

# NASA Spotlight Interactive Lesson

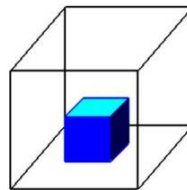
## Movement of Molecules

### Grades 5-8



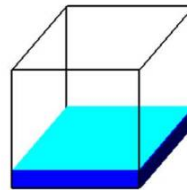
#### Phases of Matter

Glenn  
Research  
Center



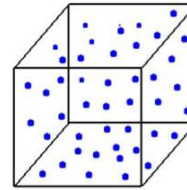
**Solid**

Holds Shape  
Fixed Volume



**Liquid**

Shape of Container  
Free Surface  
Fixed Volume



**Gas**

Shape of Container  
Volume of Container



## Teacher Packet

# NASA Spotlight Interactive Lesson Guide



This NASA eClips™ Spotlight Interactive Lesson supports existing curriculum and should be used as one of many strategies to build students' understandings of science content. The goal of this 5E lesson is to address a science misconception. Through watching a student-produced video (Engage), completing activities (Explore), explaining relevant concepts while applying new vocabulary collectively using a Frayer Model (Explain), and applying new information (Extend/Elaborate), students will develop an understanding of the science content and how to correct the science misconception.

This PDF document should be downloaded to use the interactive features. The hyperlinks included in this document open PDFs or webpages and may perform differently based on the device being used. Links may have to be cut and pasted into a web browser to open.

Try using Adobe Acrobat Reader and Flash Player for optimal performance of all interactive features included in this guide.

An accompanying student packet is located on the NASA eClips™ Website.

## What are NASA Spotlights?

NASA Spotlights are 90-120 second student-produced video segments that address common science misconceptions as determined by reputable assessment sources such as the National Assessment of Educational Progress (NAEP),

National Science Foundation (NSF) Factual Knowledge Questions, and the Misconceptions-Oriented Standards-based Assessment Resources for Teachers (MOSART). NASA Spotlights are designed to increase scientific literacy in a standards-based classroom. By producing Spotlight videos, students gain production experience, as well as deepen their understanding of science content. Approved NASA Spotlights can be found at the NASA eClips website.  
<https://nasaclips.arc.nasa.gov/>

## Animated 5E Instructional Model



NASA eClips™ Guides use the 5E constructivist model developed by Biological Sciences Curriculum Study. Constructivism is an educational philosophy that promotes student-centered learning where, students build their own understanding of new ideas. The 5E instructional model consists of five stages for teaching and learning: Engage, Explore, Explain, Extend (or Elaborate), and Evaluate.

# Lesson Information

## Science Misconception

Student Misconception: Atoms or molecules of a solid are not moving.

## Standards

### Next Generation Science Standards

2-PS1.A: Structure and Properties of Matter

5-PS1.A: Structure and Properties of Matter

- Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means.

MS-PS1 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other.
- In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.
- The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.

## Objective

In this lesson, students will address the common misconception that molecules in a solid are not moving. As the students develop their understanding of the molecules in different states through explore activities, they will learn new vocabulary that applies to new concepts. Students will apply the vocabulary as they explain how molecules move as solid, liquid, and gas.

## Time Frame

Between two and three 45-minute class periods:

Day 1 - Engage and Explore

Day 2 - Explain and Elaborate/Extend

Day 3 – Evaluate

## Materials

### Assessment

Per student: copy of pretest and posttest

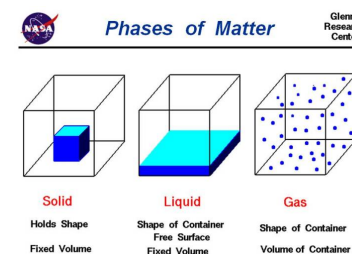
### Frayer Model Activity

- Per small group: copy of a digital Frayer Model (alternatively, this can be printed)
- Per classroom: chart paper for posting final vocabulary definitions

## Background Information

- In a solid, the atoms stay in a fixed position and vibrate. As the solid is heated the motion of the atoms increases.
- In liquids, the molecules are no longer in a fixed position. The molecules slide slowly past each other.
- The molecules in a gas collide more frequently with each other as heat is added. In gases, molecules move farther apart from each other.

**Target Vocabulary:** phase change, states of matter, atoms, molecule, solid, liquid, gas, vibrate



## Safety

Review digital citizenship before students use online resources.



This icon identifies the suggested directions and information to read to students.

**Save**



Remind students to save responses. Suggested steps: Under "file" choose "save as." Type your name in front of the document name. Choose "save."

