



Connected Chemistry

Gas Laws Unit

Lesson 2: Kinetic Molecular Theory



Student's Lesson at a Glance

Lesson Summary

This lesson contains three activities. The Connecting Activity reminds students that gases are matter and, like all other phases of matter, gases are in constant motion. The Kinetic Molecular Theory (KMT) describes this constant motion. Students simulate KMT by throwing a gas molecule in a closed container and observing the changes in the system. Using the simulations, students then explore the five postulates of KMT. In the final step of the exploration, students symbolically represent the energy exchange during collisions and determine the relationships between kinetic energy and the temperature of a system. In the final activity of the lesson, the teacher formally defines postulates for the students to record.

SWBAT (Student will be able to)

- Understand the Kinetic Molecular Theory as it applies to gases.

Essential Vocabulary

Keep a list of all important words from this lesson. This list, in addition to the lists from other lessons, will make studying easier and improve scientific communication skills. The essential vocabulary from the unit is in **bold**. Additional words that will expand your scientific vocabulary are in *italics*.

CCC Reminder

- Vectors are arrows that show both the direction and velocity of an object. The longer the vector, the faster the object is going. Vectors will be useful in drawing the motion of gas molecules in your sketches. In CCC, colored arrows represent the kinetic energy of the molecule or atom. Red represents an increased kinetic energy, black represents no change in kinetic energy, and blue represents a decreased level of kinetic energy. Vectors should be included in the keys when you produce your sketches.
- There are five postulates in the Kinetic Molecular Theory. Try to identify what each of the postulates could be based on your observations.

Notes

Homework

Upcoming Quizzes/ Tests



*This page has been left blank.
Please turn to the next page.*



Activity 1: Connecting

1. Describe how you think molecules inside birthday balloons move and interact with each other.

One of the first lessons students may learn in chemistry is on the topic of the nature of matter. Often, students are asked to provide examples of matter from their everyday observations. Some examples might include the walls of a classroom, a piece of gum, a can of soda, the tires on a car, a person, an ink pen, and many other answers. However, sometimes students do not list gases as a form of matter. What about the gases that fill a room, a car tire, or a sealed bag of chips?

Gases exist everywhere, like the steam formed in a shower, the air inflating our lungs, and the helium in birthday balloons. Recall that scientists often have to use models to better understand these complex phenomena. In the universe, there are numerous types of gases that interact. To better understand the complexity of gases, scientists need to simplify their observations with the use a *model* called an **ideal gas**. The ideal gas model approximates the behavior of a real gas across a limited range of temperatures and pressures. Scientists use the ideal gas model to predict the behavior of real gases. You will learn more about how real gases behave at very high pressures and low temperatures in Lesson 5.



Using the model of an ideal gas to describe all real gases is convenient but has some limitations. Descriptions of real gases, such as helium, oxygen, or carbon dioxide, will be close enough that any errors are compensated for easily. **Kinetic Molecular Theory (KMT)** is the theory helping to explain the behavior of the molecules in an ideal gas. KMT consists of five **postulates** (or parts).

2. By breaking apart the name of the Kinetic Molecular Theory, what do you think the theory is about?

In prior lessons, the concept that matter is always in motion (even as a solid) may have been discussed. Gases are no exception. KMT helps to accurately describe the *interactions, motion, attraction, and energy* of a gas.

3. Is air an example of matter? *Explain.*
-
-
4. Kinetic energy is the energy of motion. What do you already know about matter supporting the idea that all matter has kinetic energy?
-
-
5. Based on your observations from the macroscopic world, how do you know that gases move?
-
-



Activity 2: Kinetic Molecular Theory

Part 1: Use Simulation 2, Set 1.

In this simulation, you will explore the five parts of Kinetic Molecular Theory. The simulation contains one diatomic gas. Make sure the heat level is set at zero.

6. How are the molecules moving in the simulation?
-
-
7. What quantitative measurements do the simulation's monitors provide?
-
-

Enable tracking to turn on the tracking line. By checking the box, you will turn on a colored line that follows the path of one molecule.

8. How do molecular collisions affect molecular velocity? *Support your claim with evidence.*
-
-



9. As the molecules collide, how do changes in molecular velocity affect the average kinetic energy of the system?

10. If you could grab one molecule in the simulation and throw it at the wall of the container predict what would happen to the molecule. Include velocity, collisions, and directions in your description.

11. If you throw a molecule, how is the kinetic energy of that molecule changed?

12. Would the kinetic energy of the entire simulation change if you "threw a molecule"?

13. State at least two ways that throwing one molecule would change the system.

14. How would "throwing" 10 or more molecules change the system?



Part 2: *Continue to use Simulation 2, Set 1.*

15. Describe the appearance, location, interaction and motion of the molecules in the simulation.

16. Do the bromine gas molecules chemically react with one another? *Support your claim with evidence.*

17. What are your observations of the volume of the container and the volume of the gas?

18. Did the total kinetic energy of the system change over time? *Explain.*

Part 3: *Continue to use Simulation 2, Set 1.*

Turn the tracking on for one molecule of gas. Make sure the heat level is zero.

19. What happens when two gas molecules collide?



20. What happens to the kinetic energy of each of the molecules during the collision? *Support your claim with evidence.*

21. What happens to a molecule when it hits the side of the container?

22. How is the velocity of the gas molecule affected by the collision with the “hot” container bottom?

23. As the temperature of the system increases, what happens to the rest of the gas molecules?

24. Temperature is dependent on how much heat is added or taken away from the system. Are heat and temperature the same thing? *Explain.*

Part 4: *Continue to use Simulation 2, Set 1.*

25. Prior to the gas molecules colliding, how would you describe their velocities?



26. What happens to the velocity of a gas molecule when it collides with a cool wall?




27. As the temperature of the system decreases as heat is removed. What happens to the the gas molecules in the system?

Part 5

The diagrams below show a gas molecule involved in a collision. Remember that you can use vectors to show direction and velocity of gas molecules. The *length* of a vector represents velocity.

The *colors* in the simulation and your sketches are symbolic as they represent changes in energy or the relative velocity of the system. **Red** represents increased energy, **Blue** represents decreased energy and **Black** represents an even exchange in energy.

You do not need to redraw the wall.

-  Increased energy, fast velocity
-  Even level of energy, medium velocity
-  Decreased energy, slow velocity

Using arrows to represent changes in energy, create sketches of the four different types of collisions, after the collision occurs. You do not need to redraw the wall.

Recall from the Matter Unit that molecules are always moving. In the case of solids, with organized structures, this motion is exhibited as vibrations. The “fuzzy” molecules in the diagrams below represent vibration. For example, solid silicon dioxide (glass) molecules that have more energy in them from heat energy being added will have more vibration so they are represented with more fuzziness.



Gas before collision with hot wall	Gas before collision with room temp. wall	Gas before collision with cold wall	Two gas molecules before collision
Gas after collision with hot wall	Gas after collision with room temp. wall	Gas after collision with cold wall	Two gas molecules after collision

28. When a molecule hits a wall with a lower energy level than the molecule has, how is the molecule affected? *Explain.*

29. When a molecule hits a wall with a higher energy level than the molecule has, how is the molecule affected? *Explain.*

30. If the average kinetic energy increases, the temperature of the environment *increases* or *decreases* (*circle one*).

31. The average kinetic energy of a system is *directly* or *indirectly* (*circle one*) related to temperature.

Lesson Reflection Question

32. Using your experience with the simulations, describe what you think are the five postulates of KMT.



Activity 3: Teacher Facilitated Discussion

Part 1: Use Simulation 2, Set 1

The five postulates of KMT can be derived using the computer simulations. You have already explored these postulates in the previous activity. Follow along with your teacher as the key points from the simulation are reviewed and complete the chart below with the formally stated postulates. Complete the questions following the table and fill in the table on the next page by creating sketches of the postulates.

Postulate	Kinetic Molecular Theory
1	
2	
3	
4	
5	

33. Considering that gas molecules move quickly and have little attraction to each other, what would happen if the molecules slowed down?
-



34. Looking at the simulation, what variables could affect how gases behave?

Postulate 1: Submicroscopic Sketch	Postulate 2: Submicroscopic Sketch
Postulate 3: Submicroscopic Sketch	Postulate 4: Submicroscopic Sketch
Postulate 5: Submicroscopic Sketch	Key