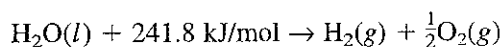
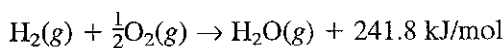


CHAPTER 14 REVIEW*Reaction Energy***ION 1****SHORT ANSWER** Answer the following questions in the space provided.

1. For elements in their standard state, the value of ΔH_f° is 0.
2. The formation and decomposition of water can be represented by the following thermochemical equations:



- taken in a. Is energy being taken in or is it being released as liquid H_2O decomposes?
- positive b. What is the appropriate sign for the enthalpy change in this decomposition reaction?

PROBLEMS Write the answer on the line to the left. Show all your work in the space provided.

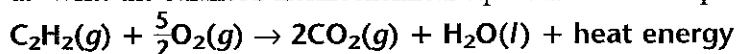
3. 70°C If 200. g of water at 20°C absorbs 41 840 J of energy, what will its final temperature be?
4. 28.9 kJ Aluminum has a specific heat of 0.900 J/(g·°C). How much energy in kJ is needed to raise the temperature of a 625 g block of aluminum from 30.7°C to 82.1°C?
5. The products in a reaction have an enthalpy of 458 kJ/mol, and the reactants have an enthalpy of 658 kJ/mol.
- 200. kJ/mol a. What is the value of ΔH for this reaction?

SECTION 1 continued

 products b. Which is the more stable part of this system, the reactants or the products?

6. The enthalpy of combustion of acetylene gas is -1301.1 kJ/mol of C_2H_2 .

a. Write the balanced thermochemical equation for the complete combustion of C_2H_2 .

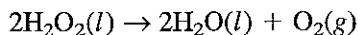


 320 kJ b. If 0.25 mol of C_2H_2 reacts according to the equation in part a, how much energy is released?

 78 g c. How many grams of C_2H_2 are needed to react, according to the equation in part a, to release 3900 kJ of energy?

7. -850. kJ/mol Determine the ΔH for the reaction between Al and Fe_2O_3 , according to the equation $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$. The enthalpy of formation of Al_2O_3 is -1676 kJ/mol. For Fe_2O_3 it is -826 kJ/mol.

8. -196.0 kJ/mol Use the data in **Appendix Table A-14** of the text to determine the ΔH for the following equation.



CHAPTER 16 REVIEW*Reaction Energy***ION 2****SHORT ANSWER** Answer the following questions in the space provided.

1. For the following examples, state whether the change in entropy favors the forward or reverse reaction:

forward reaction a. $\text{HCl}(l) \rightleftharpoons \text{HCl}(g)$

reverse reaction b. $\text{C}_6\text{H}_{12}\text{O}_6(aq) \rightleftharpoons \text{C}_6\text{H}_{12}\text{O}_6(s)$

forward reaction c. $2\text{NH}_3(g) \rightleftharpoons \text{N}_2(g) + 3\text{H}_2(g)$

reverse reaction d. $3\text{C}_2\text{H}_4(g) \rightleftharpoons \text{C}_6\text{H}_{12}(l)$

2. $\Delta G = \Delta H - T\Delta S$ a. Write an equation that shows the relationship between enthalpy, ΔH , entropy, ΔS , and free energy, ΔG .

negative b. For a reaction to occur spontaneously, the sign of ΔG should be _____.

3. Consider the following equation: $\text{NH}_3(g) + \text{H}_2\text{O}(l) \rightleftharpoons \text{NH}_4^+(aq) + \text{OH}^-(aq) + \text{energy}$

True a. The enthalpy factor favors the forward reaction. True or False?

reverse reaction b. The sign of $T\Delta S^\circ$ is negative. This means the entropy factor favors the _____.

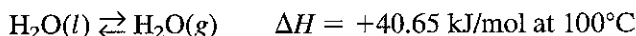
- c. Given that ΔG° for the above reaction in the forward direction is positive, which term is greater in magnitude and therefore predominates, $T\Delta S$ or ΔH ?

$T\Delta S > \Delta H$; ΔH is negative, but ΔG is positive, indicating the reaction is not

spontaneous. The randomness of the reactants and the temperature of the reaction

overshadow the exothermic factor.

4. Consider the following equation for the vaporization of water:



endothermic a. Is the forward reaction exothermic or endothermic?

reverse reaction b. Does the enthalpy factor favor the forward or reverse reaction?

forward reaction c. Does the entropy factor favor the forward or reverse reaction?

SECTION 2 continued

PROBLEMS Write the answer on the line to the left. Show all your work in the space provided.

5. Halogens can combine with other halogens to form several unstable compounds.

Consider the following equation: $I_2(s) + Cl_2(g) \rightleftharpoons 2ICl(g)$

ΔH_f° for the formation of $ICl = +18.0 \text{ kJ/mol}$ and $\Delta G^\circ = -5.4 \text{ kJ/mol}$.

- | | |
|-------------------|---|
| reverse reaction | a. Is the forward or reverse reaction favored by the enthalpy factor? |
| forward reaction | b. Will the forward or reverse reaction occur spontaneously at standard conditions? |
| forward reaction | c. Is the forward or reverse reaction favored by the entropy factor? |
| +23.4 kJ/(mol·K) | d. Calculate the value of $T\Delta S$ for this system. |
| 0.0785 kJ/(mol·K) | e. Calculate the value of ΔS for this system at 25°C. |

6. Calculate the free-energy change for the reactions described by the equations below. Determine whether each reaction will be spontaneous or nonspontaneous.

- | | |
|------------------------------|--|
| -51.0 kJ/mol; spontaneous | a. $C(s) + 2H_2(g) \rightarrow CH_4(g)$
$\Delta S^\circ = -80.7 \text{ J/(mol}\cdot\text{K)}$, $\Delta H^\circ = -75.0 \text{ kJ/mol}$,
$T = 298 \text{ K}$ |
| 195.8 kJ/mol; nonspontaneous | b. $3Fe_2O_3(s) \rightarrow 2Fe_3O_4(s) + \frac{1}{2}O_2(g)$
$\Delta S^\circ = 134.2 \text{ J/(mol}\cdot\text{K)}$, $\Delta H^\circ = 235.8 \text{ kJ/mol}$,
$T = 298 \text{ K}$ |

CHAPTER 16 REVIEW*Reaction Energy***FIXED REVIEW**

SHORT ANSWER Answer the following questions in the space provided.

1. Describe Hess's law.

The overall enthalpy change in a reaction is equal to the sum of enthalpy changes for the individual steps in the process.

2. What determines the amount of energy absorbed by a material when it is heated?

Each material has its own unique specific heat value, which is the amount of energy it takes to raise the temperature of 1 g of the substance by 1°C, or 1 K. This value is dependent on the nature of the material, the mass of the sample, and the change in temperature

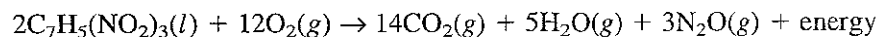
3. Describe what is meant by *enthalpy of combustion* and how a combustion calorimeter measures this enthalpy.

The enthalpy of combustion is the enthalpy change that occurs during the complete combustion of 1 mol of substance and is measured using a combustion calorimeter.

The sample is placed in the calorimeter and is ignited by an electric spark and burned in an atmosphere of pure oxygen. The energy generated by the combustion reaction warms the steel bomb and the water surrounding it. A thermometer measures the temperature change of the water and is used to calculate the energy that came from the reaction as heat.

MIXED REVIEW continued

4. The following equation represents a reaction that is strongly favored in the forward direction:



- a. Why would ΔG be negative in the above reaction?

Both energy and entropy factors favor the forward spontaneous reaction. The reaction is exothermic, and there are more gas molecules in the products than in the reactants.

PROBLEMS Write the answer on the line to the left. Show all your work in the space provided.