# Engage

## Pre-Assessment

Probe for students' prior knowledge using the pre-assessments.

1. Pretest items are located on page 12. Student packets contain a pretest.
2. Essential question
3. Discussion questions (this page)

Essential Question

Do atoms and molecules in a solid move?



## Today's Lesson

In this lesson you will learn about the movement of molecules. The activities you will do will let you explore and develop an understanding of how molecules move in three states of matter. Using interactive Frayer Models, you will learn key vocabulary that will help you explain how molecules move in a solid.

What do you already know about how atoms and molecules move in the different phases of matter?

**True or False:** Atoms and molecules in a solid move.

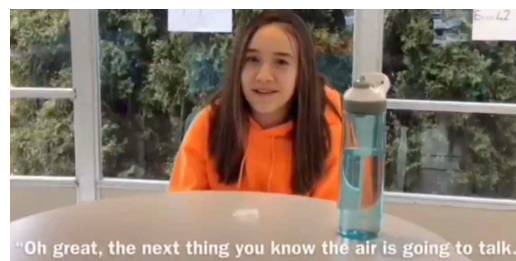
## Spotlite Video

Have students watch the NASA Spotlite video and identify key vocabulary words and phrases. Examples: phase change, states of matter, atoms, molecule, solid, liquid, gas, vibrate



## Spotlite Video

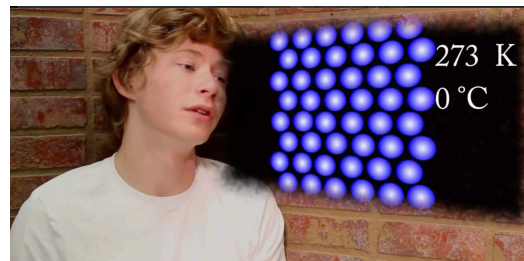
Next, watch one of the Spotlite videos on the movement of molecules. As you watch pay attention to any new vocabulary.



Video Link- [NASA Spotlite: Movement of Molecules](https://nasaclips.arc.nasa.gov)

NASA eClips Website - <https://nasaclips.arc.nasa.gov>

NASA eClips YouTube - <https://youtu.be/sPly3wwK5dw>



Video Link- [NASA Spotlite: Movement of Molecules](https://nasaclips.arc.nasa.gov)

NASA eClips Website - <https://nasaclips.arc.nasa.gov>

NASA eClips YouTube - [https://youtu.be/hS2U\\_Ro-984](https://youtu.be/hS2U_Ro-984)

Use these questions to lead the class in a discussion.

1. How do atoms and molecules move in solids?
2. How is the movement of atoms and molecules in a solid different than their movement in liquids and gases?
3. What effect does the addition or subtraction of heat have on the movement of atoms and molecules of a substance?



# Explore

## Explore Activity



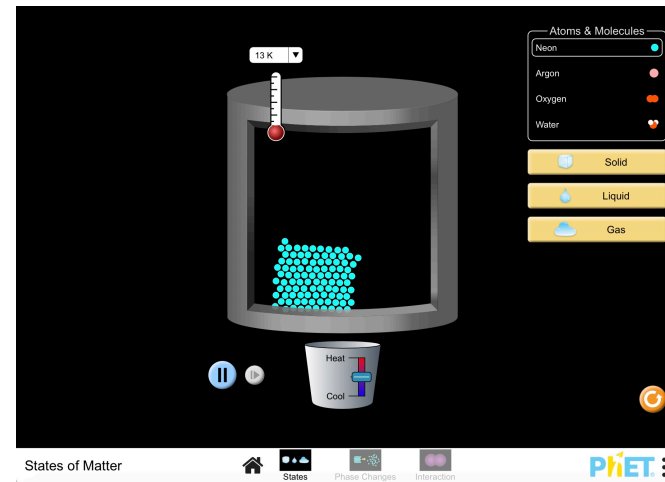
This PhET interactive lets you explore how the movement of molecules changes between different states of matter. Add or take away heat to the atoms and molecules. Pay attention to how the substance changes between solid, liquid, and gas phases. Describe the difference in the movement of the particles in a solid, liquid, and gas.

**PhET** Tips for Teachers **States of Matter**

**States Screen**  
Heat or cool atoms and molecules and watch as they change between solid, liquid and gas phases.

- VIEW** the temperature in K or °C
- CHOOSE** an atom or molecule
- EXPLORE** solid, liquid, or gas
- ADD or REMOVE** heat from the system
- OBSERVE** the motion of the sample

Link to PhET Interactive Simulations: States of Matter  
[https://phet.colorado.edu/sims/html/states-of-matter/latest/states-of-matter\\_en.html](https://phet.colorado.edu/sims/html/states-of-matter/latest/states-of-matter_en.html)



Use this link to see a screen capture of the simulation.  
<https://youtu.be/O9FnVTjQGek>



### Think-Pair-Share

What did you discover about the movement of molecules in different states of matter?

