Name _____ Date _____ Class _____

13 STATES OF MATTER

SECTION 13.1 THE NATURE OF GASES (pages 385–389)

This section introduces the kinetic theory and describes how it applies to gases. It defines gas pressure and explains how temperature is related to the kinetic energy of the particles of a substance.

▶ Kinetic Theory and a Model for Gases (pages 385–386)

1. The energy an object has because of its motion is called

_____ .

2. Circle the letter of each sentence that is true about the assumptions of the kinetic theory concerning gases.

a. A gas is composed of particles with insignificant volume that are relatively far apart from each other.

b. Strong attractive forces exist between particles of a gas.

c. Gases tend to collect near the bottom of a container.

d. The paths of uninterrupted travel of particles in a gas are relatively short because the particles are constantly colliding with each other or with other objects.

3. Is the following statement true or false? According to the kinetic theory, collisions between particles in a gas are perfectly elastic because kinetic energy is transferred without loss from one particle to another, and the total kinetic energy remains constant. _____

▶ Gas Pressure (pages 386–387)

4. Gas pressure results from the force exerted by a gas per _____

_____ .

5. Simultaneous collisions of billions of particles in a gas with an object result in _____ .

6. What force holds the particles of air in Earth's atmosphere? _____

7. What kind of pressure is measured with a barometer?

_____

8. Look at Figure 13.2 on page 386. What accounts for the difference in height of the two mercury columns shown in the figure?

_____

_____

_____

_____

9. Circle the letter next to every name of a unit of pressure.

a. mm Hg **d.** kPa

b. standard **e.** atm

c. pascal **f.** degree

10. Standard temperature and pressure (STP) are defined as _____

_____

▶ Kinetic Energy and Temperature (pages 388–389)

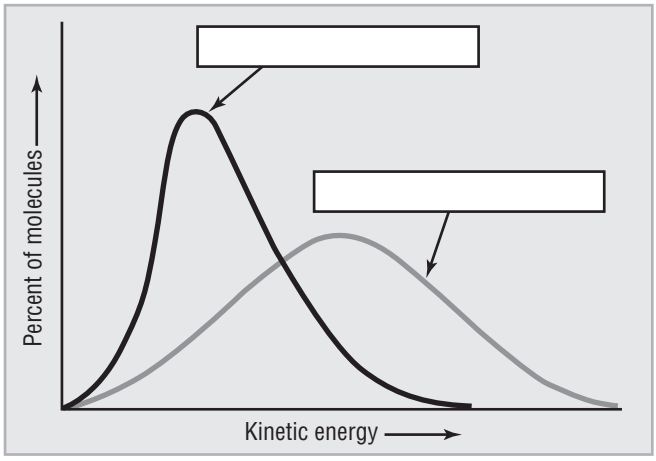
11. What happens to the temperature of a substance when the average kinetic energy of its particles increases?

_____

12. Is the following statement true or false. All the particles in a substance at a given temperature have the same kinetic energy. _____

13. The temperature 0K, or −273.15°C, is called _____ zero. Theoretically, particles of matter at this temperature would have no _____.

14. On the graph below, write the labels *lower temperature* and *higher temperature* to identify the curve that depicts the kinetic energy distribution of particles in a liquid at a lower temperature and at a higher temperature.



15. Circle the letter of the temperature scale that correctly completes this sentence. Temperature on the _____ scale is directly proportional to the average kinetic energy of the particles of a substance.

a. Celsius

b. Kelvin

c. Fahrenheit

d. Centigrade

SECTION 13.2 THE NATURE OF LIQUIDS (pages 390–395)

This section describes a model for liquids in terms of kinetic energy and the attractive forces between the particles in a liquid. It also uses kinetic theory to distinguish evaporation from boiling.

▶ A Model for Liquids (page 390)

1. Is the following sentence true or false? The kinetic theory states that there are no attractions between the particles of a liquid.

_____

2. Circle the letter next to each sentence that is true about the particles of a liquid.

a. Most of the particles in a liquid have enough kinetic energy to escape into a gaseous state.

b. Liquids are much denser than gases because intermolecular forces reduce the amount of space between the particles in a liquid.

c. Increasing pressure on a liquid has hardly any effect on its volume.

d. Liquid particles are free to slide past one another.

▶ Evaporation (page 391)

3. The conversion of a liquid to a gas or vapor is called _____ .

4. When vaporization occurs at the surface of a liquid that is not boiling, the process is called _____ .

5. As a liquid evaporates, why do only some of the particles break away from the surface of the liquid? Why does the liquid evaporate faster if the temperature is increased?

_____

_____

_____

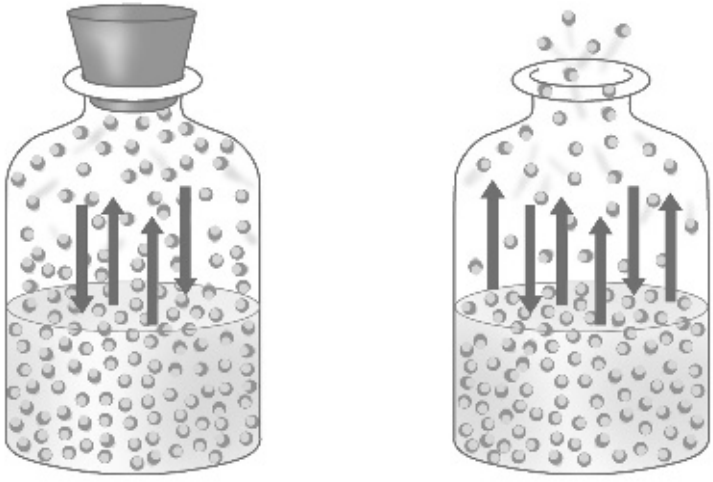
_____

_____

CHAPTER 13, States of Matter *(continued)*

6. Is the following sentence true or false? Evaporation is a cooling process because the particles in a liquid with the highest kinetic energy tend to escape first, leaving the remaining particles with a lower average kinetic energy and, thus, a lower temperature. _____

Questions 7, 8, 9, and 10 refer to either container A or container B below. Think of each container as a system involving both liquid water and water vapor.



(a) (b)

7. From which of the containers are water molecules able to escape? ____

8. In which container can a dynamic equilibrium between water molecules in the liquid state and water molecules in the vapor state be established? ____

9. In which container will the water level remain constant? ____

10. From which container is it possible for all of the liquid water to disappear through evaporation? ____

11. What causes the chill you may feel after stepping out of a swimming pool on a warm, windy day?

_____

_____

Name _____ Date _____ Class _____

▶ Vapor Pressure (pages 392–393)

12. Circle the letter next to each sentence that is true about vapor pressure.

a. Vapor pressure arises when particles of a liquid in a closed, partly filled container vaporize and collide with the walls of the container.

b. After a time in a closed, partly filled container, a liquid will evaporate and its vapor will condense at equal rates.

c. Look at Figure 13.6b on page 391. Condensation on the inside of the terrarium indicates that there is not a liquid-vapor equilibrium in the sealed terrarium.

d. When the temperature of a contained liquid increases, its vapor pressure increases.

13. Look at Figure 13.7 on page 393. How does the vapor pressure of the ethanol in the manometer change when the temperature is increased from 0°C to 20°C? Circle the letter of the correct answer.

a. The vapor pressure decreases by more than 4 kPa.

b. The vapor pressure remains constant.

c. The vapor pressure increases by more than 4 kPa.

d. There is no way to detect a change in vapor pressure with a manometer.

▶ Boiling Point (pages 393–395)

14. The boiling point of a liquid is the temperature at which the vapor pressure of the liquid is just equal to the _____ .

15. Look at Figure 13.8 on page 394. Why does the boiling point decrease as altitude increases?

_____

_____

_____

16. Use Figure 13.9 on page 394. At approximately what temperature would ethanol boil atop Mount Everest, where the atmospheric pressure is 34 kPa? Circle the letter next to the best estimate.

a. 50°C **b.** 100°C **c.** 0°C **d.** 85°C

17. Is the following sentence true or false? After a liquid reaches its boiling point, its temperature continues to rise until all the liquid vaporizes. _____

Reading Skill Practice

Writing a summary can help you remember what you have read. When you write a summary, include only the most important points. Write a summary of the discussion of boiling point on pages 393–395. Do your work on a separate sheet of paper.

SECTION 13.3 THE NATURE OF SOLIDS (pages 396–399)

This section describes the highly organized structures of solids, distinguishes between a crystal lattice and a unit cell, and explains how allotropes of an element differ.

▶ A Model for Solids (page 396)

1. Is the following sentence true or false? Although particles in solids have kinetic energy, the motion of particles in solids is restricted to vibrations about fixed points. _____

2. A solid melts when _____.

3. Is the following sentence true or false? The temperature at which the liquid and solid states of a substance are in equilibrium is the same as the melting point *and* the freezing point of the substance. _____

▶ Crystal Structure and Unit Cells (pages 396–399)

4. How are particles arranged in a crystal?

_____

5. What type of solid has a relatively low melting point?

_____

6. Do all solids melt when heated? Explain.

_____

7. Circle the letter next to each sentence that is true about solids.

a. Most solid substances are not crystalline.

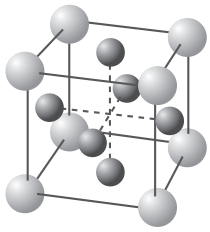
b. All crystals have sides, or faces, that intersect at angles that are characteristic for a given substance.

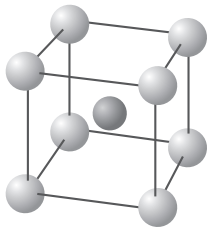
c. There are seven groups, or crystal systems, into which all crystals may be classified.

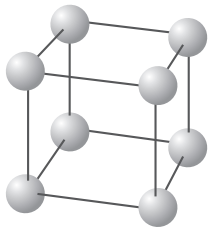
d. The orderly array of sodium ions and chloride ions gives crystals of table salt their regular shape.

Name _____ Date _____ Class _____

Identify the unit cell in each figure below as simple cubic, body-centered cubic, or face-centered cubic.







8. _____ **9.** _____ **10.** _____

11. Is the following sentence true or false? Some solid substances can exist in more than one form. Give an example to support your answer.

_____

_____

12. Two or more different molecular forms of the same element in the same physical state are called _____ .

13. What is an amorphous solid?

_____

14. Circle the letter next to each solid that is an amorphous solid.

a. table salt **c.** plastic

b. rubber **d.** glass

15. How are glasses different from crystalline solids?

_____

_____

_____

SECTION 13.4 CHANGES OF STATE (pages 401–404)

This section describes the process of sublimation. It also explains phase changes between solid, liquid, and vapor states and how to interpret a phase diagram.

▶ Sublimation (page 401)

1. The process by which wet laundry dries on an outdoor clothesline in winter is called _____ .

2. Is the following sentence true or false? Solids have vapor pressure because some particles near the surface of a solid substance have enough kinetic energy to escape directly into the vapor phase. _____

▶ Phase Diagrams (pages 402–403)

3. What does a phase diagram show?

_____

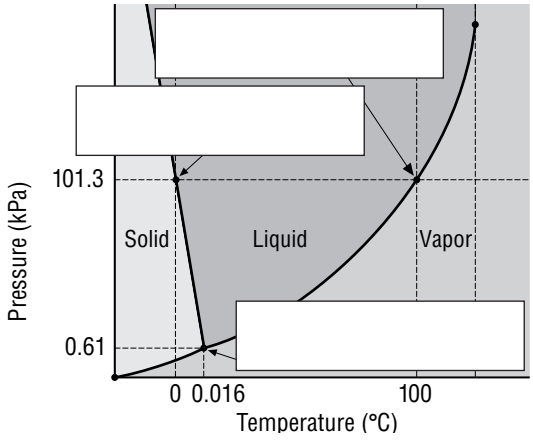
_____

4. What is the triple point of a substance?

_____

_____

5. In the phase diagram for water shown below, label the melting point and boiling point at normal atmospheric pressure, and the triple point.



6. Use the phase diagram above to answer the following question. Why is a laboratory required to produce the conditions necessary for observing water at the triple point?

_____

_____

Name _____ Date _____ Class _____

GUIDED PRACTICE PROBLEM

GUIDED PRACTICE PROBLEM 2 (page 387)

2. The pressure at the top of Mount Everest is 33.7 kPa. Is that pressure greater than or less than 0.25 atm?

Analyze

Step 1. To convert kPa to atm, what conversion factor do you need to use?

_____

Step 2. Why can you use an estimate to solve this problem?

_____

_____

Calculate

Step 3. Write the expression needed to find the answer.

_____

Step 4. Which common fraction is this number close to?

_____

Step 5. What is this fraction written as a decimal? Is this number greater than or less than 0.25?

_____

Evaluate

Step 6. Are you confident your estimate gave a correct answer to this problem?

_____

_____

EXTRA PRACTICE (similar to Practice Problem 1, page 387)

1. What pressure, in atmospheres, does a gas exert at 152 mm Hg?

What is this pressure in kilopascals?