



States & Phases of Matter

Based on NY Regents Earth Science: Rock Cycle Activity, accessed Summer 2003, no longer available online

By Amanda MacKenzie

Focus on Inquiry

The student will collect and analyze data on the kinetic energy of molecules through the different states of matter. Throughout the lab, students will be modeling the process of adding and removing energy from matter which leads to phase changes.

Lesson Content Overview

Students will use their knowledge of states of matter to introduce the relative amount of kinetic energy in each state of matter, how changes in the kinetic energy can cause phase changes in matter, and what those phase changes are called.

| | | | |
|-------------------------------|-----------------------------|---|---|
| Duration 70 minutes | Setting Classroom | Grouping Individually or in pairs | PTI Inquiry Subskills 3.1, 4.2, 4.4, 5.8, 7.3 |
|-------------------------------|-----------------------------|---|---|

| Lesson Components | Estimated Time | Inquiry Subskills Used | Technology Used | Level of Student Engagement | Brief Description |
|-------------------|----------------|-------------------------|---------------------------------|-----------------------------|--|
| <i>Engage</i> | 10 | 5.2, 5.3 | Smartboard, computer, projector | 2 | Students watch a video clip on EdPuzzle: https://edpuzzle.com/media/558c10418d5e8ad747664588 |
| <i>Explore</i> | 20 | 3.1 | None | 3 | Student will roll dice to add or remove energy as they change states of matter. |
| <i>Explain</i> | 20 | 4.2, 4.4, 5.4, 5.8, 7.3 | None | 3 | Students graph their data and answer reflection questions about states of matter and phase changes. |
| <i>Expand</i> | 10 | 7.3 | None | 3 | Students will apply their knowledge of states of matter and phase changes in a game of Quiz-Quiz-Trade. |
| <i>Evaluate</i> | 10 | 7.3 | None | 2 | States and Phases of Matter Assessment |

Level of Student Engagement

| | | |
|---|----------|--|
| 1 | Low | Listen to lecture, observe the teacher, individual reading, teacher demonstration, teacher-centered instruction |
| 2 | Moderate | Raise questions, lecture with discussion, record data, make predictions, technology interaction with assistance |
| 3 | High | Hands-on activity or inquiry; critique others, draw conclusions, make connections, problem-solve, student-centered |

Next Generation Science Standards – Inquiry

NGSS Practice 2: Developing and Using Models
 NGSS Practice 4: Analyzing and Interpreting Data
 NGSS Practice 6: Constructing explanations
 NGSS Practice 7: Engaging in arguments from evidence
 NGSS Practice 8: Obtaining, Evaluating and Communicating Information



Next Generation Science Standards – Physical Science

MS-PS1-4.: 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. (MS-PS1-4)
- 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. (MS-PS1-4)
- Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1)
- The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.

Florida Science Standards – Nature of Science

SC.8.N.3.1: Select models useful in the investigations

Florida Science Standards – Physical Science

SC.8.P.8.1: Explore the scientific theory of atoms (also known as atomic theory) by using models to explain the motion of particles in solids, liquids, and gases.

Materials and Advance Preparation

Materials List

Class set:

- Station labels & directions
- 12 dice
- Quiz-Quiz-Trade Cards

Student materials:

- Data collection sheets & graph
- Student Reflection Questions Worksheet
- Phases of Matter Assessment

Blackline Masters

1. **Blackline Master #1:** Station Labels and Directions
2. **Blackline Master #2:** Data Collection Worksheet & Graph
3. **Blackline Master #3:** States and Phases of Matter Reflection Questions
4. **Blackline Master #4:** Quiz-Quiz Trade Cards
5. **Blackline Master #5:** States and Phases of Matter Assessment
6. **Blackline Master #6:** Answer Keys

Advance Preparation

1. Print **Blackline Master #1**. Cut and adhere station labels to identify each station (2 of each state of matter: solid, liquid, gas).
2. Print station directions **Blackline Master #1**. Cut and adhere station directions at each station (2 of each state of matter: solid, liquid, gas).
3. Place 2 pair of dice at each station (12 total dice)
4. Make copies of **Blackline Master #2, #3, & #5** for each student.
5. Make a class copy of the Quiz-Quiz-Trade Cards (**Blackline Master #4**).
 - a. Cut along the dotted lines.
 - b. Fold along the middle solid line and glue or tape the two sides together.

Lesson Information

Learning Objectives

1. Students will be able to use the data collected in this lesson to correctly describe how energy changes cause changes to the state of matter.
2. Students will model the process of adding and removing energy from matter which leads to phase changes.
3. Students will be able to correctly state, based on their data, the motion of particles in solids, liquids, and gases.
4. Students will be able to understand and describe the processes that occur when matter changes state.

Prior Knowledge Needed by the Students

- Some familiarity with atoms, molecules, and the concept of kinetic energy.
- Properties of solids, liquids and gases.

Background Information

In this lesson the students are learning about three states of matter: solids, liquids, and gases. The particles in a solid have relatively low kinetic energy and vibrate in place.

Solids maintain their shape regardless of the container that they are put in. Adding energy to a solid will cause its particles to move more quickly. The particles can now slide past each other and become a liquid. This process is called fusion or melting. If enough energy is added to a solid, it can bypass the liquid state and become a gas. This process is called sublimation. Some matter has such a narrow temperature range that it exists as a liquid (like dry ice-solid carbon dioxide) that it sublimates directly into a gas and bypasses the liquid state.

