KEY

States of Matter

Section 13.1 Gases

Main Idea — **Details**

Scan *Section 1, using the checklist below as a guide.*

- Read all section titles.
- Read all boldfaced words.
- Read all tables and graphs.
- Look at all pictures and read the captions.
- Think about what you already know about this subject.

New Vocabulary *Use your text to define each term.*

kinetic-molecular theory	describes the behavior of gases in terms of particles in motion
elastic collision	collision is one in which no kinetic energy is lost
temperature	measure of the average kinetic energy of the particles in a sample of matter
diffusion	the movement of one material through another from an area of higher concentration to an area of lower concentration
Graham's law of effusion	states that the rate of effusion for a gas is inversely proportional to the square root of its molar mass
pressure	force per unit area
barometer	instrument used to measure atmospheric pressure
pascal	SI unit of pressure that is equal to a force of one newton per square meter
atmosphere	common measure of air pressure
Dalton's law of partial pressures	states that the total pressure of a mixture of gases is equal to the sum of the pressures of all the gases in the mixture

Main Idea — Details

The Kinetic-Molecular Theory

Use with pages 385–386.

Distinguish *between the three main physical properties of gas particles by completing the passages below.*

1. Size is very small. It is assumed that there are no significant attractive or repulsive forces among gas particles.
2. Motion is constantly moving in a random pattern. It is assumed that gas particles move in a straight path until they hit an object.
3. Energy is conserved. It is assumed that mass and velocity impact the energy level of a gas particle.

Describe *kinetic energy in equation form by completing the table below.*

$KE = 1/2mv^2$	Variable	Definition
KE	kinetic energy	energy of motion
m	mass	amount of matter
v	velocity	the speed and direction of motion

Explaining the Behavior of Gases

Use with pages 386–387.

Describe *the following concepts as they relate to the behaviors of gases by completing the passages below.*

low density—Gases have low density (mass per unit volume) in comparison to solids. The difference in density is partly due to the mass of the particles and also because there is a great deal of space between gas particles.

compression and expansion—The large amount of empty space between gas particles allows them to be compressed, or pushed, into a smaller volume. Once the pressure is stopped, the particles expand to the original volume.

diffusion and effusion—Because there are no significant forces of attraction between gas particles, gases flow easily past one another. This random motion allows gases to mix until they are evenly distributed. The movement of gas particles past one another is called diffusion. The process of allowing a gas to escape from a more concentrated container is called effusion.

Main Idea — Details

Write *Graham's law of effusion as a proportional statement.*

$$\text{Rate of Effusion} \propto \frac{1}{\sqrt{\text{molar mass}}}$$

Write *the proportional statement based on Graham's law of effusion that allows you to compare the diffusion rate of two different gases.*

$$\frac{\text{Rate}_A}{\text{Rate}_B} = \sqrt{\frac{\text{molar mass}_B}{\text{molar mass}_A}}$$

Gas Pressure

Use with pages 388–392.

Describe *pressure as it relates to the behaviors of gases.*

Pressure is force per unit area. Gas particles exert pressure when they collide with the walls of a container. More particles in a system exert larger amounts of pressure.

Distinguish *between a barometer and a manometer.*

A barometer measures atmospheric pressure. A manometer measures gas pressure in a closed container.

Explore *the relationship between different units of pressure by filling in the table below.*

Unit Name (unit symbol)	Conversion Ratio: 1 atm = _____	Conversion Ratio: 1 kPa = _____
kilopascal (kPa)	101.3 kPa	
millimeters of mercury (mm Hg)	760 mm Hg	7.501 mm Hg
torr	760 torr	7.501 torr
pounds per square inch (psi or lb/in^2)	14.7 psi	0.145 psi
atmosphere (atm)		0.009 869 atm

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Section 13.2 Forces of Attraction

Main Idea — **Details**

Skim *Section 2 of your text. Write three questions that come to mind from reading the headings and the illustration captions.*

1. Accept all reasonable responses.
2. _____
3. _____

New Vocabulary *Use your text to define each term.*

dispersion forces — weak forces resulting from temporary shifts in the density of electrons in electron clouds

dipole-dipole force — attractions between oppositely charged regions of polar molecules

hydrogen bond — a dipole-dipole attraction that occurs between molecules containing a hydrogen atom bonded to a small, highly electronegative atom with at least one lone electron pair

Academic Vocabulary *Define the following term.*

distribute — divide among several or many

Main Idea

Intermolecular Forces

Use with pages 393–395.

Details

Describe *the difference between an intramolecular and an intermolecular force.*

Intramolecular forces are the forces that hold particles together in ionic, covalent, and metallic bonds. Intermolecular forces are forces between or among molecular structures.

Compare and contrast *intramolecular forces by completing the table below.*

Force	Basis of Attraction	Example
Ionic	cations and anions	NaCl
Covalent	positive nuclei and shared electrons	H_2
Metallic	metal cations and mobile electrons	Fe

Compare *intermolecular forces by completing the table below.*

Force	Basis of Attraction	Example
Dispersion	weak forces resulting from temporary shifts in the density of electrons in electron clouds	F_2
Dipole-dipole	attraction between oppositely charged regions of polar molecules	HCl
Hydrogen bond	dipole-dipole attraction between a hydrogen atom and a small, highly electronegative atom with at least one lone pair of electrons	H_2O

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Section 13.3 Liquids and Solids

Main Idea — **Details**

Scan *Section 3, using the checklist below as a guide.*

- Read all section titles.
- Read all boldfaced words.
- Read all tables and graphs.
- Look at all pictures and read the captions.
- Think about what you already know about this subject.

New Vocabulary *Use your text to define each term.*

viscosity — measure of the resistance of a liquid to flow

surface tension — measure of inward pull by particles in the interior of a liquid

surfactant — compounds that lower the surface tension of water; also called surface active agents

crystalline solid — solid whose atoms, ions, or molecules are arranged in an orderly, geometric, three-dimensional structure

unit cell — smallest arrangement of connected points that can be repeated in three directions to form a crystal lattice

amorphous solid — solid in which the particles are not arranged in an regular, repeating pattern

Academic Vocabulary *Define the following term.*

predict — indicate in advance or foretell

Main Idea — Details

Liquids

Use with pages 396–398.

Compare and contrast *the following paired concepts as they relate to the properties of liquids by completing the following statements.*

Density and compression: A liquid can take the shape of its container, but its volume is fixed. The density of a liquid is greater than the density of the same substance as a gas. Liquids cannot usually be compressed except under extremely high pressure.

Fluidity and viscosity: Fluidity is the ability to flow. Liquids flow through each other but at a slower rate than gases do. Viscosity is the measure of the resistance of a liquid to flow. The stronger attractive forces slow down the ability to flow, which increases resistance (viscosity).

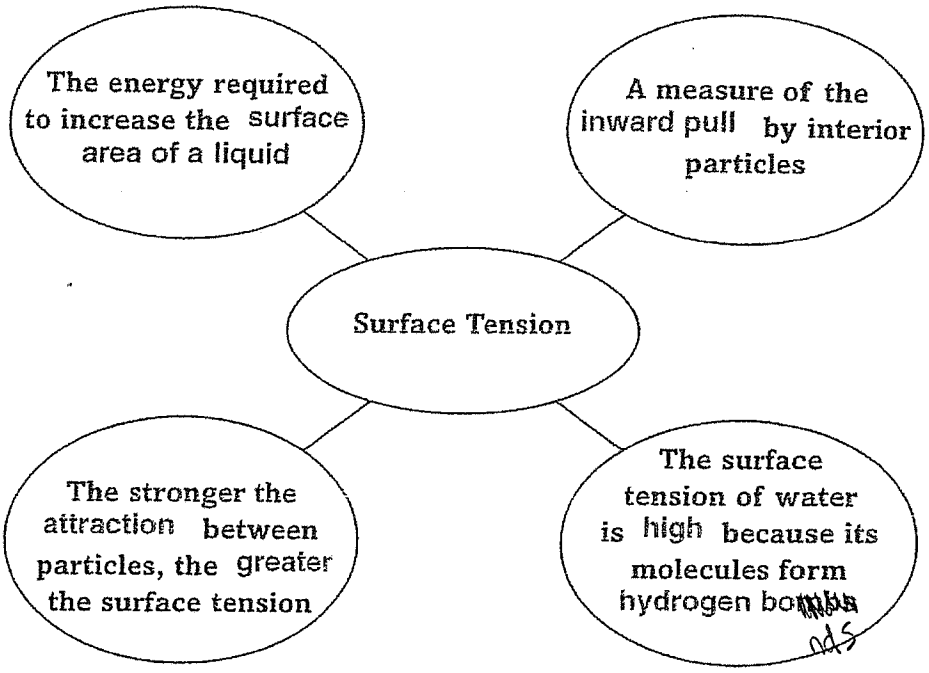
Viscosity and temperature: Temperature affects the viscosity of a liquid. Viscosity decreases with temperature.

Analyze *the relationship between viscosity, temperature, and change in kinetic energy by completing the table.*

Temperature	Δ KE	Viscosity	Effect in Liquid
increases	increases	decreases	flows faster
decreases	decreases	increases	flows slower
stays the same	no change	no change	no change

Main Idea — Details

Explain *surface tension by completing the web diagram below.*



Use with page 399.

Describe *the following concepts as they relate to the properties of liquids by completing the following passages.*

Capillary action is the movement of a liquid up a narrow tube; a function of cohesion and adhesion.

Cohesion is the force of attraction between identical molecules.

Adhesion is the force of attraction between molecules that are different.

Main Idea — Details

Solids

Use with pages 399–400.

Contrast *the density of solids and liquids by completing the following paragraph.*

In general, the particles in a solid are more closely packed—that is, more dense—than those in a liquid. When liquid and solid states of the same substance exist at the same time, the solid usually sinks in the liquid. One familiar exception is water. When water is in its solid state as ice, it floats to the top, such as ice cubes in a glass or a(n) ice-covered lake. This is because there is more space between the molecules in ice than in liquid water.

Use with pages 400–403.

Compare *the different types of crystalline solids by completing the following table.*

Type	Unit Particles	Characteristics	Examples
Atomic	atoms	soft to very soft; very low melting points; poor conductivity	Group 8A elements
Molecular	molecules	fairly soft; low to moderately high melting points; poor conductivity	I_2, H_2O, NH_3, CO_2, $C_{12}H_{22}O_{11}$
Covalent network	atoms connected by covalent bonds	very hard; very high melting points; often poor conductivity	diamond (C) and quartz (SiO_2)
Ionic	ions	hard; brittle; high melting points; poor conductivity	NaCl, KBr, $CaCO_3$
Metallic	atoms surrounded by mobile valence electrons	soft to hard; low to very high melting points; malleable and ductile; excellent conductivity	all metallic elements

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Section 13.4 Phase Changes

Main Idea — **Details**

Skim *Section 4 of your text. Write a brief summary of the main topics covered.*

Accept all reasonable responses.

New Vocabulary *Use your text to define each term.*

sublimation: process by which a solid changes directly to a gas without first becoming a liquid

condensation: process by which a gas or a vapor becomes a liquid

deposition: process by which a substance changes from a gas or vapor to a solid without first becoming a liquid

phase diagram: a graph of pressure versus temperature that shows in which phase a substance exists under different conditions of temperature and pressure

Compare and contrast *the following terms using your text as a guide.*

melting point, freezing point, and triple point: The temperature at which the forces holding the crystal lattice together are broken so that the solid becomes a liquid is called the melting point. The freezing point is the temperature at which a liquid is converted to a crystalline solid. The point on a phase diagram that represents the temperature and pressure at which three phases of a substance can coexist is the triple point.

vaporization and evaporation: Vaporization is the process by which a liquid changes to a gas or vapor. When vaporization occurs only at the surface of a liquid, this is called evaporation.

Name _____ Date _____

Section 13.4 Phase Changes (continued)

Main Idea — Details

Phase Changes That Require Energy

Use with page 404.

Classify *the types of phase changes by completing the table below. Use Figure 13–22 in your text for reference.*

Phase Transition	Type of Transition
gas to solid	deposition
solid to liquid	melting
liquid to gas	vaporization
liquid to solid	freezing
gas to liquid	condensation
solid to gas	sublimation

Use with pages 404–407.

Describe *the phase changes that require energy by completing the following outline.*

I. Melting

A. Heat energy disrupts hydrogen bonds.

B. The amount of energy required depends on the strength of the bonds.

C. The melting point is the temperature at which a crystalline solid becomes a liquid.

D. The melting point of amorphous substances may be unspecified.

II. Vaporization

A. In liquid water, some particles have more energy.

B. Particles that escape from liquid enter the gas phase.

C. When vaporization occurs only at a surface it is called evaporation.

D. The pressure exerted by a vapor over liquid is called vapor pressure.

E. The temperature at which vapor pressure equals atmospheric pressure is called the boiling point.

III. Sublimation

A. Many solids can become gases without entering the liquid phase first.

B. Some solids sublime at room temperature.

C. The process of freeze drying is an example of sublimation.

Name _____ Date _____

Section 13.4 Phase Changes (continued)

Main Idea — **Details**

Phase Changes That Release Energy

Use with pages 407–408.

Organize *the phase changes that release energy. Identify the phase, describe the process, and identify the reverse process by completing the table below.*

Phase Change	Process Description	Reverse Process
condensation	process by which a gas or vapor becomes a liquid	vaporization
freezing	process in which a liquid becomes a solid	melting
deposition	process by which a gas becomes a solid without ever becoming a liquid	sublimation

Phase Diagrams

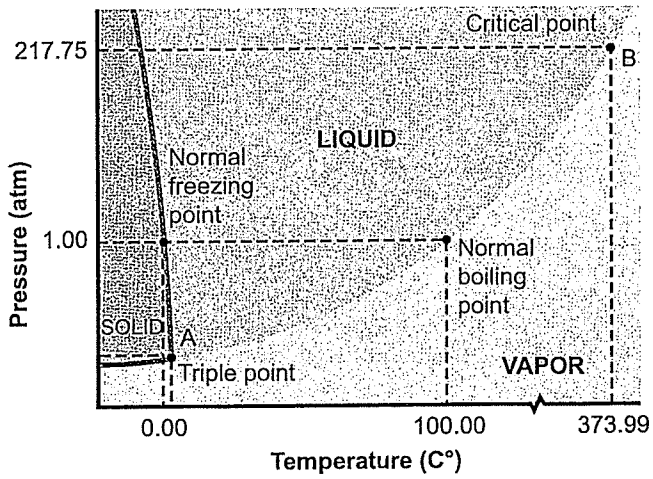
Use with pages 408–409.

Explain *how the critical point affects water.*

The critical point is the critical pressure and critical temperature above which water cannot exist as a liquid. Water vapor at critical temperature cannot be changed into a liquid if pressure is increased.

Identify *normal freezing point, normal boiling point, critical point, and triple point in the phase diagram for H_2O below. Use Figure 13–28 in your text for reference.*

Phase Diagram for H_2O



Name _____ Date _____

States of Matter Chapter Wrap-Up

After reading this chapter, list three key equations and relationships.
Accept all reasonable responses. Possible answers:

1. $KE = 1/2mv^2$
2. **Viscosity decreases as temperature increases.**
3. **Melting is the reverse process of freezing.**

Review

Use this checklist to help you study.

- ☐ Study your Science Notebook for this chapter.
- ☐ Study the definitions of vocabulary words.
- ☐ Review daily homework assignments.
- ☐ Reread the chapter and review the tables, graphs, and illustrations.
- ☐ Review the Section Assessment questions at the end of each section.
- ☐ Look over the Study Guide at the end of the chapter.

Real-World Connection

You see examples of phase changes every day. Use your text to identify which phase change each of the following transitions demonstrates. The first one has been done for you.

frost forms on a windowpane	deposition
ice becomes water	**melting**
steam rises from a cup of coffee	**vaporization**
a water pipe bursts on a very cold day	**freezing**
drops of water cover the mirror after a shower	**condensation**
snow melts without leaving a puddle	**sublimation**