

## 12-1 Review and Reinforcement

### Chemical Reactions That Involve Heat

On the line at the left, write the letter of the definition that best matches each term.

- |                                |  |
|--------------------------------|--|
| _____ 1. heat                  | a. reactions that release heat                               |
| _____ 2. thermochemistry       | b. the SI unit of energy and heat                            |
| _____ 3. exothermic reactions  | c. the energy that is transferred from one object to another |
| _____ 4. endothermic reactions | d. the study of the changes in heat in chemical reactions    |
| _____ 5. joule                 | e. example of an exothermic reaction                         |
| _____ 6. combustion            | f. reactions that absorb heat                                |

If the statement is true, write "true." If it is false, change the underlined word or words to make the statement true. Write your answer on the line provided.

- \_\_\_\_\_ 7. It is energy that maintains your body temperature close to 37°C.
- \_\_\_\_\_ 8. Bond breaking in chemical reactions releases energy.
- \_\_\_\_\_ 9. Heat is transferred between two objects that are at the same temperature.
- \_\_\_\_\_ 10. An exothermic reaction absorbs heat from the environment.
- \_\_\_\_\_ 11. All combustion reactions are exothermic.
- \_\_\_\_\_ 12. If a reaction is endothermic, the amount of heat appears on the right side of the arrow in the balanced equation.
- \_\_\_\_\_ 13. Energy can be stored in the chemical bonds of a substance.

Answer each of the following questions in the space provided.

14. Provide two examples from daily life that demonstrate how heat is transferred from one object to another.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

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*12-1 Review and Reinforcement (continued)*

15. Why is the joule, the SI unit of energy, also the appropriate unit for measuring heat?

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16. Provide an analogy that explains why bond breaking requires energy.

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17. When ammonium chloride dissolves in a beaker of water, the beaker becomes cold to the touch. Explain this phenomenon.

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Name \_\_\_\_\_ Date \_\_\_\_\_ Class \_\_\_\_\_

# 12-4 Review and Reinforcement

## Calorimetry

Complete each of the following sentences by filling in the appropriate word or phrase from the list below.

- |        |               |               |
|--------|---------------|---------------|
| water  | heat capacity | specific heat |
| heat   | calorimetry   | temperature   |
| oxygen | calorimeter   | carbohydrates |

- The study of heat flow and heat measurement is called \_\_\_\_\_.
- The words calorimeter, calorimetry, and calorie are all derived from the Latin word *calor*, which means \_\_\_\_\_.
- The amount of heat needed to raise an object's temperature depends on its \_\_\_\_\_.
- Every substance has a \_\_\_\_\_, which tells you how much heat is necessary to raise the temperature of 1 gram of the substance by 1 Celsius degree.
- \_\_\_\_\_ has one of the highest specific heats of any common substance.
- A transfer of heat is detected by measuring a \_\_\_\_\_ change.
- A \_\_\_\_\_ is a well-insulated container used to measure temperature changes.
- On the average, \_\_\_\_\_ supply 17 kJ/g (4 Cal/g) of energy.
- Foods are reacted with \_\_\_\_\_ in a laboratory calorimeter to determine their energy values.

Use your knowledge from Section 12-4 to write the meaning of each of the following symbols.

- $T_i$  \_\_\_\_\_
- $T_f$  \_\_\_\_\_
- $q_{rxn}$  \_\_\_\_\_
- $q_{sur}$  \_\_\_\_\_
- $m$  \_\_\_\_\_
- $C$  \_\_\_\_\_

Name \_\_\_\_\_ Date \_\_\_\_\_ Class \_\_\_\_\_

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*12-4 Review and Reinforcement (continued)*

*Answer the following question in the space provided.*

16. Explain how a calorimeter is used to determine the quantity of heat transferred in a chemical reaction.

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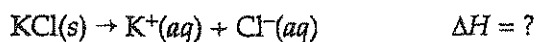
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*Solve each of the following problems as directed. Show all your work.*

17. A metal that has a mass of 23.4 g has a heat capacity of  $6.18 \text{ J/C}^\circ$ . What is the specific heat of the metal?
18. 15.3 g of  $\text{NaNO}_3$  were dissolved in 100. g of water in a calorimeter. The temperature of the water dropped from  $25.00^\circ\text{C}$  to  $21.56^\circ\text{C}$ . Calculate  $\Delta H$  for the solution process.
19. A 1.0-g sample of octane ( $\text{C}_8\text{H}_{18}$ ) is burned in a calorimeter containing 1200 g of water. The temperature of the water rises from  $25.00^\circ\text{C}$  to  $33.20^\circ\text{C}$ . Calculate  $\Delta H$  for this process.
20. How much heat is required to raise the temperature of 20.0 g of iron from  $26^\circ\text{C}$  to  $72.30^\circ\text{C}$ ? The specific heat of iron is  $0.447 \text{ J/g}\cdot\text{C}^\circ$ .

