Introduction to Gases Guided Inquiry

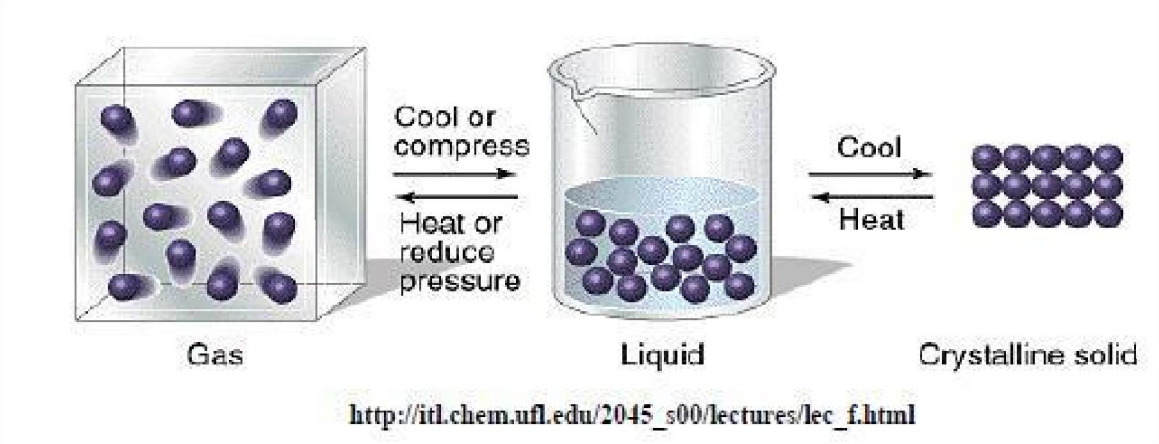
Why?

The kinetic-molecular theory is a model or a mental image of how particles of matter behave. Knowledge of the kinetic-molecular theory allows us to predict the action of solids, liquids, and gases and understand how the changes of state occur.

Learning Objectives

- Identify the basic differences between particle behavior in the solid, liquid and gaseous phases.
- Develop an understanding of the postulates of the kinetic-molecular theory.

Model 1 Representation of Atoms in Different Phases



Key Questions

A. What are the key characteristics of atoms and molecules in gases, liquids, and solids? In Table 1 below, describe the characteristics of particles for each phase of matter based on Model 1 on the previous page. Be specific with regard to spacing, the potential of particles for movement, and whether or not the particles will fill the container.

Table 1. Characteristics of the Phases of Matter

	SOLID	LIQUID	GAS
SPACING			
POTENTIAL FOR MOVEMENT			
FILLING A CONTAINER			

B. In which phase of matter is there the least spacing between particles?

C. In which phase of matter is there the most potential for movement?

D. Which phase of matter does not have a definite shape yet the particles will not fill the container?

E. In terms of spacing, what would be necessary to change from a solid to a liquid? What is this process called and how is this accomplished?

F. In terms of spacing, what would be necessary to change a liquid to a gas? What is this process called and how is this accomplished?

G. In terms of spacing, what would be necessary to change a liquid to a solid? What is this process called and how is this accomplished?

Model 2 POSTULATES OF THE KINETIC MOLECULAR THEORY

The following is a model to explain IDEAL gas behavior:

1. **Gases consist of tiny neutral particles (atoms or molecules)**
2. **These particles are so small, compared with the distances between them that the volume (size) of the individual particles can be assumed to be negligible (zero).**
3. **The particles are in constant, random, straight-line motion, transferring energy when colliding with the walls of the container and each other. These collisions cause the pressure exerted by the gas.**
4. **The gas particles are assumed to not attract nor repel each other.**
5. **The average kinetic energy of the gas particles is directly proportional to the Kelvin temperature.**

Key Questions

A. What causes a gas to exert pressure when confined in a container?

B. How does the total volume of gas particles compare to the volume of the space between the gas particles?

C. As the temperature of a gas decreases, what change occurs in the amount of kinetic energy?

D. When gas particles collide, they are “assumed not to attract nor repel each other”. Why do you think this is?

E. What is the relationship between temperature and molecular motion?

F. In terms of the kinetic-molecular theory of gases, how can an increase in the temperature of a gas confined in a rigid container cause an increase in the pressure of the gas?

G. The postulates of the Kinetic Molecular Theory are for IDEAL gases. However, we DO NOT have ideal gases here on earth; instead we have REAL gases. Which two postulates of the Kinetic Molecular Theory do not hold true for real gases here on earth?

H. What conditions of temperature and pressure will allow real gases to behave more ideally?

Questions for Understanding

1. A sample of a gas is contained in a closed rigid cylinder. According to kinetic molecular theory, what occurs when the gas inside the cylinder is heated?
   A) The number of gas molecules increases.
   B) The number of collisions between gas molecules per unit time decreases.
   C) The average velocity of the gas molecules increases.
   D) The volume of the gas decreases.

2. Under which conditions of temperature and pressure would He behave most like an ideal gas?
   A) 50 K and 20 kPa
   B) 50 K and 600 kPa
   C) 750 K and 20 kPa
   D) 750 K and 600 kPa

3. The kinetic molecular theory assumes that the particles of an ideal gas
   A) are in random, constant, straight-line motion
   B) are arranged in a regular geometric pattern
   C) have strong attractive forces between them
   D) have collisions that result in the system losing energy

4. The concept of an ideal gas is used to explain
   A) the mass of a gas sample
   B) the behavior of a gas sample
   C) why some gases are diatomic
   D) why some gases are monatomic

5. Under which conditions does a real gas behave most like an ideal gas?
   A) at low temperatures and high pressures
   B) at high temperatures and high pressures
   C) at low temperatures and low pressures
   D) at high temperatures and low pressures

6. Two basic properties of the gas phase are
   A) a definite shape and a definite volume
   B) no definite shape but a definite volume
   C) a definite shape but no definite volume
   D) no definite shape and no definite volume

7. An assumption of the kinetic theory of gases is that the particles of a gas have
   A) little attraction for each other and a significant volume
   B) little attraction for each other and an insignificant volume
   C) strong attraction for each other and a significant volume
   D) strong attraction for each other and an insignificant volume

8. According to the kinetic theory of gases, which assumption is correct?
   A) Gas particles strongly attract each other.
   B) Gas particles travel in curved paths.
   C) The volume of gas particles prevents random motion.
   D) Energy may be transferred between colliding particles.

9. When a sample of a gas is heated at constant pressure, the average kinetic energy of its molecules
   A) decreases, and the volume of the gas increases
   B) decreases, and the volume of the gas decreases
   C) increases, and the volume of the gas increases
   D) increases, and the volume of the gas decreases

10. A real gas behaves more like an ideal gas when the gas molecules are
    A) close and have strong attractive forces between them
    B) close and have weak attractive forces between them
    C) far apart and have strong attractive forces between them
    D) far apart and have weak attractive forces between them

11. A real gas differs from an ideal gas because the molecules of real gas have
    A) some volume and no attraction for each other
    B) some volume and some attraction for each other
    C) no volume and no attraction for each other
    D) no volume and some attraction for each other