The particles in a liquid have more kinetic energy than those of a solid and can slide around each other. Liquids have a fixed volume but no fixed shape; they can take the shape of any container they are put in. Removing energy from a liquid causes its particles to move more slowly, move more closely together, and take on a more fixed shape. This process is called freezing. The liquid now becomes a solid. Adding energy to a liquid causes its particles to move more quickly and overcome the intermolecular forces that hold them together. This process is called vaporization or evaporation. The liquid now becomes a gas. Vaporization happens when heat is added to the liquid and gas bubbles are formed from the bottom of the liquid (boiling). Evaporation happens when more energetic liquid particles at the surface of the liquid escape as a gas. The energy needed to raise the temperature to the liquid's "boiling point" is not required for evaporation.

The particles in a gas have a lot of kinetic energy and have completely overcome the intermolecular forces that hold the molecules together and can freely escape each other. Gases have no fixed volume or shape, completely filling any container that they are placed in. Removing energy from a gas causes the particles to slow down and move closer together, and take on a fixed volume. This process is called condensation. The gas becomes a liquid. If you remove enough energy from a gas, its molecules will slow down enough to form into a solid. This process is called deposition.

The fourth state of matter (not discussed in this lab) is plasma. Plasma are superheated gases. They are so energized that they contain positively and negatively charged particles. Plasma can be found in fluorescent lights and in stars.

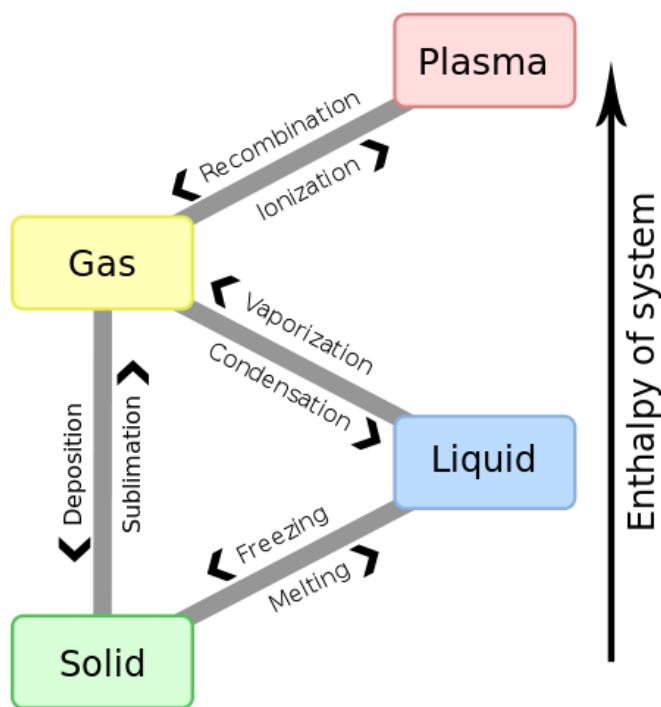


Photo Credit: https://commons.wikimedia.org/wiki/File:Phase_change_-_en.svg

Lesson Procedure

Engage

- Send each student a link to the Heat Transfer, States of Matter video:
<https://edpuzzle.com/assignments/571fa7007fc8a15a04db3acc/watch>
 - Alternatively this can be done as a whole class activity if only the teacher has access to a computer. This activity probes students' prior knowledge and uncovers misconceptions about matter.
 - To sign up for a free EdPuzzle account, please click on "Sign Up" at the bottom of the dialog box. You can sign up using Google or Edmodo, or by filling in your name and email and establishing a password.
 - EdPuzzle is a free service and does not require any credit card or payment information for its use.
- If you would prefer to use the YouTube video without the prompted questions in EdPuzzle, here is the link to the YouTube Video: <https://www.youtube.com/watch?v=WL57SXVQ-vU>
 - NOTE:** *If there is an advertisement at the beginning of the video, please fast forward or "Skip" through the ad if available. Make sure to display the video full screen (arrows to the right of video time bar at the bottom of the screen) so that the web page advertisements and other suggested videos are not seen. Watch for and close any pop-up ads that may occur during the video.*
- Questions asked during the EdPuzzle or that could be asked during YouTube video include:
 - Why do you think Olaf does not have any experiences with heat? *Student responses will vary but could include because he's a snowman and he's always cold.*
 - Identify what states of matter you see in the glass. Explain one idea how the states of matter are different. *Student responses will vary but could include solid (ice cubes), liquid (drink), and gas (bubbles in drink). Solids take a fixed shape and are usually hard. Liquids take the shape of their container and have a fixed volume. They're typically "wet." Gases take the shape of their container and have no fixed volume. They're typically invisible and "dry."*
 - Identify which states of matter are shown here (Olaf floating in a pond). Explain one difference between these two states of matter. *Student responses will vary but could include liquid and solid. Liquids can take the shape of their container and solids cannot.*
 - Olaf says, "Winter is a good time to stay in and cuddle, put me in summer and I'll be a...HAPPY SNOWMAN!" Which state of matter do you think he'd really be in summer? Write a brief sentence (10 words or less) why you think that. *Student responses will vary but could include that Olaf would be a liquid, possibly a gas if he got hot enough. When solid heat up, they oftentimes (not always) melt into liquids. If the liquid got hot enough, it would turn to a gas.*
 - What phase change process most likely occurred to Olaf just now? *Student responses will vary but could include Olaf became a gas through the process of vaporization. The students may say that he "evaporated" because they are not yet familiar with the difference between evaporation and vaporization.*
 - If you were Kristoff, what would you have told Olaf? *Student responses will vary.*
- After students have watched the video. Enhance the discussion with the following questions:
 - What were some of the states of matter you observed in the video? *Solids, liquids, and gases.*
 - Can matter change? *Yes.*
 - What is happening when it changes? *Students may not know the mechanics of how matter changes, but they may know that it changes state from solid to liquid to gas.*
- Recap that these are processes in the phase change cycle which they will now explore.