## 12-4 Practice Problems

1. When a 12.8-g sample of KCl dissolves in 75.0 g of water in a calorimeter, the temperature drops from 31.0°C to 21.6°C. Calculate  $\Delta H$  for the process.
6. What is the specific heat of gold if the temperature of a 8.21-g sample of gold is increased by 6.2 C° when 6.51 J of heat is added?



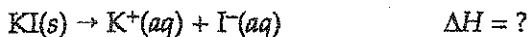
2. What is the specific heat of aluminum if the temperature of a 28.4-g sample of aluminum is increased by 8.1 C° when 207 J of heat is added?
7. When a 19.2-g sample of KCN dissolves in 65.0 g of water in a calorimeter, the temperature drops from 28.1°C to 15.4°C. Calculate  $\Delta H$  for the process.



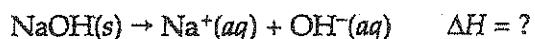
3. When a 25.7-g sample of NaI dissolves in 80.0 g of water in a calorimeter, the temperature rises from 20.5°C to 24.4°C. Calculate  $\Delta H$  for the process.
8. What is the specific heat of silver if the temperature of a 15.4-g sample of silver is increased by 11.2 C° when 40.5 J of heat is added?



4. What is the specific heat of silicon if the temperature of a 4.11-g sample of silicon is increased by 3.8 C° when 11.1 J of heat is added?
9. When a 28.7-g sample of KI dissolves in 60.0 g of water in a calorimeter, the temperature drops from 27.2°C to 13.2°C. Calculate  $\Delta H$  for the process.

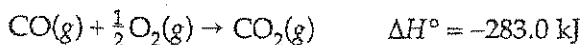
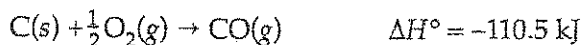


5. When a 16.9-g sample of NaOH dissolves in 70.0 g of water in a calorimeter, the temperature rises from 22.4°C to 86.6°C. Calculate  $\Delta H$  for the process.
10. What is the specific heat of titanium if the temperature of a 36.7-g sample of titanium is increased by 4.8 C° when 91.6 J of heat is added?



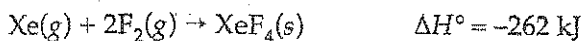
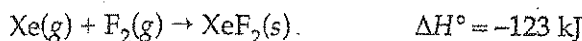
## 12-3 Practice Problems

1. From the following enthalpy changes,



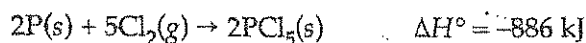
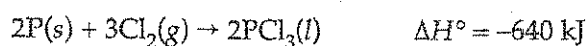
calculate the value of  $\Delta H^\circ$  for the reaction  
 $\text{C}(s) + \text{O}_2(g) \rightarrow \text{CO}_2(g)$ .

6. From the following enthalpy changes,



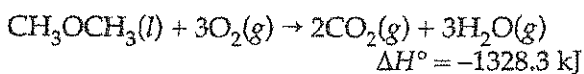
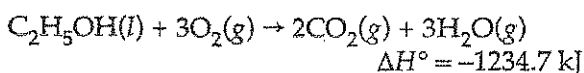
calculate the value of  $\Delta H^\circ$  for the reaction  
 $\text{XeF}_2(s) + \text{F}_2(g) \rightarrow \text{XeF}_4(s)$ .

2. From the following enthalpy changes,



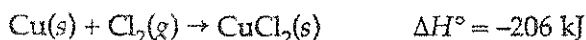
calculate the value of  $\Delta H^\circ$  for the reaction  
 $\text{PCl}_3(l) + \text{Cl}_2(g) \rightarrow \text{PCl}_5(s)$ .