# Explore



## **Let's compare your answers.**

Particles in a gas are well separated with no regular arrangement. They vibrate and move freely at high speeds.

Particles in a liquid are close together with no regular arrangement. The particles vibrate, move about, and slide past each other.

Particles in a solid are tightly packed, usually in a regular pattern. The particles in solid vibrate (jiggle) in place.

# Explain

## Vocabulary Development

It's almost impossible to learn science concepts without also learning vocabulary words. Those vocabulary words help people discuss science concepts, so they're important. However, knowing vocabulary words is not the same as understanding science concepts. This section is designed to help your students do more than memorize definitions as they connect the vocabulary to the science concepts that they have explored.

1. Place the word "**vibration**" in the center of the graphic organizer. (See page 11 for a fillable Frayer Model.) Facilitate a discussion with students exploring why this word is key vocabulary to this study.
2. Ask students to brainstorm characteristics of "**vibration**" and add responses to the area with the corresponding heading on the graphic organizer.
3. Ask students to continue their exploration as they research the topic using a variety of resources including their textbook and notes.
4. Next, ask students to add examples and non-examples in the Frayer Model. Emphasize the higher-level thinking skill of comparing and contrasting.



How are the examples alike/different than the non-examples?

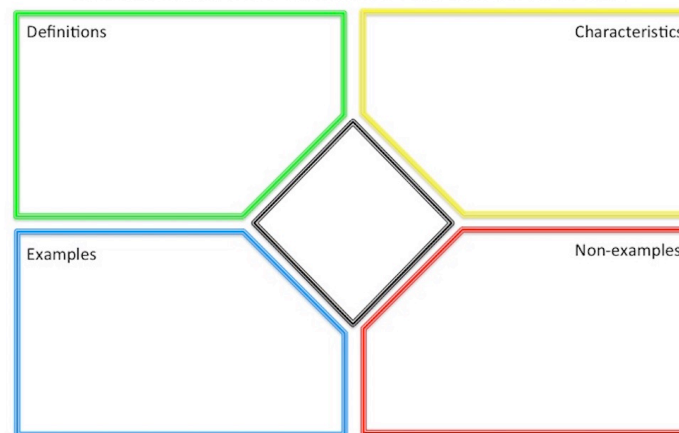
5. Using the information provided, ask students to develop their own definition of the word "**vibration**" that is clear and concise. An example is in the Answer Key section of this document (page 14).
6. After completing the example together, assign a new vocabulary word to each group of students to work on collaboratively.



Now complete a new Frayer Model with a partner. Select one word from the key vocabulary list and fill in the graphic organizer. We will share some as a class.

### Frayer Model for Vocabulary Development

Use the graphic organizer to write definitions, characteristics, examples and non-examples for a vocabulary word. You can include drawings, graphics, and diagrams.



7. Groups will share their Frayer Models and lead discussions to check for understanding of each vocabulary word. Refer to definitions in the Answer Key (page 8).
8. Compile and post final definitions so all students have access for later reference.



You will review key vocabulary. Pay attention to how your definitions compare to standard definitions.

# Explain

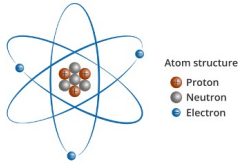
Word	Definition
<b>ATOM</b> 	Atoms are the smallest part of an element that maintains the chemical properties of that element.

Image Credit: by Vector FX, Shutterstock.com

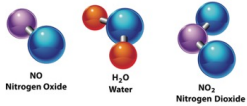
Word	Definition
<b>MOLECULE</b> 	A molecule is a group of two or more atoms held together by a covalent bond.

Image Credit: by OSweetNature, Shutterstock.com

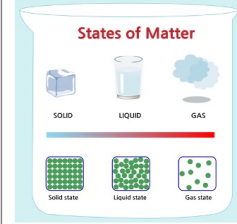
Word	Definition
<b>STATES OF MATTER</b> 	States of matter are the distinct forms of matter. Three common states of matter are solid, liquid, and gas.

Image Credit: by Jakinboaz, Shutterstock.com


Word	Definition
<b>GAS</b> 	A gas is a state of matter that has no definite shape and no definite volume. The molecules in a gas move rapidly in all directions and spread out to fill the space they are in.