Explore

- Distribute the data collection sheet (**Blackline Master #2**). Go over the directions at the top of the sheet.

2. Model how to do two or three die tosses and how to record that data on the lab sheet. Discuss what to do if they toss the same station more than once (they write down each toss every time). Emphasize to students that dice should stay on top of the desks and off the floor.
 3. Assign students to the starting stations randomly and evenly. Make sure students push in their chairs and stow their bookbags so that tripping hazards are reduced.
 4. Remind the students that they are representing one of many molecules in a glass of water and that they should record their movements on the data sheet.
 5. Students will get 10 minutes to complete data collection.
- Begin the round of data collection (consider putting a countdown timer on your SmartBoard, for example: <http://www.classtools.net/education-games-php/timer>). Circulate around the room to make sure that students are properly recording their data.
6. When the 10 minutes are up ask students to return to their seats.

Explain

1. Have students plot the number of times that they visited each state of matter (Blacklist Master #3).
2. Additional questions you can ask students as they work on their graph include:
 - a. What type of graph would you use? *Bar graph*
 - b. What will go on your x-axis? *States of matter*
 - c. Why did you choose that? *It's the independent variable/categories*
 - d. What will go on your y-axis? *Number of visits*
 - e. Why did you choose that? *It's the dependent variable/measured variable*
 - f. Have you given your graph a title? *Yes*
3. Have students complete their reflection questions.
4. Have students compare their graph with their neighbor's.
 - a. Do you notice any similarities? *Student responses will vary*
5. Discuss as a class if there was a place where they spent more time than others.
 - a. What would account for the amount of time you spent as each state of matter? *Stations were represented evenly, so really it's just the luck of the dice.*
6. Discuss reflection questions once students have completed them.

Expand/Elaborate

1. Pass one Quiz-Quiz-Trade card (**Blackline Master #4**) out to each student.
2. Students will use the stand-up, hand-up, pair up strategy to meet with different classmates to quiz each other and then trade cards.
3. Students will continue until the teacher calls time (approximately 10 minutes).
4. Play 3 corners with the labels of solid, liquid, and gas in each corner. Divide students into each corner. Give them a couple minutes to discuss the following as a group.
 - a. How would they act out the molecules in their state of matter? *Solids; all particles would be huddled close together vibrating in place, Liquid: particles were in contact with each other moving around one another, Gas: particles were moving quickly and moving all over the place.*
 - b. How would they explain to someone who didn't know about the states of matter how it changes from state to state? *Students' responses will vary, but should include that as the particles gain or lose energy, they speed up or slow down and it causes the matter to change state.*
 - c. What has to happen for it to change state? *The bonds that are formed between the molecules in the substance are either formed from losing energy, or broken from gaining energy.*
5. After students discuss with group they will share out by demonstrating the motion of the particles of their state of matter and explaining what has to happen to move to different state of matter.

Evaluate

1. Questions **Blackline Master #5**
2. Answer key **Blackline Master #6**

WRAP UP.

1. Bring the lesson to a close by reviewing students' labeled phase change diagrams.
2. Students will work with their shoulder partner to compare their phase change diagrams to ensure that they are labeled correctly, represent the correct energy changes, and that their transition arrows are pointing in the correct direction.

Supplementary Resources

Teachers & Students

Chem4Kids.com. (2015). *Matter*. Retrieved from http://www.chem4kids.com/files/matter_intro.html

Study.com. (2015). *Phase Change: Evaporation, Condensation, Freezing, Melting, Sublimation & Deposition*. Retrieved from <http://study.com/academy/lesson/phase-change-evaporation-condensation-freezing-melting.html>.

CITATION OF SOURCES.

Blanchard, Pamela. 2015. The Rock Cycle Simulation.

<http://science4inquiry.com/LessonPlans/EarthScience/RockCycle/Lesson%20Rock%20Cycle%20Simulation%20with%20links.pdf>

Chem4Kids.com. (2015). *Matter*. Retrieved from http://www.chem4kids.com/files/matter_intro.html

WikiMediaCommons. (2008). Phase Change Graphic. Retrieved from https://commons.wikimedia.org/wiki/File:Phase_change_-_en.svg

WikiMediaCommons. (2007). Molecule pictures. Retrieved from https://commons.wikimedia.org/wiki/File:Solid_liquid_gas.svg

Yes, I cited all materials and resources used in this lesson

Amanda MacKenzie

Lesson author signature

Station Labels

Solid

Liquid

Gas

Solid

Liquid

Gas

Station Directions

| Solid | |
|----------------|--|
| If you roll a: | Then do this: |
| 1 | No change in energy, Stay |
| 2 | Energy is added, molecules speed up and are able to slide past one another, melting occurs Go to Liquid |
| 3 | Energy is added, molecules speed up and can move freely from one another, sublimation occurs Go to Gas |
| 4 | No change in energy, Stay |
| 5 | Energy is added, molecules speed up and are able to slide past one another, melting occurs Go to Liquid |
| 6 | Energy is added, molecules speed up and can move freely from one another, sublimation occurs Go to Gas |

| Solid | |
|----------------|--|
| If you roll a: | Then do this: |
| 1 | No change in energy, Stay |
| 2 | Energy is added, molecules speed up and are able to slide past one another, melting occurs Go to Liquid |
| 3 | Energy is added, molecules speed up and can move freely from one another, sublimation occurs Go to Gas |
| 4 | No change in energy, Stay |
| 5 | Energy is added, molecules speed up and are able to slide past one another, melting occurs Go to Liquid |
| 6 | Energy is added, molecules speed up and can move freely from one another, sublimation occurs Go to Gas |

