy Practice Questions

1. According to Table *I*, which equation represents a change resulting in the greatest quantity of energy released?

A) $2C(s) + 3H_2(g) \rightarrow C_2H_6(g)$
B) $2C(s) + 2H_2(g) \rightarrow C_2H_4(g)$
C) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
D) $N_2(g) + O_2(g) \rightarrow 2NO(g)$

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Enthalpy Practice Questions

2. In a chemical reaction, the difference between the potential energy of the products and the potential energy of the reactants is equal to the

A) activation energy
B) entropy of the system
C) heat of fusion
D) heat of reaction

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Enthalpy Practice Questions

3. Given the balanced equation representing a reaction:

$H_2 \rightarrow H + H$

What occurs during this reaction?

A) Energy is absorbed as bonds are formed.
B) Energy is absorbed as bonds are broken.
C) Energy is released as bonds are formed.
D) Energy is released as bonds are broken.

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Enthalpy Practice Questions

4. Which balanced equation represents an endothermic reaction?

A) $C(s) + O_2(g) \rightarrow CO_2(g)$
B) $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(\ell)$
C) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
D) $N_2(g) + O_2(g) \rightarrow 2NO(g)$

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Enthalpy Practice Questions

5. Given the balanced equation representing a reaction:

$CH_4(g) + 2O_2(g) \rightarrow 2H_2O(g) + CO_2(g) + \text{heat}$

Which statement is true about energy in this reaction?

A) The reaction is exothermic because it releases heat.
B) The reaction is exothermic because it absorbs heat.
C) The reaction is endothermic because it releases heat.
D) The reaction is endothermic because it absorbs heat.

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Enthalpy Practice Questions

6. Which reaction releases the greatest amount of energy per 2 moles of product?

A) $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$
B) $4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$
C) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$
D) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

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Enthalpy Practice Questions

7. Given the balanced equation representing a reaction at 101.3 kPa and 298 K:

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g) + 91.8\ kJ$
Which statement is true about this reaction?

A) It is exothermic and ΔH *equals –91.8 kJ.*
B) It is exothermic and ΔH *equals +91.8 kJ.*
C) It is endothermic and ΔH *equals –91.8 kJ.*
D) It is endothermic and ΔH *equals +91.8 kJ.*

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Enthalpy Practice Questions

8. Given the reaction:

$2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(\ell) + 571.6\ kJ$
What is the approximate ΔH for the formation of 1 mole of $H_2O(\ell)$?

A) –285.8 kJ
B) +285.8 kJ
C) –571.6 kJ
D) +571.6 kJ

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Enthalpy Practice Questions

9. Given the reaction:

$H_2O(\ell) + 286\ kJ \leftrightarrow H_2(g) + \frac{1}{2}O_2(g)$

Which statement describes the reverse reaction?

A) It is endothermic and releases 286 kJ.
B) It is endothermic and absorbs 286 kJ.
C) It is exothermic and releases 286 kJ.
D) It is exothermic and absorbs 286 kJ.

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Enthalpy Practice Questions

10. According to Reference Table I, *which* reaction has a ΔH equal to –283 kJ/mole at 25°C and 1 atmosphere?

A) $C(s) + O_2(g) \rightarrow CO_2(g)$
B) $CO(g) + \frac{1}{2} O_2(g) \rightarrow CO_2(g)$
C) $\frac{1}{2} N_2 + \frac{3}{2} O_2 \rightarrow NH_3(g)$
D) $2\,C + 3\,H_2 \rightarrow C_2H_6$

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Enthalpy Practice Questions - Answers

1. C
2. D
3. B
4. D
5. A
6. B
7. A
8. A
9. C
10. B

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