Connected Chemistry

Thermodynamics Unit

Lesson 5: Mass, Motion and Energy

Student's Lesson at a Glance

Lesson Summary

This lesson has three activities that demonstrate the relationship between mass, motion, and energy. Following a connecting reading and teacher demonstration of technology, students use a CCC simulation with three gases to determine the relationship between particle mass, particle velocity, and energy. Students conclude the lesson by labeling and analyzing a graphic representation of the average molecular speed of five different gases found in air.

SWBAT (Students Will Be Able To)

- Identify how mass affects the velocity of molecules
- Identify the relationships between mass of molecules, velocity of the molecules, and the energy of molecules in a system

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

- Gas laws and thermodynamics are closely connected. Looking back on concepts and related to gas laws may be helpful in this unit.
- Prefixes and suffixes on words can help you discover the meaning of a word.
- Use the vocabulary section and note section to take good notes so that studying for tests and quizzes is easier.
- Supporting claims with evidence is not only a skill that scientists use, but a skill that will help you in other classes and everyday life.
- Draw a key when you are sketching. Keys can help you and others decode your sketches at a later time.
- Arrows will be helpful in showing both direction and velocity in your submicroscopic sketches.
- There is a periodic table and list of common elements used in the back of this book. You will need to refer to the periodic table often.

Notes

Homework

Upcoming Quizzes/Tests

Activity 1: Connecting

1. Do you think every molecule in a sample of air moves at the same exact velocity? *Support your claim with evidence.*

2. Are the collisions between gas molecules elastic or inelastic? *Be sure to include your own personal definition for the term elastic and how it relates to the submicroscopic level.*

Air is composed of matter; it is a mixture of many types of gases including nitrogen, carbon dioxide, oxygen, argon, and water vapor. These gas molecules are in constant motion. As discussed previously, the velocity of particles is related to the thermal energy in a system. However, thermal energy depends not only on the speed of particles, but also on particle mass. Thus, each type of gas in a mixture of air might move with equal velocity, but because they have different masses, they differ in thermal energy.

3. What factors affect the way air molecules move and interact?

4. Does every gas molecule in a sample of air have the same kinetic energy? *Support your claim with evidence.*

5. Consider the picture of the hot air balloon. Are the molecules inside the balloon moving at the same speed as the molecules outside of the balloon?

Activity 2: Demonstrating Mass, Motion, and Energy

Demonstration: *Use Simulation 2, Set 1*

- *Your teacher will start the simulation by adding 10 molecules each of nitrogen, oxygen, and carbon dioxide to a closed system. These three elements represent some of the gaseous components of air. Temperature is held constant in the simulation.*
- *Using the simulation, create a key and a submicroscopic sketch, gather the required data, and record your observations regarding particle appearance, location, interaction, and motion. You will need to calculate total mass for the gases.*

Create a submicroscopic sketch of the simulation	Record Data from Monitors			
	Volume		Temperature	
	Pressure		Total Energy of System	
	Mass		Total Average Velocity	
	Record your observations (appearance, location, interactions, motion)			
Key				

6. Kinetic energy is calculated with the following equation: $KE = {}^{1}/_{2}\ mV^{2}$. Would you expect the kinetic energy of each type of gas to be the same at constant temperature? Explain why you think your answer is correct.

7. Using data from the simulation, do you think the average velocity of each of the three different gas molecules equal at constant temperature? *Support your claim with evidence.*

Activity 3: Simulating Mass, Motion, and Energy

Simulation: *Use Simulation 2, Set 1*

- *Reset your simulation. Add nitrogen to the simulation at constant temperature.*
- *Create a key and submicroscopic sketch, gather the required data, and record your observations regarding particle appearance, location, interactions and motion.*
- *Repeat this procedure for oxygen, then for carbon dioxide.*

<table>
<tr><td rowspan="5">N_2</td><td rowspan="5">Create a Submicroscopic Sketch of the Simulation</td><td colspan="4">Record Data from Monitors</td></tr>
<tr><td>Volume</td><td></td><td>Temperature</td><td></td></tr>
<tr><td>Pressure</td><td></td><td>Mass</td><td></td></tr>
<tr><td>Total Energy of System</td><td></td><td>Total Average Velocity</td><td></td></tr>
<tr><td colspan="4">Record Your Observations</td></tr>
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<tr><td rowspan="5">O_2</td><td rowspan="5">Create a Submicroscopic Sketch of the Simulation</td><td colspan="4">Record Data from Monitors</td></tr>
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<tr><td>Volume</td><td></td><td>Temperature</td><td></td></tr>
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8. How does the mass of each gas relate to its average velocity at a constant temperature?

9. Why does the kinetic energy of the system remain constant?

10. Calculate the average kinetic energy of each of the substances. Rank the substances from highest average kinetic energy to lowest average kinetic energy. Recall that $KE = 1/2\ mV^2$. *Support your claim with evidence.*

Lesson Reflection Question

11. As the kinetic energy of the system increases, what other variable(s) change when mixing gases? *Explain why the variables you selected would change.*