| Liquid | |
|-----------------------|---|
| If you roll a: | Then do this: |
| 1 | No change in energy, Stay |
| 2 | Energy is added, molecules speed up and are able move freely from one another, evaporation occurs Go to Gas |
| 3 | Energy is removed, molecules slow down and vibrate in place, freezing occurs Go to Solid |
| 4 | No change in energy, Stay |
| 5 | Energy is added, molecules speed up and are able move freely from one another, vaporization (boiling) occurs Go to Gas |
| 6 | Energy is removed, molecules slow down and vibrate in place, freezing occurs Go to Solid |

| Liquid | |
|-----------------------|---|
| If you roll a: | Then do this: |
| 1 | No change in energy, Stay |
| 2 | Energy is added, molecules speed up and are able move freely from one another, evaporation occurs Go to Gas |
| 3 | Energy is removed, molecules slow down and vibrate in place, freezing occurs Go to Solid |
| 4 | No change in energy, Stay |
| 5 | Energy is added, molecules speed up and are able move freely from one another, vaporization (boiling) occurs Go to Gas |
| 6 | Energy is removed, molecules slow down and vibrate in place, freezing occurs Go to Solid |

| Gas | |
|-----------------------|---|
| If you roll a: | Then do this: |
| 1 | No change in energy, Stay |
| 2 | Energy is removed, molecules slow down and vibrate in place, deposition occurs Go to Solid |
| 3 | Energy is removed, molecules slow down and can only slide past one another, condensation occurs Go to Liquid |
| 4 | No change in energy, Stay |
| 5 | Energy is removed, molecules slow down and vibrate in place, deposition occurs Go to Solid |
| 6 | Energy is removed, molecules slow down and can only slide past one another, condensation occurs Go to Liquid |

| Gas | |
|-----------------------|---|
| If you roll a: | Then do this: |
| 1 | No change in energy, Stay |
| 2 | Energy is removed, molecules slow down and vibrate in place, deposition occurs Go to Solid |
| 3 | Energy is removed, molecules slow down and can only slide past one another, condensation occurs Go to Liquid |
| 4 | No change in energy, Stay |
| 5 | Energy is removed, molecules slow down and vibrate in place, deposition occurs Go to Solid |
| 6 | Energy is removed, molecules slow down and can only slide past one another, condensation occurs Go to Liquid |

Data Collection Worksheet

You are one of many molecules in a glass of water. Begin at your first station (write that down in row 1 in the table below). Roll the dice to find out where you go to next. Read the directions at the station to find out what happens to you and where you go. Fill out this information in the table. Repeat this until time is up or until you have rolled 15 times (whichever comes first).

| | Station (State of Matter) | Energy (removed or added) | Molecule movement (speed up or slow down) | Process (phase change) | Destination (new state of matter) |
|-----|-------------------------------------|-------------------------------------|---|----------------------------------|---|
| 1. | | | | | |
| 2. | | | | | |
| 3. | | | | | |
| 4. | | | | | |
| 5. | | | | | |
| 6. | | | | | |
| 7. | | | | | |
| 8. | | | | | |
| 9. | | | | | |
| 10. | | | | | |
| 11. | | | | | |
| 12. | | | | | |
| 13. | | | | | |
| 14. | | | | | |
| 15. | | | | | |

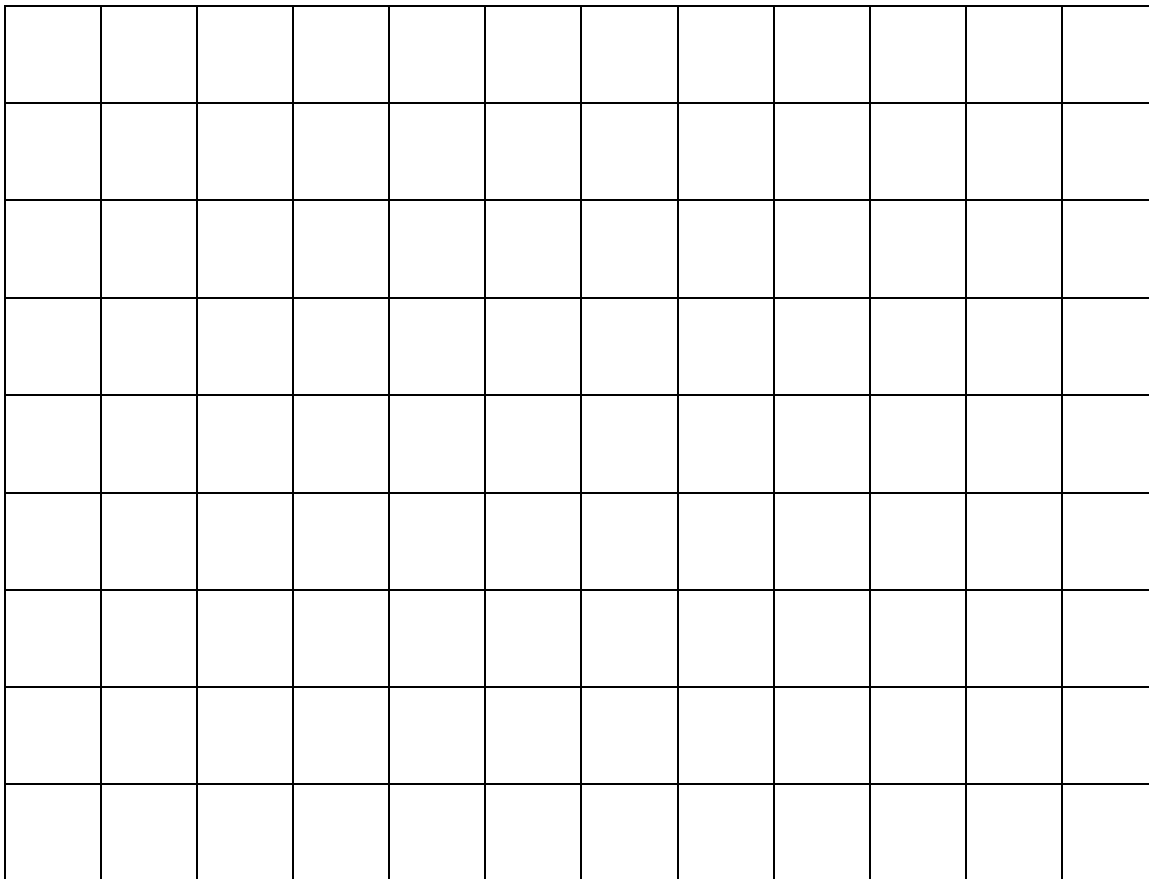
Blackline Master #2

Graph the number of times you visited each state of matter.

Things to consider:

- What will your x-axis label be?
- What will your y-axis label be?
- What increments will you use to label your y-axis?
- What will you title your graph?
- What type of graph will you make?

Title: _____



States & Phases of Matter Reflection Questions

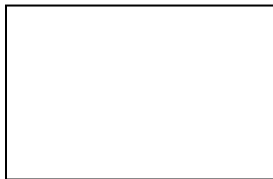
1. What are the 3 most common forms matter on Earth? _____
2. Describe what happens to the molecules in a solid when energy is added? _____

3. Describe what happens to the molecules in a gas when energy is removed?

4. Create and label a phase change diagram. Use the data that you've collected to help you. Don't forget to include arrows to identify which direction the transition is happening. Your diagram should include energy changes, states of matter, and names of phase changes.

5. How could you represent your phase change diagram (above) in words?

6. Draw the arrangement of the molecules in each of the 3 states of matter. Label each state of matter.



7. Write down some key words to describe each of the 3 states of matter.

solid _____

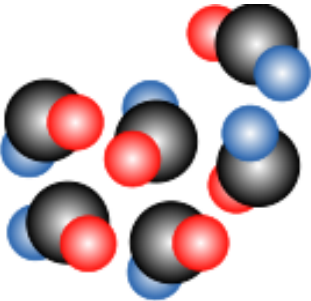
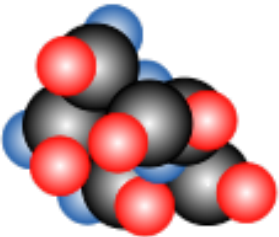
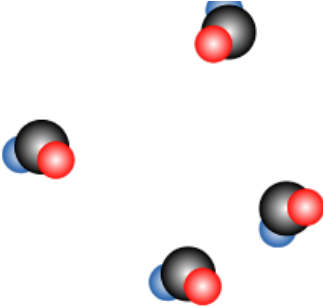
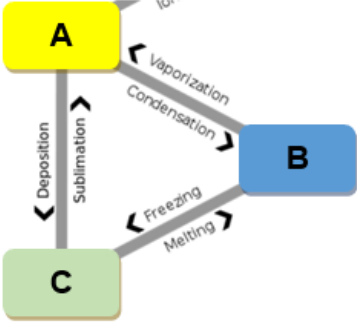
liquid _____

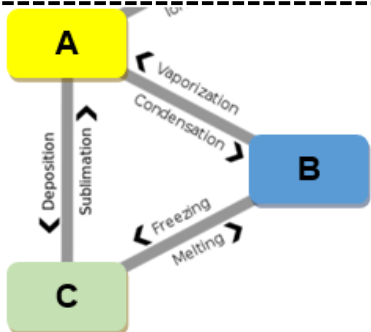
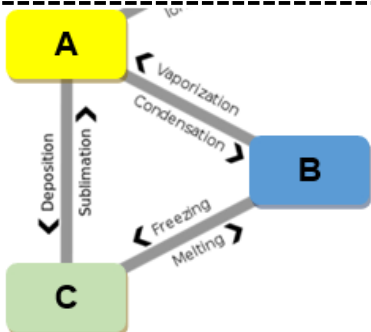
gas _____

8. Why are diagrams, pictures, and processes (like this lab) useful as models?

9. Pretend you are a water molecule. Describe the journey you take and what happens to you as you transition between the solid, liquid, and gas phases. *You can journey in whichever direction you please, as long as your energy changes and your phase change terminology is correct.*

Quiz-Quiz-Trade Cards

| | |
|---|---------------|
|  <p>What state of matter am I?</p> | <p>Liquid</p> |
|  <p>What state of matter am I?</p> | <p>Solid</p> |
|  <p>What state of matter am I?</p> | <p>Gas</p> |
|  <p>What is A?</p> | <p>Gas</p> |

| | |
|--|---------------|
|  <p>What is B?</p> | <p>Liquid</p> |
|  <p>What is C?</p> | <p>Solid</p> |
| <p>I maintain my shape regardless of the container that you put me in. Who am I?</p> | <p>Solid</p> |
| <p>I have a fixed volume but no fixed shape. I can take the shape of any container that you put me in. Who am I?</p> | <p>Liquid</p> |

| | |
|--|---------------|
| <p>I have no fixed volume or shape. I spread out and completely fill any container that you put me in. Who am I?</p> | <p>Gas</p> |
| <p>Of the three states of matter, my particles have the most energy. Who am I?</p> | <p>Gas</p> |
| <p>Of the three states of matter, my particles have a moderate amount of energy. Who am I?</p> | <p>Liquid</p> |
| <p>Of the three states of matter, my particles have the least amount of energy. Who am I?</p> | <p>Solid</p> |

| | |
|--|---|
| <p>Adding energy to a solid causes this to happen.</p> | <p>The particles speed up, spread out, and the solid becomes a liquid. Melting or Fusion</p> |
| <p>Adding energy to a solid so that it bypasses the liquid phase and turns into a gas is called this.</p> | <p>Sublimation</p> |
| <p>Adding energy to a liquid causes this to happen.</p> | <p>The particles speed up, spread out, and the liquid becomes a gas. Evaopration or Vaporization</p> |
| <p>Removing energy from a liquid causes this to happen.</p> | <p>The particles slow down, move closer together, and the liquid becomes a solid. Freezing</p> |

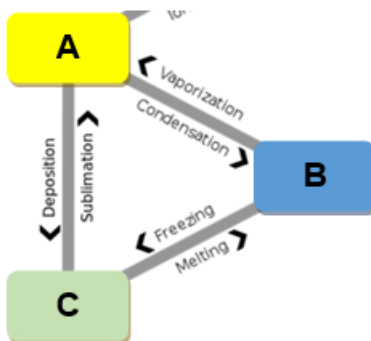
| | |
|---|---|
| <p>Removing energy from a gas causes this to occur.</p> | <p>The particles slow down, move closer together, and the gas becomes a liquid. Condensation</p> |
| <p>Removing energy from a gas so that it bypasses the liquid phase and turns into a solid is called this.</p> | <p>Deposition</p> |
| <p>Solid =====> Gas</p> | <p>Sublimation</p> |
| <p>Solid =====> Liquid</p> | <p>Melting or Fusion</p> |

| | |
|---------------------|-----------------------------|
| Liquid =====> Gas | Evaopration or Vaporization |
| Gas =====> Liquid | Condensation |
| Gas =====> Solid | Deposition |
| Liquid =====> Solid | Freezing |

Blackline Master #5

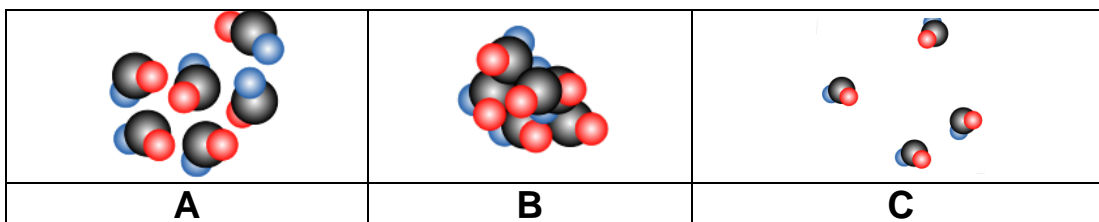
States & Phases of Matter Assessment

- Which of the states of matter are involved in the process of melting? (SC.8.P.8.1)
 - Gas and Liquid
 - Solid and Liquid
 - Solid and Gas
 - It affects all 3 states of matter
- By which process does a gas become a liquid? (SC.8.P.8.1)
 - Condensation
 - Evaporation
 - Freezing
 - Sublimation
- The diagram below shows the phase change cycle.



- Which statement correctly identifies A, B, and C? (SC.8.P.8.1) (PTI 5.8)
- A is solid, B is liquid, C is gas
 - A is liquid, B is gas, C is solid
 - A is gas, B is solid, C is gas
 - A is gas, B is liquid, C is solid

4.



- Using the diagram above, which picture represents the particles of a liquid? (SC.8.P.8.1) (PTI 5.8)
- A
 - B
 - C

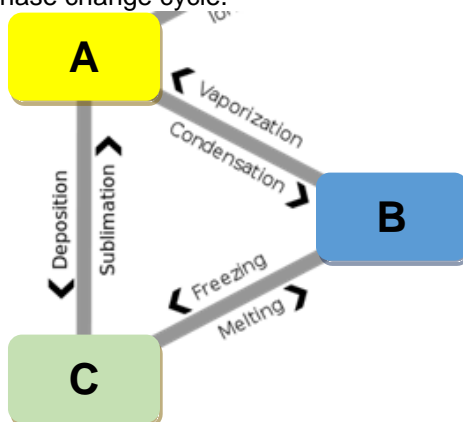
- Why is it helpful to use a diagram model of the phase changes? (SC.8.N.3.2) (PTI 5.8)
 - Because phase changes are impossible to see.
 - So that you can understand how to create or destroy matter.
 - It's not likely that you'll ever get to see matter in all three states.
 - So that you can see the relationships between each state of matter.

Answer Key

Checking for Understanding: Phases of Matter

- Which of the states of matter are involved in the process of melting?
 - Gas and Liquid
 - Solid and Liquid
 - Solid and Gas
 - It affects all 3 states of matter
- By which process does a gas become a liquid?
 - Condensation
 - Evaporation
 - Freezing
 - Sublimation

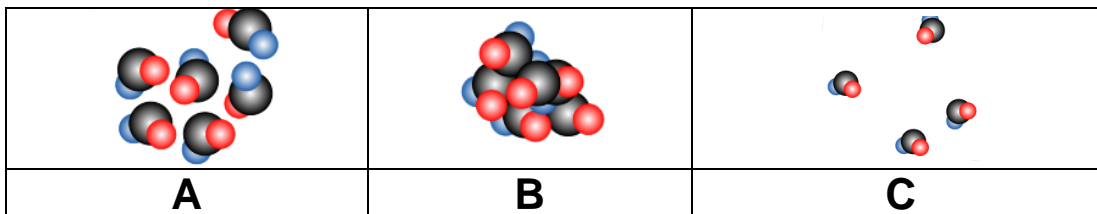
3. The diagram below shows the phase change cycle.



Which statement correctly identifies A, B, and C?

- A is solid, B is liquid, C is gas
- A is liquid, B is gas, C is solid
- A is gas, B is solid, C is gas
- A is gas, B is liquid, C is solid

4.



Using the diagram above, which picture represents the particles of a liquid?

- A
 - B
 - C
- Why is it helpful to use a diagram model of the phase changes? (SC.8.N.3.2) (PTI 5.8)
 - Because phase changes are impossible to see.
 - So that you can understand how to create or destroy matter.
 - It's not likely that you'll ever get to see matter in all three states.
 - So that you can see the relationships between each state of matter.

Data Collection Worksheet

You are one of many molecules in a glass of water. Begin at your first station (write that down in row 1 in the table below). Roll the dice to find out where you go to next. Read the directions at the station to find out what happens to you and where you go. Fill out this information in the table. Repeat this until time is up or until you have rolled 15 times (whichever comes first). *Student responses will vary. This is an example of possible Student Responses/Data*

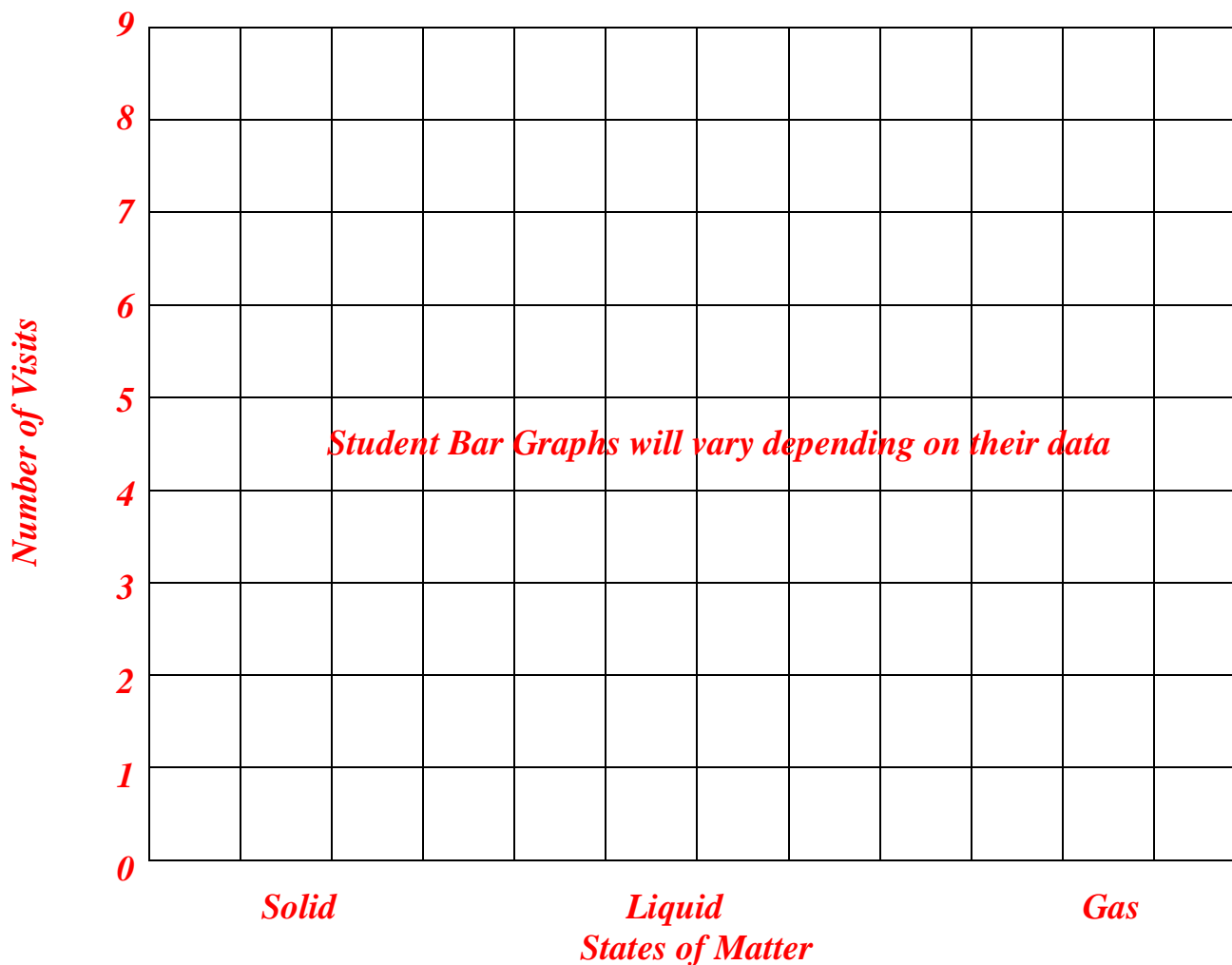
| | Station (State of Matter) | Energy (removed or added) | Molecule movement | Process | Destination |
|-----|---------------------------|---------------------------|-----------------------|------------------------|-------------|
| 1. | Gas | No change in energy | No change in movement | n/a | Gas |
| 2. | Gas | Energy removed | Molecules slow down | Condensation | Liquid |
| 3. | Liquid | Energy added | Molecules speed up | Evaporation | Gas |
| 4. | Gas | No change in energy | No change in movement | n/a | Gas |
| 5. | Gas | No change in energy | No change in movement | n/a | Gas |
| 6. | Gas | Energy removed | Molecules slow down | Condensation | Liquid |
| 7. | Liquid | No change in energy | No change in movement | n/a | Liquid |
| 8. | Liquid | No change in energy | No change in movement | n/a | Liquid |
| 9. | Liquid | No change in energy | No change in movement | n/a | Liquid |
| 10. | Liquid | Energy added | Molecules speed up | Evaporation | Gas |
| 11. | Gas | Energy removed | Molecules slow down | Condensation | Liquid |
| 12. | Liquid | Energy added | Molecules speed up | Vaporization (Boiling) | Gas |
| 13. | Gas | Energy removed | Molecules slow down | Deposition | Solid |
| 14. | Solid | Energy added | Molecules speed up | Melting | Liquid |
| 15. | Liquid | Energy removed | Molecules slow down | Freezing | Solid |

Graph the number of times you visited each state of matter.

Things to consider:

- What will your x-axis label be?
- What will your y-axis label be?
- What increments will you use to label your y-axis?
- What will you title your graph?
- What type of graph will you make?

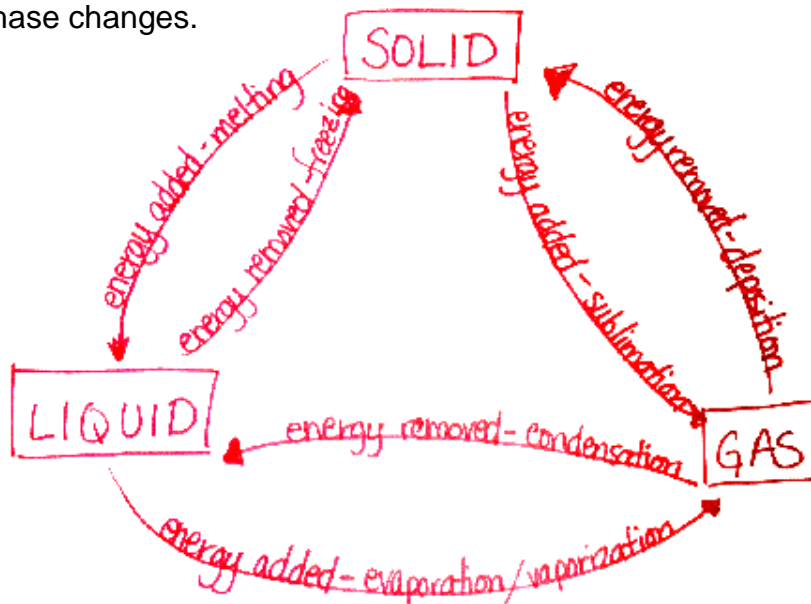
Title: Example: Changing States of Matter



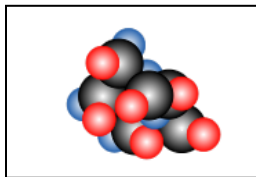
States & Phases of Matter Reflection Questions

Possible Student Responses

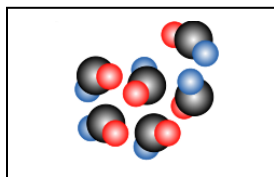
1. What are the 3 most common forms matter on Earth? Solid, Liquid, Gas
2. Describe what happens to the molecules in a solid when energy is added?
When energy is added, the molecules can move more freely against each other.
3. Describe what happens to the molecules in a gas when energy is removed?
Particles slow down and begin to group together into a liquid form
4. Create and label a phase change diagram. Use the data that you've collected to help you. Don't forget to include arrows to identify which direction the transition is happening. Your diagram should include energy changes, states of matter, and names of phase changes.



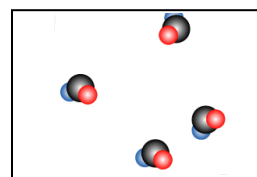
5. How could you represent your phase change diagram (above) in words?
Student responses may vary but should include information related to their phase change diagram that they drew for #4.
6. Draw the arrangement of the molecules in each of the 3 states of matter. Label each state of matter.



Solid



Liquid



Gas

Blackline Master #6

7. Write down some key words to describe each of the 3 states of matter.
- Solid** Student answers will vary but should include that the particles are grouped together and have very little motion
- Liquid** Student answers will vary but should include that the particles remain close together but can freely move around and past one another
- Gas** Student answers will vary but should include that the particles spread far apart, constantly move, and completely fill their container
8. Why are diagrams, pictures, and processes (like this lab) useful as models?
- Diagrams and pictures allow us to see how everything in a system is interrelated or allow us to see processes or objects that might otherwise be unseen (like molecules) because they are too large, too small, too dangerous, or too far away. Walking through a process model, like our lab, allows us to experience the process, make more sense of it, and learn about it better.
9. Pretend you are a water molecule. Describe the journey you take and what happens to you as you transition between the solid, liquid, and gas phases. You can journey in whichever direction you please, as long as your energy changes and your phase change terminology is correct.
- Student responses will vary but should accurately describe the path of a molecule through the phase changes of becoming solid, liquid, and gas. Answer should include vocabulary words including condensation, evaporation, vaporization (boiling), melting, freezing, sublimation, and deposition. Answer should also describe how particle motion/kinetic energy of particles changes during each stage and how energy is added or removed from the system.