Image Credit: by Jakinboaz, Shutterstock.com

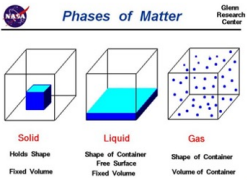
Word	Definition
<b>PHASES</b> 	In physical science, a phase describes the physical state of matter. The four common phases of matter are solid, liquid, gas, and plasma.

Image Credit: NASA's Glenn Research Center

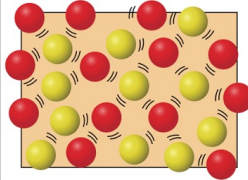
Word	Definition
<b>VIBRATE</b> 	Vibrate is to move to-and-fro or from side to side.

Image Credit: by Nasky, Shutterstock.com

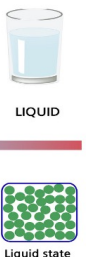
Word	Definition
<b>LIQUID</b> 	A liquid is a state of matter having a definite volume but not a definite shape; a fluid. The molecules in a liquid move slowly past each other often colliding.

Image Credit: by Jakinboaz, Shutterstock.com


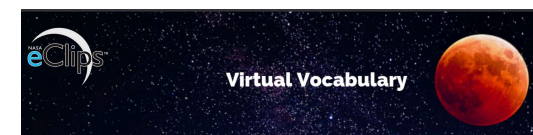
Word	Definition
<b>SOLID</b> 	A solid is a state of matter having a definite shape and a definite volume. The molecules in a solid vibrate in place.

Image Credit: by Jakinboaz, Shutterstock.com



Visit the NASA eClips™ Virtual Vocabulary for more definitions.

## Elaborate/Extend

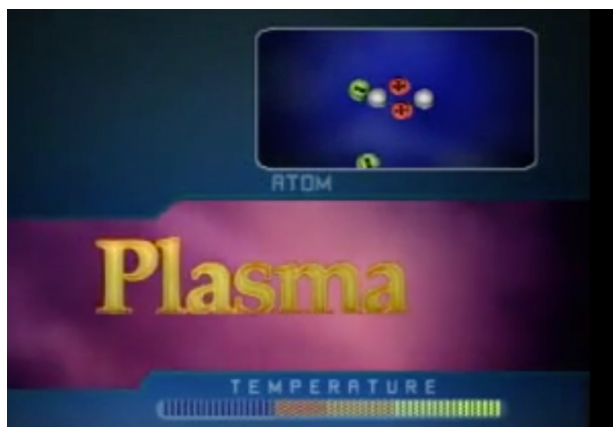
It is important for the students to explain what's going on by applying what they have learned. It is not unusual for students to have a bit of difficulty with elaborate activities. Student are not used to doing "novel" activities and being asked to apply what they know.



### NASA Connection

Real World: Chemistry and Advanced Propulsion Technologies (<https://nasaclips.arc.nasa.gov/>)

In this video review the four states of matter and explore the make-up of atoms. Learn about NASA technologies that use plasma.



What did you learn about how NASA uses plasma?

### Analyzing Icicles

An icicle forms when the sun melts snow or ice in below-freezing temperatures. As melting occurs, small water drops form and begin to drip off of a surface (like a roof). In the cold temperatures, the drops begin to freeze again forming an icicle.



1. Draw a picture illustrating the molecules in an icicle. Add a caption that describes the movement of the molecules.
2. Now, draw a picture to illustrate the molecules in the drops of water falling off the icicle. Include a caption that describes the movement of these molecules.

3. How are the two drawings of the molecules different?

# Evaluate

## Post-Assessment

Check students' understanding with these activities.

## Identify Misconception



What is a common misconception about how molecules move in solids and how can you correct it?



Carefully rewatch one of the NASA Spotlite videos about the movement of molecules to assess your understanding of how molecules behave in different phases.



[Video Link- NASA Spotlite: Movement of Molecules](#)

NASA eClips Website - <https://nasaclips.arc.nasa.gov/spotlite>



[Video Link- NASA Spotlite: Movement of Molecules](#)

## Discussion Questions

1. How do atoms and molecules move in solids?
2. How is the movement of atoms and molecules in a solid different than their movement in liquids and gases?
3. What effect does the addition or subtraction of heat have on the movement of atoms and molecules of a substance?

## Vocabulary Review

You just landed on the Moon with a new team of NASA astronauts to explore the Moon's surface. Below is an example of the first sample collected called the Genesis Rock. Using the vocabulary and what you have learned in this lesson, describe this sample. Be sure to include what you have learned about the particles that make up this sample.

## Word Bank

atom  
molecule  
solid  
liquid  
gas  
vibrate  
state of matter  
phase





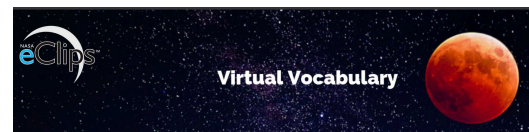
# Resources

## Fruyer Model for Vocabulary Development

Use the graphic organizer to write definitions, characteristics, examples and non-examples for a vocabulary word. You can include drawings, graphics, and diagrams.

The graphic organizer is a central diamond shape with four quadrants. The top-left quadrant is labeled 'Definitions' and has a green border. The top-right quadrant is labeled 'Characteristics' and has a yellow border. The bottom-left quadrant is labeled 'Examples' and has a blue border. The bottom-right quadrant is labeled 'Non-examples' and has a red border. The central diamond is outlined with a double black border.

Visit the NASA eClips™ Vocabulary for more definitions.



# Resources

## Movement of Molecules Pretest / Posttest NASA Spotlite Interactive Lesson

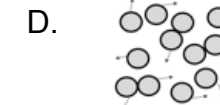
Read each question and select the best choice.

1. A woman buys her son a baseball. The molecules in the baseball:

2. How will an increase in temperature affect the movement of molecules?

3. Which of the following items would have molecules that are tightly packed together and vibrate in place?

4. When heat is added to matter, the activity of the molecules changes. Which picture best represents the movement of molecules in a solid?



5. When a substance changes from a liquid to a solid, the molecules:

# Answer Key

## Movement of Molecules Pretest / Posttest NASA Spotlite Interactive Lesson

Read each question and select the best choice.

1. A woman buys her son a baseball. The molecules in the baseball:

- A. **are packed tightly together and vibrate in place.** \*\*\*
- B. are moving freely around each other.
- C. spread apart and move quickly.
- D. are not moving at all.

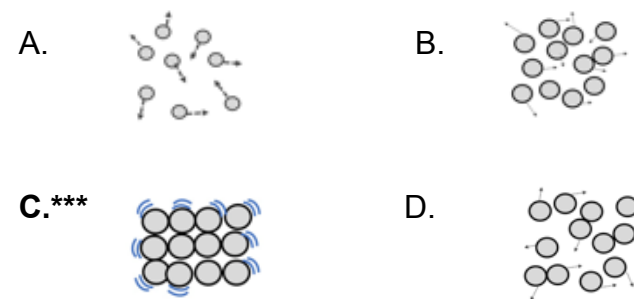
2. How will an increase in temperature affect the movement of molecules?

- A. The molecules will slow down.
- B. The molecules will not move.
- C. **The molecules will move faster.** \*\*\*
- D. There will be no change in the movement of the molecules.

3. Which of the following items would have molecules that are tightly packed together and vibrate in place?

- A. river water
- B. melting snow on a mountain
- C. air
- D. **rock making up a mountain**\*\*\*

4. When heat is added to matter, the activity of the molecules changes. Which picture best represents the movement of molecules in a solid?



5. When a substance changes from a liquid to a solid, the molecules:

- A. get closer together and stop moving.
- B. maintain the same motion and separation.
- C. move faster and farther apart.
- D. **move closer together and vibrate in place.** \*\*\*

# Answer Key

## Frayer Model for Vocabulary Development

Use the graphic organizer to write definitions, characteristics, examples and non-examples for a vocabulary word. You can include drawings, graphics, and diagrams.

The graphic organizer is a diamond-shaped frame divided into four quadrants by a central diamond. The quadrants are labeled as follows:

- Definitions:** Top-left quadrant, outlined in green.
- Characteristics:** Top-right quadrant, outlined in yellow.
- Examples:** Bottom-left quadrant, outlined in blue.
- Non-examples:** Bottom-right quadrant, outlined in red.

The central diamond is outlined in black.

### Vocabulary Word

vibration

### Characteristics

-to shake slightly and quickly  
-repeated motion

### Examples

shaking, pulsating, quivering

### Non-examples

still, no movement

### Definition

Vibration means to move or cause to move continuously and rapidly to and fro; periodic back-and-forth motion of particles.

# Product Information

This product has been developed by the National Institute of Aerospace's Center for Integrative STEM Education.

This document is based upon work supported by NASA under award No. NNX16AB91A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration (NASA).

Published December 2019