5. Consider the following equation and data: $2\text{NO}_2(g) \rightarrow \text{N}_2\text{O}_4(g)$

$$\Delta H_f^\circ \text{ of } \text{N}_2\text{O}_4 = +9.2 \text{ kJ/mol}$$

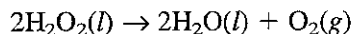
$$\Delta H_f^\circ \text{ of } \text{NO}_2 = +33.2 \text{ kJ/mol}$$

$$\Delta G^\circ = -4.7 \text{ kJ/mol } \text{N}_2\text{O}_4$$

$\Delta H^\circ = -57.2 \text{ kJ/mol}$ Use Hess's law to calculate ΔH° for the above reaction.

6. $2.26 \times 10^4 \text{ J}$ Calculate the energy needed to raise the temperature of 180.0 g of water from 10.0°C to 40.0°C. The specific heat of water is 4.18 J/(K · g).

7. a. -233.5 kJ/mol Calculate the change in Gibbs free energy for the following equation at 25°C.



$$\text{Given } \Delta H = -196.0 \text{ kJ/mol}$$

$$\Delta S = +125.9 \text{ J/mol}$$

- b. yes Is this reaction spontaneous?

12 Solutions**Section: Types of Mixtures**

- | | |
|------|-------|
| 1. a | 2. b |
| 3. c | 4. b |
| 5. d | 6. c |
| 7. a | 8. a |
| 9. b | 10. c |

Section: The Solution Process

- | | |
|------|-------|
| 1. d | 2. a |
| 3. d | 4. c |
| 5. a | 6. c |
| 7. a | 8. d |
| 9. d | 10. d |

Section: Concentration of Solutions

- | | |
|------|-------|
| 1. c | 2. a |
| 3. a | 4. d |
| 5. c | 6. d |
| 7. a | 8. d |
| 9. b | 10. c |

13 Ions in Aqueous Solutions and Colligative Properties**Section: Compounds in Aqueous Solutions**

- | | |
|------|-------|
| 1. d | 2. a |
| 3. a | 4. c |
| 5. a | 6. d |
| 7. c | 8. a |
| 9. b | 10. b |

Section: Colligative Properties of Solutions

- | | |
|------|-------|
| 1. b | 2. b |
| 3. d | 4. b |
| 5. c | 6. a |
| 7. c | 8. b |
| 9. c | 10. b |

14 Acids and Bases**Section: Properties of Acids and Bases**

- | | |
|------|-------|
| 1. d | 2. c |
| 3. b | 4. a |
| 5. a | 6. a |
| 7. a | 8. c |
| 9. d | 10. b |

Section: Acid-Base Theories

- | | |
|------|-------|
| 1. c | 2. b |
| 3. a | 4. b |
| 5. b | 6. a |
| 7. d | 8. c |
| 9. b | 10. d |

Section: Acid-Base Reactions

- | | |
|------|-------|
| 1. c | 2. c |
| 3. c | 4. d |
| 5. b | 6. c |
| 7. d | 8. c |
| 9. a | 10. a |

15 Acid-Base Titration and pH**Section: Aqueous Solutions and the Concept of pH**

- | | |
|------|-------|
| 1. d | 2. d |
| 3. d | 4. b |
| 5. c | 6. b |
| 7. a | 8. b |
| 9. d | 10. d |

Section: Determining pH and Titrations

- | | |
|------|-------|
| 1. d | 2. b |
| 3. c | 4. a |
| 5. c | 6. b |
| 7. b | 8. b |
| 9. c | 10. a |

16 Reaction Energy**Section: Thermochemistry**

- | | |
|------|-------|
| 1. d | 2. a |
| 3. b | 4. a |
| 5. c | 6. c |
| 7. c | 8. b |
| 9. c | 10. b |

Section: Driving Forces of Reactions

- | | |
|------|-------|
| 1. b | 2. a |
| 3. d | 4. a |
| 5. b | 6. a |
| 7. a | 8. b |
| 9. c | 10. d |