Lesson Topic: Gases and Liquids

Objective:
Students will be able to:

1. Explain how water molecule movement changes with energy
2. Observe the relationship between molecule movement and phases

Time Required: 75 minutes

Materials Needed:

- Ice water
- Hot water / microwave or hot plate to heat water
- Measuring cup for each group
- Thermometer for each group
- Stopwatch / timer for each group
- 3 beakers for each group
- Teacher computer with internet access
- Projector/Smartboard
- 1 computer/laptop/iPad per student with internet access
- Molecules in Gases and Liquids handout (attached)

Teacher Preparation:

- Assign a Legends of Learning Instructional Quick Play playlist for the day(s) you will be teaching the lesson.
    - Instructional - Middle School - Gases and Liquids
- Assign a Legends of Learning Content Review Quick Play playlist for the day(s) you will be teaching the lesson.
    - Content Review - Middle School - Gases and Liquids
- Set aside water in a large beaker to heat (this can also be done while students are completing the Explore section of the lesson)
- Set aside water in a large beaker and place in the refrigerator
- Set up 3 beakers, measuring cup, food coloring, thermometer, stopwatch for each group
- Make copies of Molecules in Gases and Liquids handout (1 per student)

Engage (5 minutes):

1. Show class video on the Arrangement of Particles in Solids, Liquids, and Gases
    a. Arrangement of Particles in Solids, Liquids, and Gases
2. While watching, have students focus on the liquids and gases information.

Explore (20 minutes):

1. Have your students sign in to Legends of Learning. Instruct students to complete the Instructional playlist.
2. As students complete the assigned game, students should fill out the top portion of the Molecules in Gases and Liquids Handout.
3. Assist students as needed during game play, pause playlist if you need to address

content or questions to the entire class.

Explain (10 minutes):

1. Review answers to top portion of Molecules in Gases and Liquids handout by drawing diagrams on board or using Smartboard.
2. Explain to the class that they are going to test out this knowledge with an experiment involving water and how the molecules change speed with heat.

Elaborate (25 minutes):

1. Break students into groups (3-4 in each group) and distribute materials as needed.
2. Explain the directions and how the chart section should be recorded (review how to accurately measure volume and temperature if needed).
3. Assist groups as needed with distribution of heated and cold water.
4. Let groups begin by measuring out 200ml of water into each beaker.
5. After equal amounts of water have been dispersed to each beaker, instruct students to measure temperature (°C) and record.
6. Next, have students squeeze 2 drops of food color into each beaker and start timer.
7. Students should watch and record qualitative observations according to the increments on the hand out.
8. After all observations have been recorded, have students talk with in their groups and draw a conclusion as to why the food color behaved differently in each beaker.
    a. *Answer: The food color should have dissipated much more quickly in the hot water than at room temperature or cold water. This is because the molecules move more quickly and freely in an energized (heated) state.*
9. Ask groups if this would be the same for gases?
    a. *Answer: Yes. Most gases are invisible to the naked eye, but the molecules behave the same if energized (heated)*

Evaluate (15 minutes):

1. As a class, ask the groups to share their conclusions and address any misconceptions, if needed.
2. Have your students sign in to Legends of Learning. Instruct students to complete the Content Review playlist.
3. Analyze student results to determine what concepts need to be a focus for reteaching.

Additional Lesson Strategies:

- To use Legends for additional instruction, create a custom playlist with an instructional game and pre and post assessment.
- To use Legends for a quick formative assessment, create a 5-question assessment in a playlist.
- To use Legends for a student-directed experience, create a targeted freeplay playlist.
- Encourage students to play on their own at home in Legends of Learning: Awakening for a student-driven experience including avatars, battling, and quests all centered around topics they are covering in class.

Molecules in Gases and Liquids

Directions: Use the space below to draw a picture of the molecules for each state of matter.

Gas	Liquid

1. Gas molecules _____ (speed up/ slow down) when energy is added.
2. Liquid molecules flow _____ (faster/ slower) when energy is added.

Molecules in Movement Experiment

You Must Have:

- 3 Beakers each filled with the same amount of water (hot, room temperature, cold), food coloring, thermometer, measuring cup, stopwatch/ timer

Directions:

1. Fill each beaker with 200ml of water. Use the measuring cup provided. You should have one beaker of hot water, one beaker of room temperature water, and one beaker of hot water.
2. Measure and record the water temperature of each beaker (℃).
3. Quickly squeeze 2 drops of food coloring into each beaker.
4. Start timer and record observations of the movement of the food coloring at each time increment (30 sec, 1 min, 2 min, 5 min)
5. Your observations can be pictures or words, but must be recorded for each beaker at each time.
6. With your group, draw a conclusion about what happened with the food coloring, based on what you know about energy in molecules.

Read the directions for the Molecules in Movement Experiment with your group. Record data in the chart below using words, numbers, or pictures.

Water Type	**Temperature (℃)**	**30 seconds**	**1 minute**	**2 minutes**	**5 minutes**
Cold water					
Room Temperature water					
Hot water					

What conclusion can you draw about the movement of molecules in a liquid when energy (heat) is added? Use evidence from the experiment to support your answer.

_____

_____

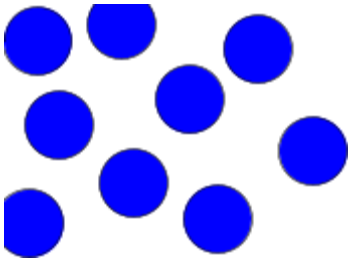
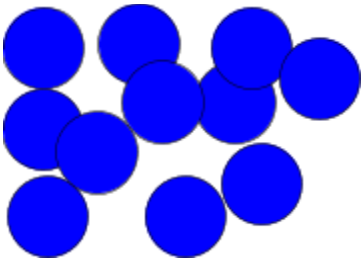
_____

_____

Do you think the same is true for gases? Explain your reasoning. _____

Molecules in Gases and Liquids Key

Directions: Use the space below to draw a picture of the molecules for each state of matter.

Gas	Liquid
	

1. Gas molecules _____ (**speed up**/ slow down) when energy is added.
2. Liquid molecules flow _____ (**faster**/ slower) when energy is added.

Molecules in Movement Experiment

You Must Have:

- 3 Beakers each filled with the same amount of water (hot, room temperature, cold), food coloring, thermometer, measuring cup, stopwatch/ timer

Directions:

1. Fill each beaker with 200ml of water. Use the measuring cup provided. You should have one beaker of hot water, one of room temperature water, and one of hot water.
2. Measure and record the water temperature of each beaker (℃).
3. Start timer and record observations at each time increment (30 sec., 1 min., 2 min., 5 min.)
4. Your observations can be pictures or words, but must be recorded for each beaker at each time.

5. Draw a conclusion about what happened with the food coloring, based on what you know about energy in molecules.

Read the directions for the Molecules in Movement Experiment with your group. Record data in the chart below using words, numbers, or pictures.

Water Type	**Temperature (℃)**	**30 seconds**	**1 minute**	**2 minutes**	**5 minutes**
Cold water	2 - 10 ℃	*The food color appears to sink slowly in the water, does not mix quickly*	*The food color has mixed in more, but most of it appears to sit at the bottom of the beaker*	*The food color is slowly mixing*	*The food color has still not completely mixed with the water*
Room Temperature water	20 - 25 ℃	*The food color has mixed some, not as quickly as the hot, but not as slowly as the cold*	*The food color continues to mix*	*The food color continues to mix*	*The food color is completely mixed*
Hot water	+75℃	*The food color has swirled around the beaker and mixed in a large portion of the water*	*The food color has mixed almost completely*	*The food color has mixed completely*	*The food color has mixed completely*

What conclusion can you draw about the movement of molecules in a liquid when energy (heat) is added?_____*The food color dissipated much more quickly in the hot water than at room temperature or cold water. This is because the molecules move more quickly and freely in an energized (heated) state*_____

Do you think the same is true for gases? Explain your reasoning. ___*Yes, we can not see gases with the naked eye, but if we could color the gas, we would see the same thing with the molecules when it is heated.*_____