3. From the following enthalpy changes,



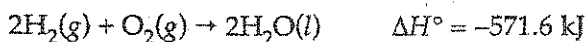
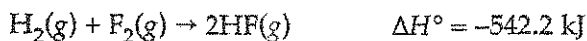
calculate the value of  $\Delta H^\circ$  for the reaction  
 $\text{C}_2\text{H}_5\text{OH}(l) \rightarrow \text{CH}_3\text{OCH}_3(l)$ .

4. From the following enthalpy changes,



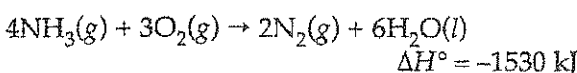
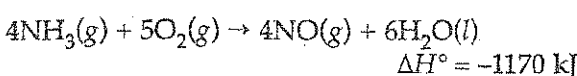
calculate the value of  $\Delta H^\circ$  for the reaction  
 $\text{CuCl}_2(s) + \text{Cu}(s) \rightarrow 2\text{CuCl}(s)$ .

5. From the following enthalpy changes,



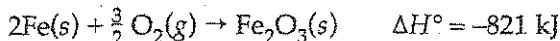
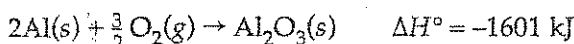
calculate the value of  $\Delta H^\circ$  for the reaction  
 $2\text{F}_2(g) + 2\text{H}_2\text{O}(l) \rightarrow 4\text{HF}(g) + \text{O}_2(g)$ .

7. From the following enthalpy changes,



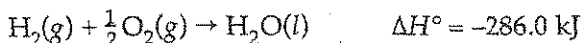
calculate the value of  $\Delta H^\circ$  for the reaction  
 $\text{N}_2(g) + \text{O}_2(g) \rightarrow 2\text{NO}(g)$ .

8. From the following enthalpy changes,



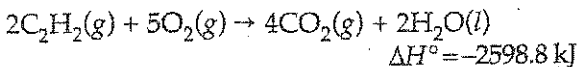
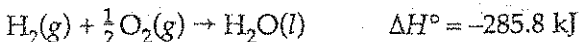
calculate the value of  $\Delta H^\circ$  for the reaction  
 $2\text{Al}(s) + \text{Fe}_2\text{O}_3(s) \rightarrow 2\text{Fe}(s) + \text{Al}_2\text{O}_3(s)$ .

9. From the following enthalpy changes,



calculate the value of  $\Delta H^\circ$  for the reaction  
 $\text{H}_2(g) + \text{H}_2\text{O}_2(l) \rightarrow 2\text{H}_2\text{O}(l)$ .

10. From the following enthalpy changes,



calculate the value of  $\Delta H^\circ$  for the reaction  
 $2\text{C}(s) + \text{H}_2(g) \rightarrow \text{C}_2\text{H}_2(g)$ .

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## 12-2 Review and Reinforcement

### Heat and Enthalpy Changes

Complete each of the following sentences by filling in the appropriate word or phrase from the list below.

- |        |                          |          |
|--------|--------------------------|----------|
| less   | endothermic              | change   |
| moles  | exothermic               | pressure |
| energy | standard enthalpy change | enthalpy |

1. The heat absorbed or released in a reaction depends on a quantity called \_\_\_\_\_.
2. The enthalpy of a substance is similar to, but not exactly the same as, the \_\_\_\_\_ of a substance.
3. The symbol  $\Delta H$  literally means a \_\_\_\_\_ in enthalpy.
4. The  $\Delta H$  for a(n) \_\_\_\_\_ reaction always has a positive sign.
5. In an exothermic reaction,  $H_{\text{products}}$  will always be \_\_\_\_\_ than  $H_{\text{reactants}}$ .
6. Conditions such as temperature, \_\_\_\_\_, and the physical states of the substances in a reaction can affect  $\Delta H$ .
7. The enthalpy change measured at 1 atm and 25°C, when the reactants and products are in their standard states, is called a \_\_\_\_\_.
8. You must know the number of \_\_\_\_\_ of reactants involved in a reaction to calculate  $\Delta H$ .

Answer each of the following questions in the space provided.

9. How is the enthalpy of a substance related to the energy of a substance?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
10. If you were given  $\Delta H^\circ$  of a reaction, could you determine whether the reaction was exothermic or endothermic? Explain your answer.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## 12-2 Review and Reinforcement (continued)

11. Compare the enthalpy of the reactants and the products in both exothermic and endothermic reactions.

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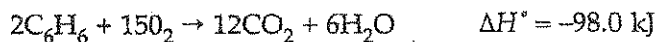
12. What is meant by the standard state of an element?

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Solve each of the following problems as directed. Show all your work.

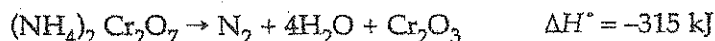
13. Calculate the amount of heat released by the combustion of 1.75 mol of benzene ( $C_6H_6$ ).



14. How much heat is transferred when 100.0 g of calcium oxide ( $CaO$ ) reacts with carbon according to the equation below? Is this reaction endothermic or exothermic?



15. Ammonium dichromate decomposes in a vigorous reaction when it is heated. Calculate the heat transferred for the decomposition of 53.0 g of ammonium dichromate according to the following equation.





## 12-2 Practice Problems

1. How much heat will be released when 6.44 g of sulfur reacts with excess  $O_2$  according to the following equation?



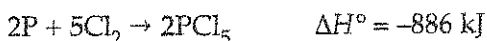
2. How much heat will be released when 4.72 g of carbon reacts with excess  $O_2$  according to the following equation?



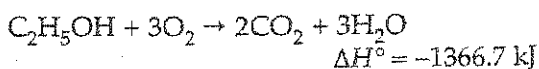
3. How much heat will be absorbed when 38.2 g of bromine reacts with excess  $H_2$  according to the following equation?



4. How much heat will be released when 1.48 g of chlorine reacts with excess phosphorus according to the following equation?



5. How much heat will be released when 4.77 g of ethanol ( $C_2H_5OH$ ) reacts with excess  $O_2$  according to the following equation?



6. How much heat will be absorbed when 13.7 g of nitrogen reacts with excess  $O_2$  according to the following equation?



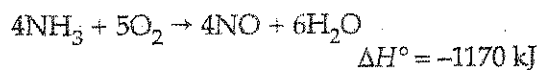
7. How much heat will be released when 11.8 g of iron reacts with excess  $O_2$  according to the following equation?



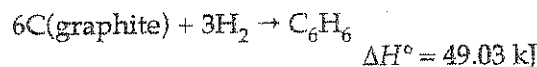
8. How much heat will be released when 18.6 g of hydrogen reacts with excess  $O_2$  according to the following equation?



9. How much heat will be transferred when 14.9 g of ammonia reacts with excess  $O_2$  according to the following equation? Is this reaction endothermic or exothermic?



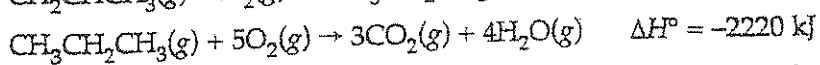
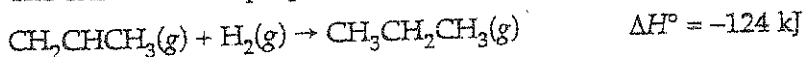
10. How much heat will be transferred when 5.81 g of graphite reacts with excess  $H_2$  according to the following equation? Is this reaction endothermic or exothermic?



## 12-3 Review and Reinforcement (continued)

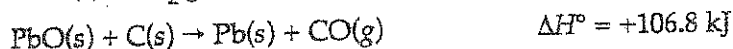
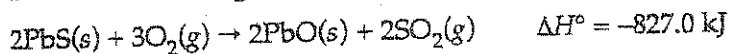
Solve the following problems in the space provided. Show all your work.

7. The combustion of propene proceeds in two steps:



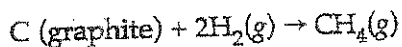
Calculate the value of  $\Delta H^\circ$  for the combustion of 2.70 mol of propene into carbon dioxide and water.

8. From the following enthalpy changes,



calculate the value of  $\Delta H^\circ$  when 1.55 mol of PbS reacts to form lead in the following reaction:  
 $2\text{PbS}(s) + 3\text{O}_2(g) + 2\text{C}(s) \rightarrow 2\text{Pb}(s) + 2\text{CO}(g) + 2\text{SO}_2(g)$ . Is the reaction endothermic or exothermic?

9. Determine the change in enthalpy for the following reaction:



Use these reaction equations:

