

Visualizing the Kinetic Molecular Theory

Use with textbook pages 134, 135, and 138.

1. The key points of the kinetic molecular theory of matter are:
 - a) All matter is made up of very small molecules.
 - b) There are a lot of empty space between the particles.
 - c) Particles are always in constant random movement.
 - d) Particles move because they have kinetic energy. As they gain energy, they move faster.

2. Windsurfers depend on the properties of the three states of matter to enjoy their water activity. They ride the waves of the water to perform jumps and spinning manoeuvres on their board. Their movement is powered by wind on the sail. In the diagram below, describe the particle spacing and movement in a solid, a liquid, and a gas. Indicate the relative amount of kinetic energy in each state of matter.

Particle spacing: high ✓

Particle movement: high ✓

Kinetic energy: medium ✗

GAS (air)

Particle spacing: medium ✓

Particle movement: medium ✓

Kinetic energy: low ✗

LIQUID (water)

Particle spacing: low ✓

Particle movement: low ✓

Kinetic energy: medium ✗

SOLID (board, sail)

Properties of the States of Matter

Use with textbook pages 134, 135, and 138.

1. Complete the following table for solids, liquids, and gases. The table has been partially completed to help you with the descriptions.

	Solid	Liquid	Gas
Shape	fixed ✓	Not fixed ✓	<ul style="list-style-type: none"> • not fixed • takes the shape of the container
Volume	fixed ✓	<ul style="list-style-type: none"> • fixed volume 	Not fixed ✓
Mass	definite ✓	definite ✓	<ul style="list-style-type: none"> • definite
Arrangement of Particles	Particles are touching each other but unable to move ✓	<ul style="list-style-type: none"> • randomly arranged • particles are touching, but able to move past one another 	Randomly arranged. They're touching and are very free to move ✓
Movement of Particles	Is very tight and can't move ✓	Can move around at a medium pace ✓	<ul style="list-style-type: none"> • can move freely and quickly in all directions in the container

2. The metal lid on a jar of jam is screwed on tight. Use what you know about the behaviour of particles to explain whether it would be a good idea to run some cold or hot water under the lid to help to remove it.

Even if you heated the metal lid and the glass jar equally, you would loosen the lid a bit because the thermal expansion of the metal is greater than that of the glass. ✓

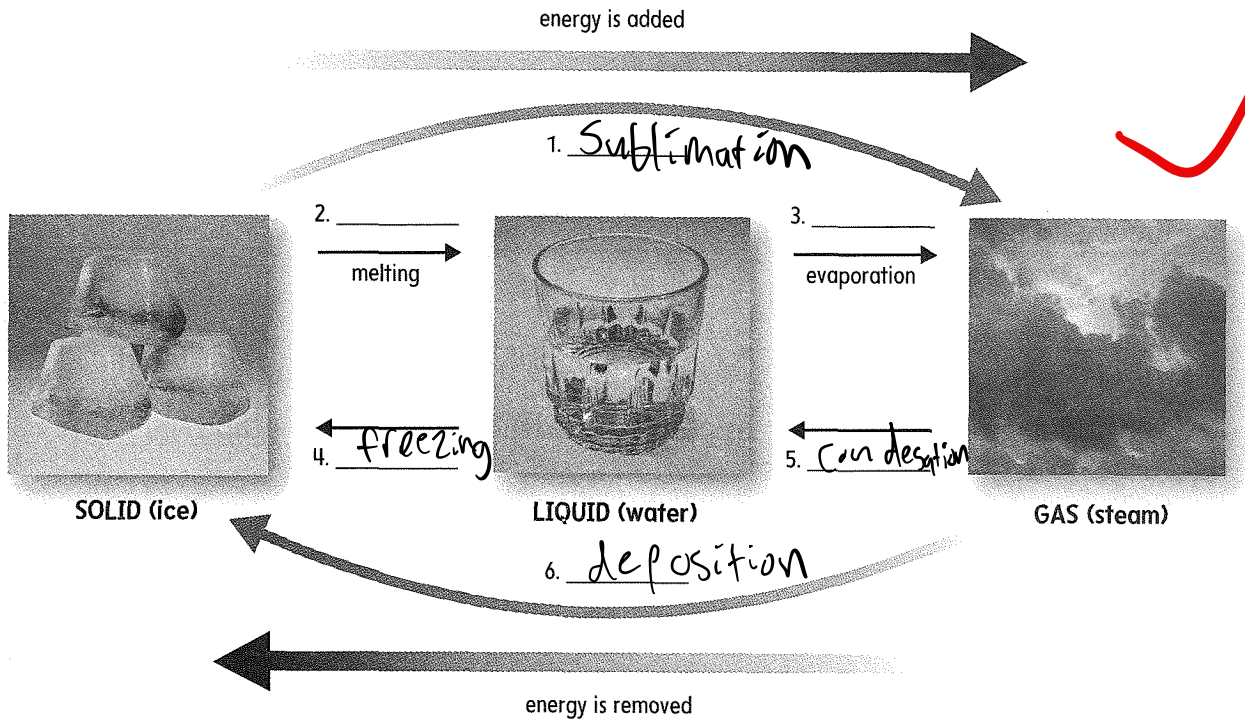
3. Engineers recommend the use of structural steel columns and reinforced concrete slabs to build parking garages. The steel increases the strength of the concrete. These two materials are often used together because they have similar rates of thermal expansion. Use your knowledge of the kinetic molecular theory and thermal expansion to explain the importance of steel and concrete having almost the same expansion rates.

It's important otherwise if for example the steel expanded faster it would crack the concrete that is trying to expand. ✓

Changes of State

Use with textbook pages 139-141.

1. Label the diagram shown below using the following terms: **condensation**, **deposition**, **vaporization**, **melting**, **freezing**, and **sublimation**. Place the terms in the correct locations on the numbered arrows.



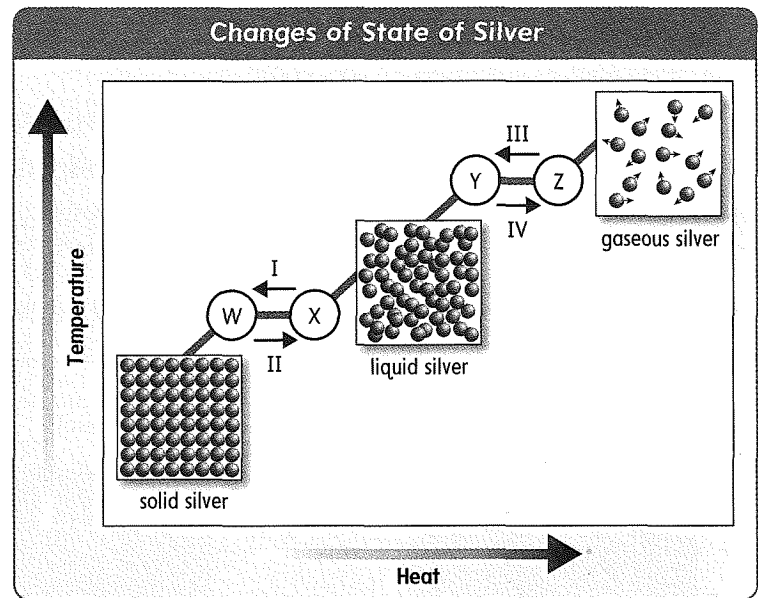
2. Complete the following table by indicating the initial and final states of matter and whether kinetic energy is added or removed. Give an example of each of the changes of state.

State Change	State of Matter		Kinetic Energy		Example
	Initial State	Final State	Added	Removed	
Melting	Solid	Liquid	Added	Removed	
Freezing	liquid	Solid		Removed	
Deposition	Solid	liquid			
Sublimation	gas	Solid			
Vaporization	liquid	gas	Added	Removed	
Condensation	Gas	Liquid		Removed	

Changes of State of Silver

Use with textbook pages 139-141.

The graph shows how temperature changes as energy is added to silver.



1. What do points I, II, III, and IV on the graph represent?
Representing the changing states

2. Use the kinetic molecular theory to explain how liquid silver becomes solid silver.
Kinetic energy is removed by reducing the temperature

3. What change of state occurs at points I, II, III, and IV on the graph?
Liquid to solid solid to liquid gas to liquid liquid to gas

4. What must be added to solid silver to cause it to change to a liquid?
Heat

5. What is happening to the particles during the process represented by IV on the graph?

6. If the temperature is increased, describe what happens to the kinetic energy of the particles in solid silver and the arrangement and movement of these particles. How is this change in motion detected?

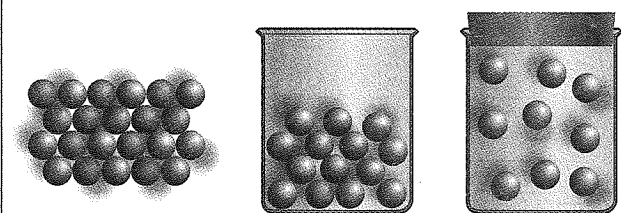
7. Explain what the temperature from point W to point X on the graph represents.

8. Explain what the temperature from point Y to point Z on the graph represents.
Y and z represents the boiling point.

9. Why is the temperature constant from point W to point X? What do you think is happening to the particles of silver as energy continues to be added to the silver?

2.3 Assessment

Match each description on the left with the state of matter on the right. Each state of matter may be used **more than once**.

Description	State of Matter
1. <u>Y</u> can diffuse the fastest	 <p style="text-align: center;">X Y Z</p>
2. <u>X</u> particles can only vibrate	
3. <u>X</u> has fixed shape and volume	
4. <u>Z</u> moves quickly in all different directions	
5. <u>Z</u> has shape and volume similar to plasma	
6. <u>Y</u> state of matter that is the end result of melting	
7. <u>X</u> particles are arranged in regular, repeating patterns	
8. <u>Y</u> particles slip and slide past each other in a container	

Circle the letter of the best answer for questions 9 to 23.

9. Which of the following analogies are appropriate to explain the different states of matter?

I	Solid—people standing side by side in a crowded elevator
II	Liquid—people dancing and moving around other people in a gym
III	Gas—two people at opposite corners of an empty football stadium

A. I and II only ✓

C. II and III only

B. I and III only

D. I, II, and III

10. Which state of matter is a gas-like mixture of positively and negatively charged particles that occur in the Sun and in lightning?

A. gas

C. liquid

B. solid

D. plasma ✓

11. Which of the following has a definite volume, but its shape is determined by its surrounding?

A. coffee ✓

C. a helium balloon

B. an apple

D. neon gas in an OPEN sign

12. What does the kinetic molecular theory explain?

- A. how particles behave when “their spacing and movement change”
- B. how to measure the kinetic energy of solids, liquids, and gases
- C. how to find the rate of diffusion of solids, liquids, and gases
- D. how to determine the change in temperature as a solid changes to a liquid and then to a gas

13. Which of the following are the key concepts of the kinetic molecular theory?

I	particles are in constant motion
II	matter is made up of very small particles
III	heat and kinetic energy make the particles move

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II, and III

14. What happens to a substance when energy is removed from it?

- A. The particles increase in volume.
- B. The particles become less dense.
- C. The particles take up more space.
- D. The particles move around at a slower rate.

15. Which of the following explains why running through air is easier than running through water?

- A. There are more empty spaces in air than water.
- B. The particles are more compact in air than water.
- C. Air is denser than water and easier to manoeuvre around.
- D. There are no particles in air, while there are lots of particles in water.

16. Which of the following changes of state involve energy being released to the environment?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II, and III

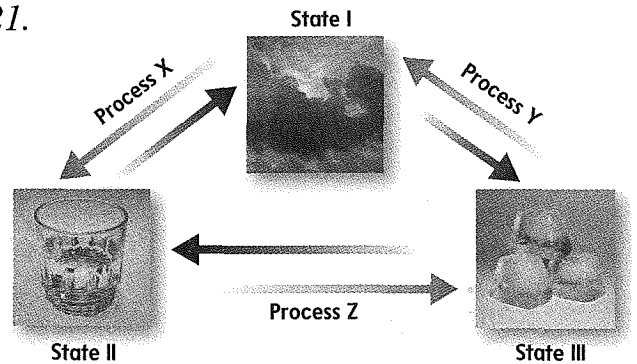
I	deposition
II	vaporization
III	condensation

17. Which of the following describe melting?

- A. I and II only
 B. I and III only
 C. II and III only
 D. I, II, and III

I	energy is added
II	the opposite of freezing
III	change of state from a solid to a liquid

Use the diagram to answer questions 18 to 21.



18. Which of the following shows the three states of matter in order of increasing kinetic energy?

	Least amount of kinetic energy →		← Greatest amount of kinetic energy
A	State I	State II	State III
B	State II	State I	State III
C	State III	State I	State II
D	State III	State II	State I

19. What represents **Process Y** in the diagram?

- A. melting
 B. freezing
 C. sublimation
 D. vaporization

20. Which of the following occurs during **Process Z**?

- A. Kinetic energy is added.
 B. Particles start to slow down.
 C. The volume becomes indefinite.
 D. Particles spread farther apart.

21. Which of the following is an example of **Process X**?

- A. the hardening of cement
 B. dew forming on grass in the morning
 C. liquid hand sanitizer evaporating from your hand
 D. the heat from the flame melting the wax on a birthday candle

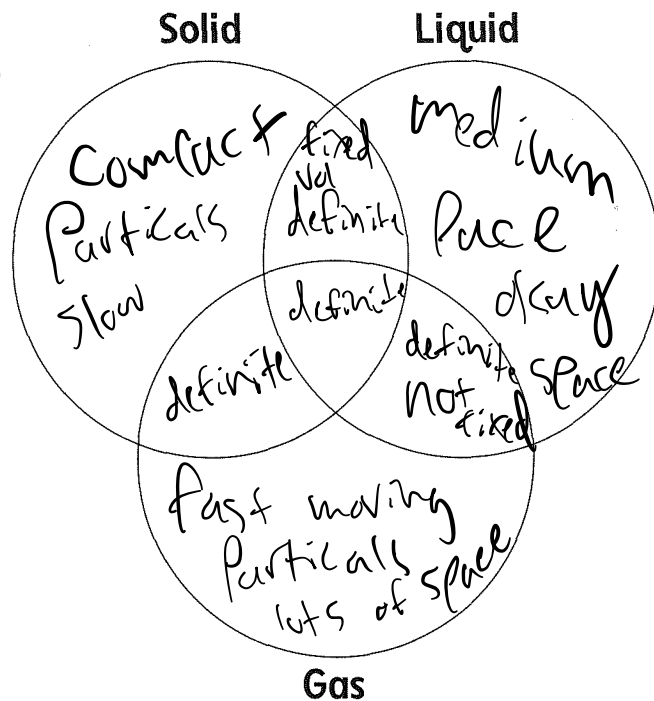
22. Which of the following refers to the temperature at which a liquid becomes a gas?

- A. dew point
- B. boiling point**
- C. melting point
- D. freezing point

23. When a metal expands due to a temperature increase, this is referred to as

- A. plasma
- B. thermal expansion**
- C. a chemical change
- D. thermal contraction

24. Complete the Venn diagram to compare and contrast a solid, a liquid, and a gas.



25. Create a mind map for matter. You may use lines to connect any two terms together. Use the following terms in your mind map:

