

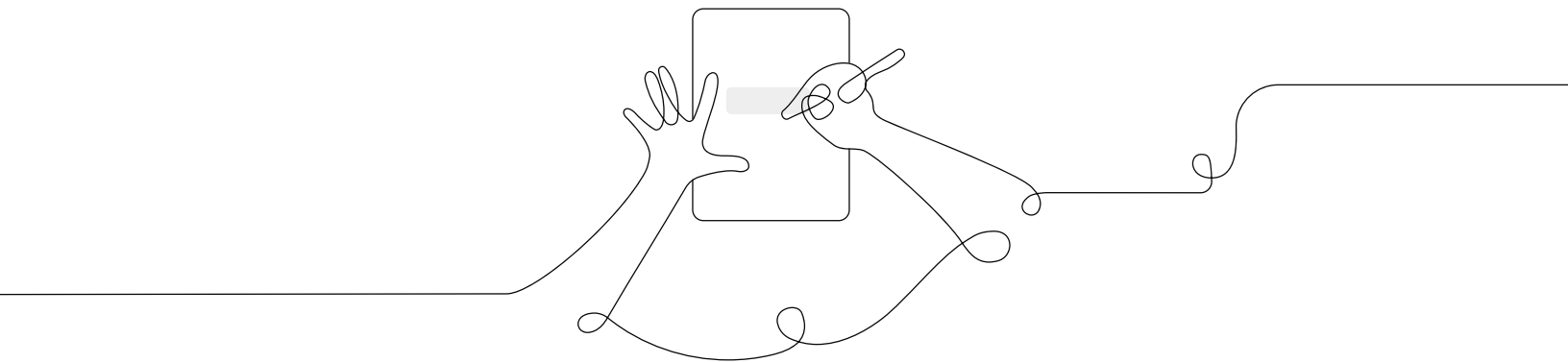
Amplify Science

# Participant Notebook

Deep-dive and Strengthening Workshop

Phase Change

Grade 7





# Welcome to the workshop

This Participant Notebook will serve as a resource during today's workshop.

## Phase Change Grade 7

Amplify Science

# Unit-specific workshop agenda

## Introductions

### Framing and reflection

- Reflecting on our teaching
- Scenario challenge

### Experiencing the unit

- Model experiences from Phase Change
- Reflecting on coherence

### Science Seminar modeling and analysis

### Targeted small group work time

- Analyzing the End-of-Unit Assessment
- Deepening understanding of content
- Formative assessment and differentiation
- Internalizing the upcoming unit

### Closing

- Questions
- Survey

## Demo account for your workshop:

URL: [learning.amplify.com](https://learning.amplify.com) (Log in with Amplify)

Temporary account (teacher): \_\_\_\_\_@tryamplify.net

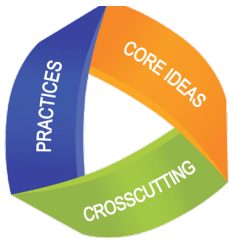
Temporary account (students): \_\_\_\_\_@tryamplify.net

\_\_\_\_\_@tryamplify.net

\_\_\_\_\_@tryamplify.net

Password (for all): **AmplifyNumber1**

# Three dimensions of NYSSLS reference



3-D learning engages students in using scientific and engineering practices and applying crosscutting concepts as tools to develop understanding of and solve challenging problems related to disciplinary core ideas.

## Science and Engineering Practices

1. Asking Questions and Defining Problems
2. Developing and Using Models
3. Planning and Carrying Out Investigations
4. Analyzing and Interpreting Data
5. Using Mathematics and Computational Thinking
6. Constructing Explanations and Designing Solutions
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating, and Communicating Information

## Disciplinary Core Ideas

### Earth and Space Sciences:

ESS1: Earth's Place in the Universe  
ESS2: Earth's Systems  
ESS3: Earth and Human Activity

### Life Sciences:

LS1: From Molecules to Organisms  
LS2: Ecosystems  
LS3: Heredity  
LS4: Biological Evolution

### Physical Sciences:

PS1: Matter and its Interactions  
PS2: Motion and Stability  
PS3: Energy  
PS4: Waves and their Applications

### Engineering, Technology and the Applications of Science:

ETS1: Engineering Design  
ETS2: Links among Engineering Technology, Science and Society

## Crosscutting Concepts

1. Patterns
2. Cause and Effect
3. Scale, Proportion, and Quantity
4. Systems and System Models
5. Energy and Matter
6. Structure and Function
7. Stability and Change

# Reflecting on Amplify Science implementation

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1. What was a positive moment from teaching your first unit(s)? What was particularly effective in your classroom?

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2. What was a challenge you experienced in your first few units? What was an “aha” moment you had while planning or teaching that helped you overcome that challenge?

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3. Amplify Science uses a multimodal approach — students **do, talk, read, write,** and **visualize** as they construct explanations of phenomena. Describe a time when the multimodal approach helped a particular student or students in your classroom.

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# Self-assessment: How comfortable are you teaching Amplify Science?

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**Directions:**

After each group shares the solution to their scenario, rank your comfort level with the scenario's category using the statements along the top of the table.

Scenario	I am starting to understand this	I can do this (with a little help)	I've got this! I feel confident	I can teach this to a peer
<p><b>Scenario 1</b> Using program resources to deepen content knowledge and find information to answer content questions</p>				
<p><b>Scenario 2</b> Using formative assessment to inform instruction</p>				
<p><b>Scenario 3</b> Analyzing student work on the End-of-Unit Assessment</p>				
<p><b>Scenario 4</b> Understanding the 3-D nature of standards in the unit</p>				
<p><b>Scenario 5</b> Understanding how ideas build across a chapter and unit</p>				
<p><b>Scenario 6</b> Preparing to teach a lesson</p>				



## Unit Map

### Why did the methane lake on Titan disappear?

Taking on the role of student chemists working for the fictional Universal Space Agency, students investigate the mystery of a disappearing methane lake on Titan. One team of scientists at the Universal Space Agency claims that the lake evaporated while the other team of scientists claims that the lake froze. The students' assignment is to determine what happened to the lake. They discover what causes phase changes, including the role of energy transfer and attraction between molecules.

#### Chapter 1: What happened to the liquid in Titan's lake?

**Students figure out:** The liquid in the lake changed phase, either from liquid to gas (evaporated) or from liquid to solid (froze). Both of these changes involve a change in the freedom of movement of the molecules. As liquid, molecules of the lake moved around each other. If the lake evaporated, its molecules would have become able to move apart from one another. If the lake froze, its molecules would have become able only to move in place. The number of molecules and the size of molecules do not change during a phase change.

**How they figure it out:** They analyze the movement of molecules during each of the phases in a digital Simulation. They read a text, engage in hands-on investigations of evaporation and condensation, and visually represent their understanding of possible phase changes in the lake using a Modeling Tool.

#### Chapter 2: What could cause liquid methane to change phase?

**Students figure out:** An increase or decrease of energy could have caused the liquid methane to change phase. If the energy increased, this would have caused the kinetic energy of the molecules—and possibly their freedom of movement—to increase. If the energy decreased, the molecules' kinetic energy and possibly their freedom of movement would have decreased. The lake disappeared during Titan's summer, when the amount of energy being transferred into the lake was higher than at other times, so the lake must have evaporated, not frozen.

**How they figure it out:** In the Sim, they investigate how adding or removing energy can affect molecules' freedom of movement. They use magnetic marbles as a physical model and, based on new evidence about the seasons on Titan, represent their thinking using the Modeling Tool.

#### Chapter 3: Why didn't the liquid methane change phase before 2007?

**Students figure out:** It had been summer since 2002, but the lake didn't evaporate until 2007. This is because attraction between molecules pulls them toward each other, and there hadn't been enough energy transferred to the lake to overcome this attraction until 2007. During this time, the kinetic energy of the methane molecules in the lake was increasing, but the lake was still liquid. After 2007, the sun had transferred enough energy so that the kinetic energy of the methane molecules increased enough to overcome the attraction between them. The lake evaporated and the molecules started moving away from each other.

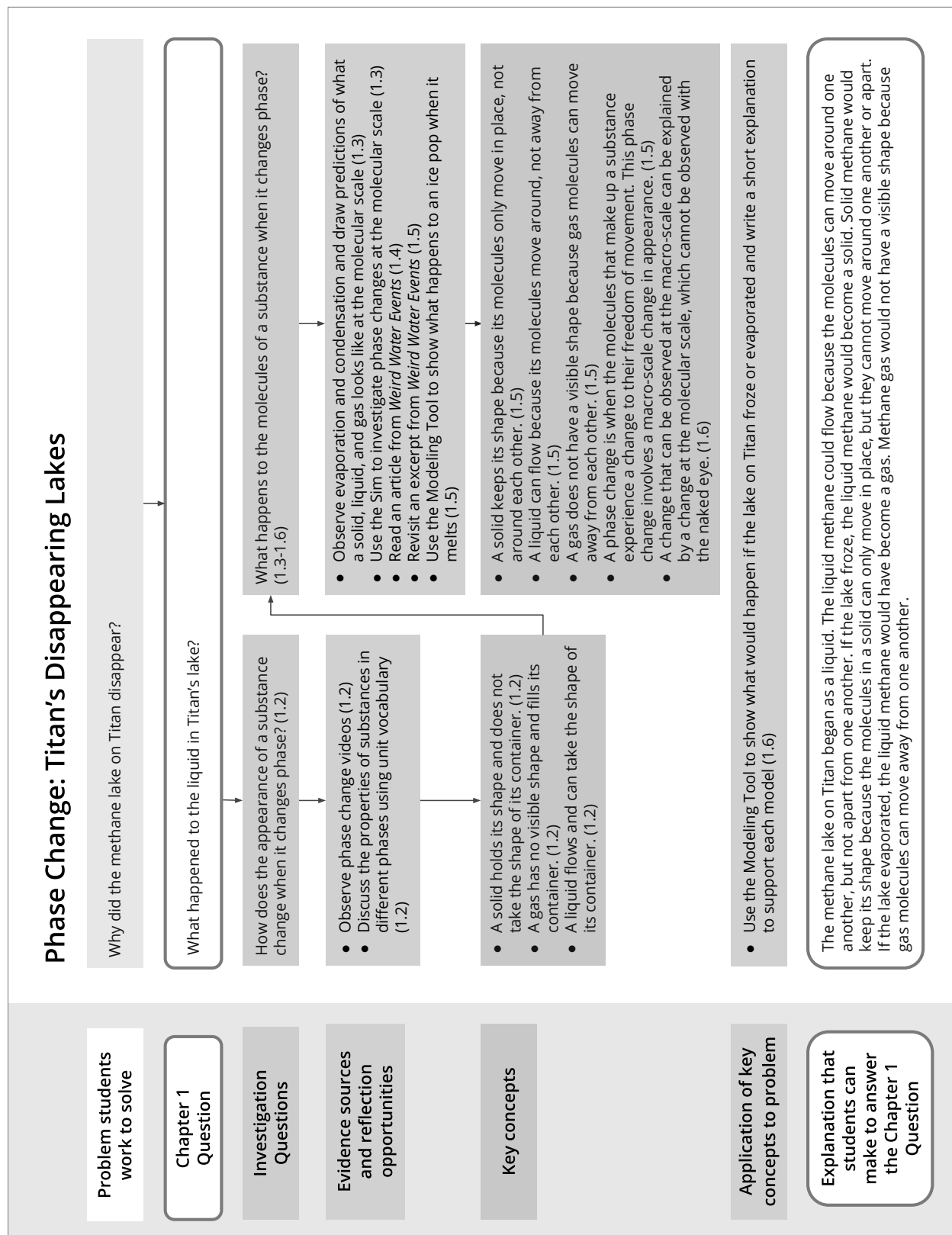
**How they figure it out:** They use the Simulation and hands-on observations to investigate why some substances do not change phase as easily as others. They read an article and compare a physical model to the Sim to help explain differences between substances. Using the Modeling Tool, students visually represent their thinking.



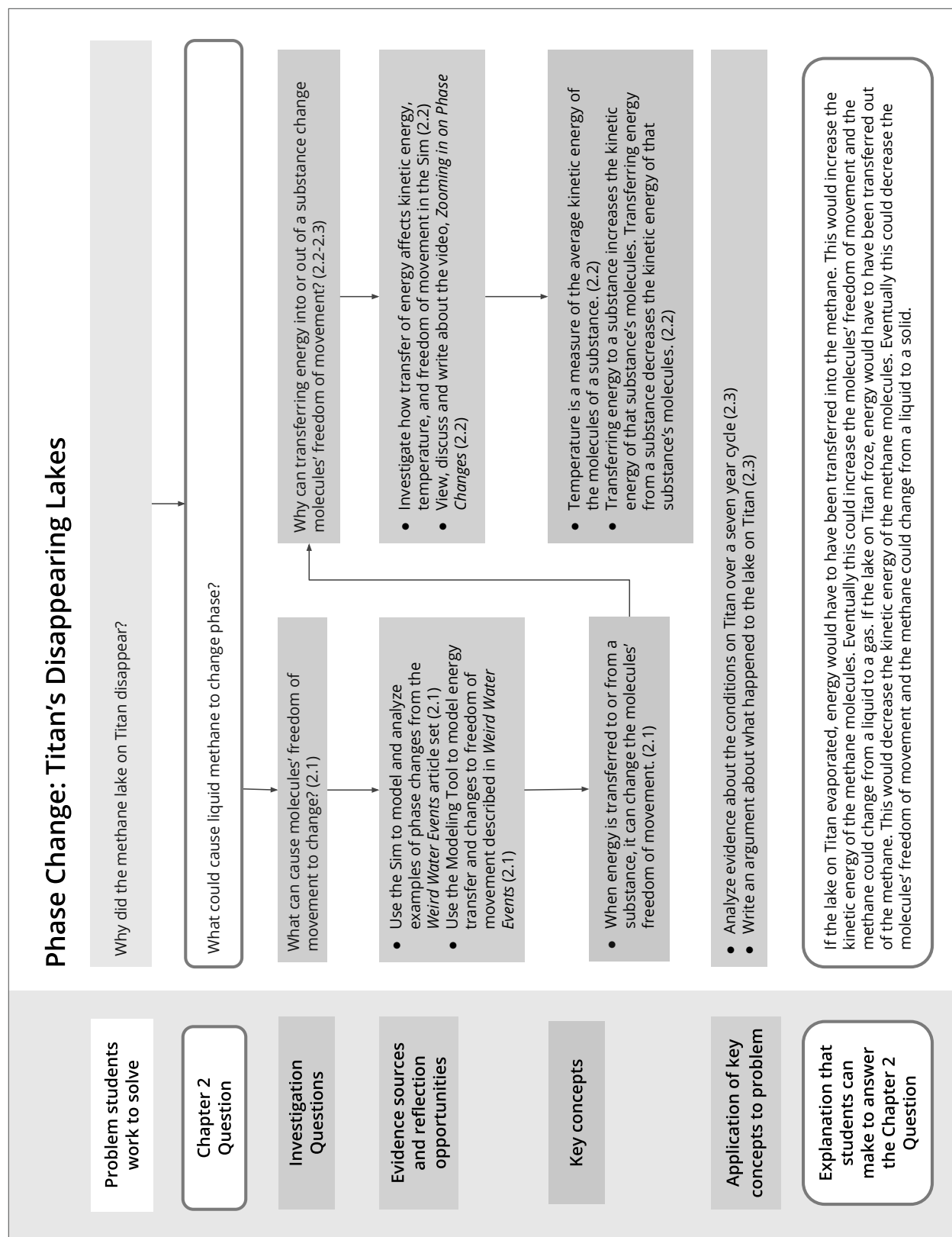
**Chapter 4: Students apply what they learn to a new question—Why is the liquid oxygen machine producing less liquid oxygen than normal?**

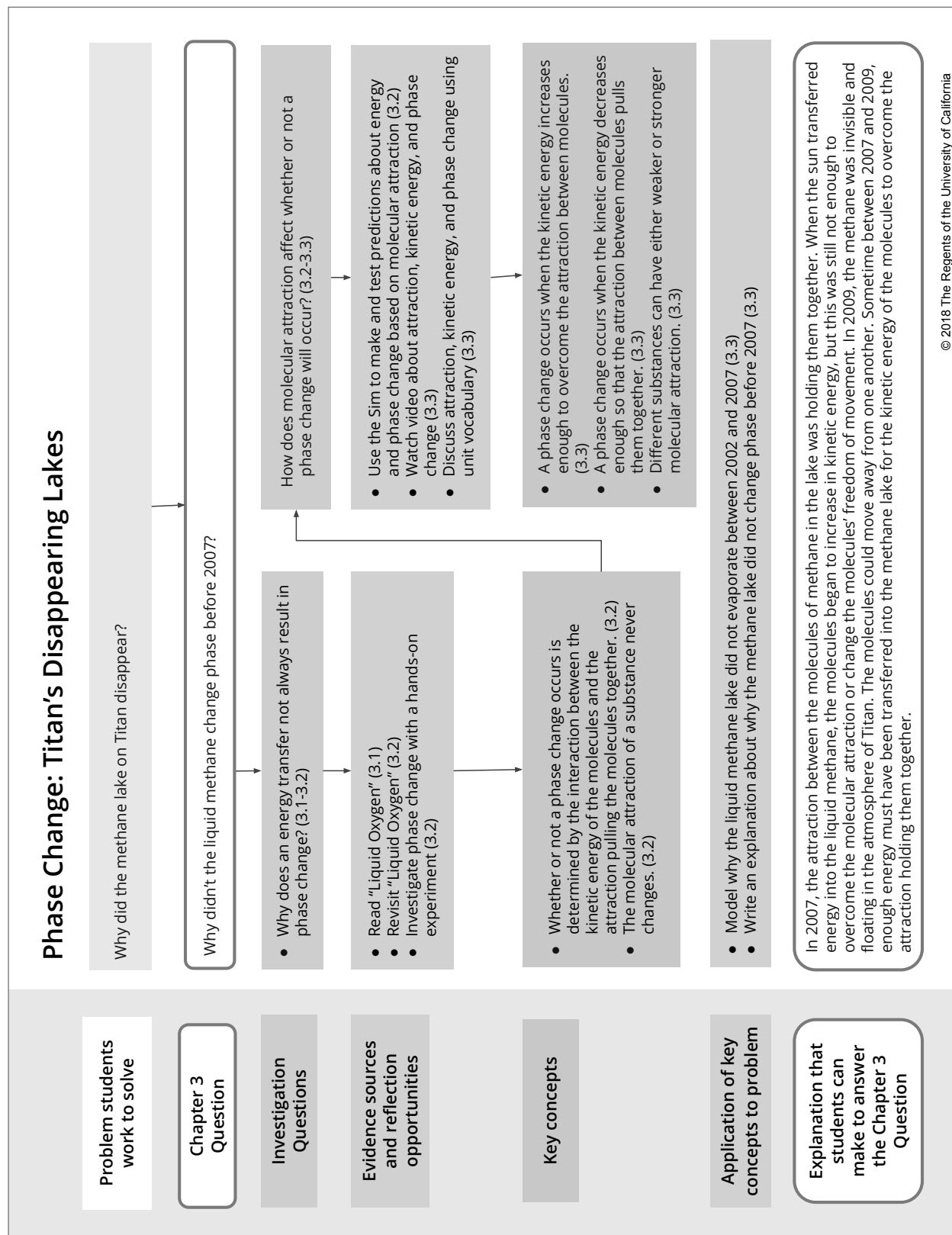
The rockets for the next mission to gather evidence about Titan will use liquid oxygen for fuel, but the device that makes the liquid oxygen is not working. The device makes liquid oxygen from air by changing the phase of nitrogen, water vapor, and oxygen. Students reread a short article about this kind of device and analyze each phase change involved in the process. Students consider three claims about why the device is malfunctioning and review the available evidence to make an argument. They engage in oral argumentation in a student-led discourse routine called a Science Seminar and then individually write their final arguments.

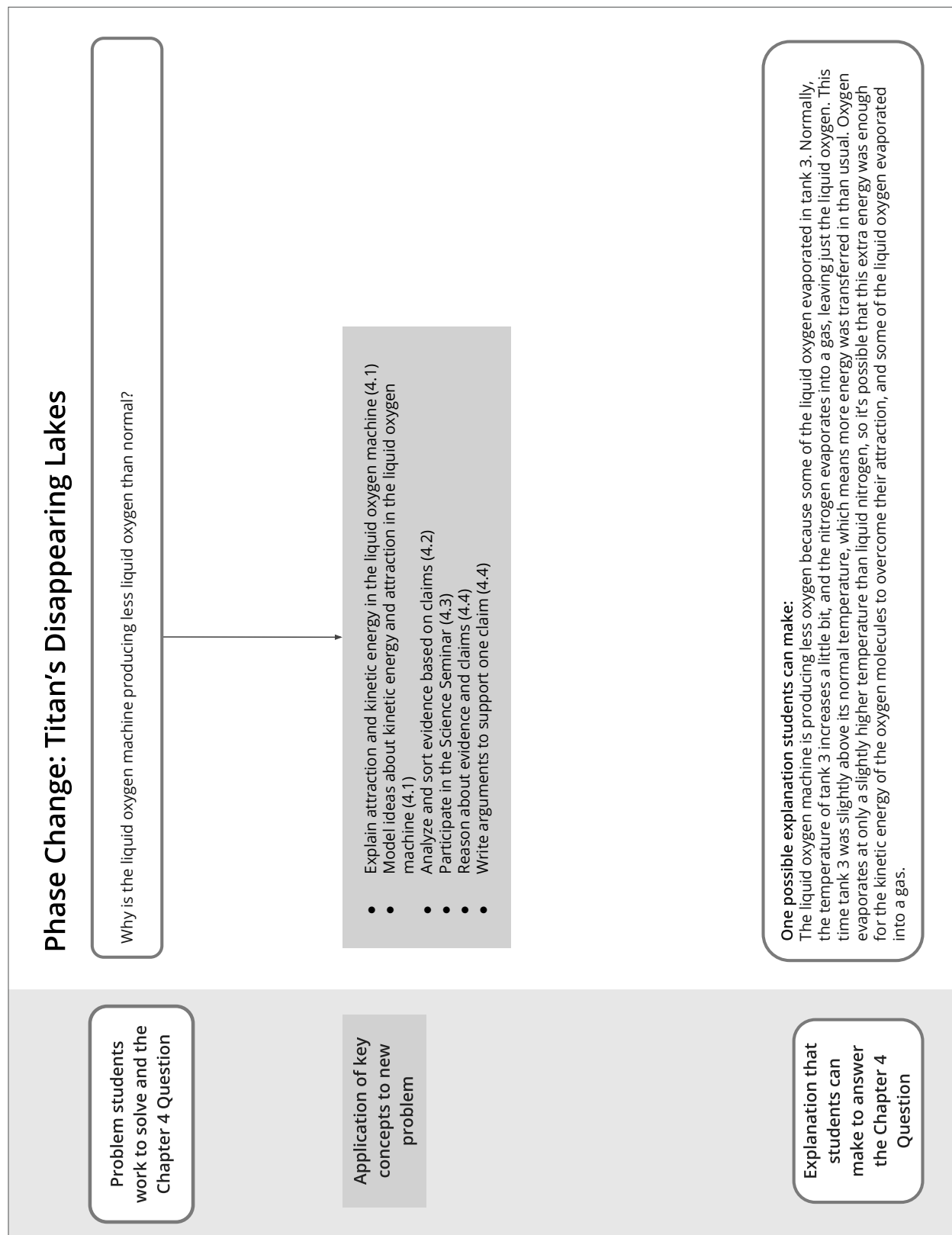
# Phase Change Coherence Flowchart



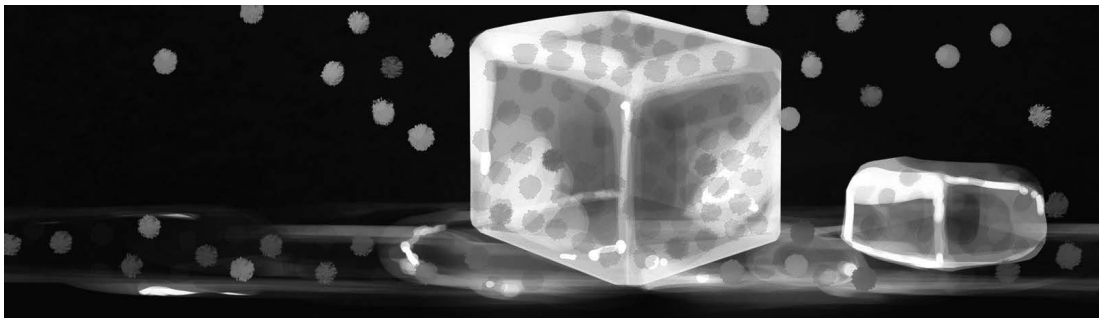
# Phase Change Coherence Flowchart cont.







AmplifyScience



## Phase Change:

### Titan's Disappearing Lakes

**Investigation Notebook**

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Discussing Difference in Appearance

Discuss the phase change videos with your partner. Pick one of the videos and answer the questions about it below. Include terms from the word bank in your responses.

### Word Bank

condensation	does not flow	evaporation	flows
freezing	gas	has its own shape	invisible
liquid	melting	phase change	solid
takes the shape of its container	visible		

1. How would you describe the appearance of the substance before the phase change?

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2. How would you describe the appearance of the substance after the phase change?

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3. Based on your description, choose which phase change you think occurred in your video. Circle the name of the video you discussed and the phase change you think occurred.

#### Video

*Condensation on a Cup*

*Evaporating Mud Puddle*

*Melting Ice Pop Timelapse*

*Ice Forming on Tree Branches*

#### Phase change that occurred

freezing (liquid to solid)

melting (solid to liquid)

evaporation (liquid to gas)

condensation (gas to liquid)

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Considering Molecules and Phase Change

### Safety Note: Using Hot Water

- Be careful around hot water and heating elements. Avoid splashing and protect your eyes as needed.

In the last lesson, we investigated the appearance of a substance when it changes phase. Today, we will complete an activity that will allow us to observe one or more phase changes. Read the instructions below. Then, complete this activity.



### Setup Instructions

- Make sure the foam cup is filled with hot water. It should be one-quarter full.
- Take the plastic cup and turn it upside down. Place it on top of the foam cup.
- Observe any phase changes that occur, using the provided magnifying glasses as needed.
- Answer the questions below.

What did you observe happening in the cups?

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Did a phase change or phase changes occur? If so, which one or ones?

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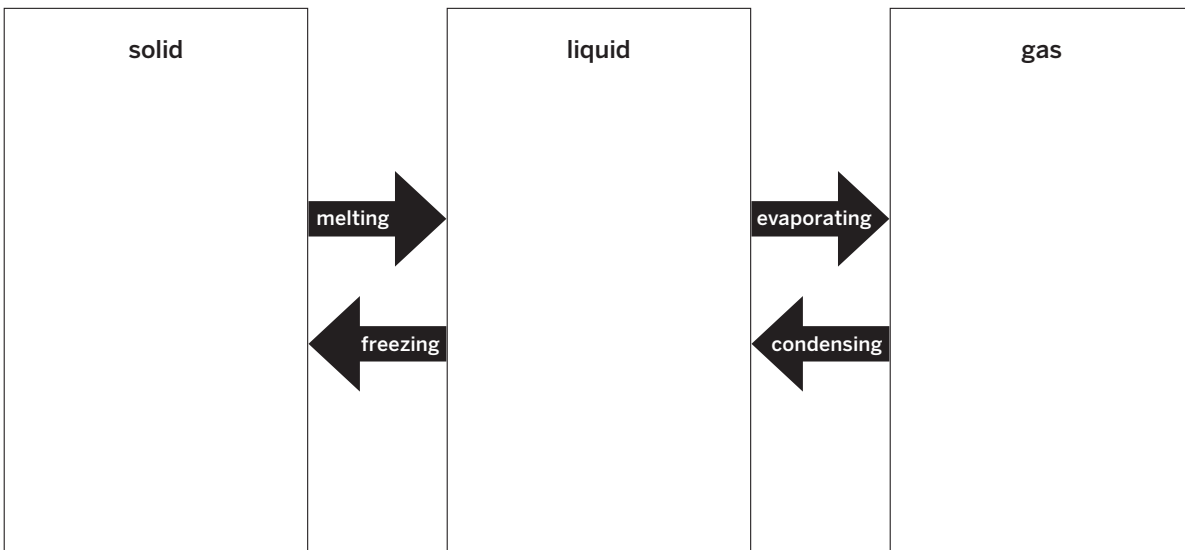
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Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Modeling Molecules and Phases

1. Before completing this activity, think back on the phase change videos you watched in the last lesson and the hands-on activity you completed in this lesson. Also, consider observations you have made in relation to phase change in the past.
2. Then, use the boxes below to draw a model that shows what you think happens to water molecules at the molecular scale of each phase.
  - Use simple shapes, such as circles or squares, to represent the molecules.
  - **Note:** You will have the chance to revise your models in a later lesson.



Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Exploring the *Phase Change* Simulation

**To:** Student Chemists  
**From:** Dr. Daniela Flores, Lead Chemist at the Universal Space Agency  
**Subject:** *Phase Change* Simulation



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You're off to a great start with your investigation of phase changes! Today, you will explore the *Phase Change* Simulation to further investigate Titan's methane-lake mystery at the molecular scale. As you read in the last lesson, Titan and Earth are similar in a few important ways. As molecules behave the same way everywhere in the universe, this Simulation will help you understand phase changes that occur on Titan. I look forward to your next update.

1. Launch the *Phase Change* Simulation.
2. As you explore the *Phase Change* Simulation, consider the following questions:
  - What can you do or change in the Sim?
  - What do you think you can learn from the Sim?

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Investigating the Molecular Scale

### Part 1

1. Launch the *Phase Change* Simulation and observe different phases in the Sim.
2. In the data table below, record your observations about the molecular scale of each phase.
3. Consider how the movement of molecules relates to the macro-scale appearance of each phase.

Phase	Macro-scale appearance	Molecular scale
Gas	Fills container and has no visible shape	
Liquid	Flows, stays at the bottom of the container, and takes shape of container	
Solid	Rigid and keeps its shape	

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Reading *Weird Water Events*

1. Select one of the four articles to read and annotate.
  - “Flash Floods in Slot Canyons”
  - “Glacier Caves of Iceland”
  - “Frozen Niagara Falls”
  - “Old Faithful Geyser”
2. Choose and mark annotations to discuss with your partner. Once you have discussed these annotations, mark them as discussed.
3. Now, choose and mark a question or connection, either one you already discussed or a different one you still want to discuss with the class.
4. Answer the reflection question below.

Rate how successful you were at using Active Reading skills by responding to the following statement:

**As I read, I paid attention to my own understanding and recorded my thoughts and questions.**

- Never
- Almost never
- Sometimes
- Frequently/often
- All the time

### Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Reading About Molecular Movement

Read and annotate the first two paragraphs of the article set and review the diagram on the previous page.

Review your notes about the molecular scale from Lesson 1.3 on page 15. You may want to summarize these notes in the third column of the table below. After you have done this, edit or add to your notes, describing molecules' freedom of movement in each phase.

Phase	Macro-scale appearance	Molecular scale (molecules' freedom of movement)
Gas	Fills container and has no visible shape	
Liquid	Flows, stays at the bottom of the container, and takes shape of container	
Solid	Rigid and keeps its shape	

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Modeling Evaporating and Freezing

### Part 1

1. Open the *Phase Change* Modeling Tool activity: Methane Lake Freezing.
2. When your model is complete, press HAND IN. If you worked with a partner, write their name here:

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**Goal:** If the lake froze, show how the methane in the lake would be different in 2007 compared to 2009.

#### Do:

- Press the pencil icon and edit the Substance Description for the methane in 2007 (before freezing) and in 2009 (after freezing).
- Show how the molecules are moving.
- Select statements to describe the appearance of the methane.
- Select a phase.

#### Tips:

- The phases for the methane in 2007 and 2009 have already been selected for you.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Modeling Evaporating and Freezing (continued)

### Part 2

1. Open the *Phase Change* Modeling Tool activity: Methane Lake Evaporating.
  2. When your model is complete, press HAND IN. If you worked with a partner, write their name here:
- 

**Goal:** If the lake evaporated, show how the methane in the lake would be different in 2007 compared to 2009.

#### Do:

- Press the pencil icon and edit the Substance Description for the methane in 2007 (before evaporating) and in 2009 (after evaporating).
- Show how the molecules are moving.
- Select statements to describe the appearance of the methane.
- Select a phase.

#### Tips:

- The phases for the methane in 2007 and 2009 have already been selected for you.

# Weird Water Events

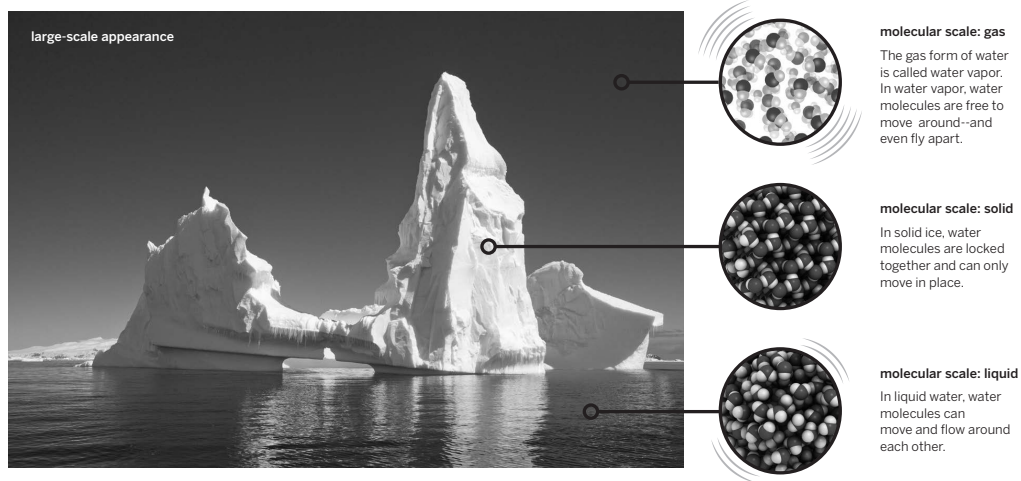
## Chapter 1 Weird Water

Water is amazing stuff, and it does some amazing things: It flows, it sparkles like diamonds, and it seems to appear and disappear like magic. These are all large-scale observations of water’s appearance that we can make with the human eye. We can also think about water, and all substances, on another scale that we cannot usually see: the molecular scale. Molecules are too tiny to see, but they are very important. Water is made of molecules, and so is almost everything else on Earth. The appearance of water is determined by the way the water molecules are moving.

You might think of water as a liquid, but water can actually exist in three different phases: liquid water, solid ice, and a gas called water vapor. No matter what phase water is in, the water is still made of the same molecules; they just move differently.

In the solid phase (known as ice), water molecules are tightly packed and can move only in place. In the liquid phase, water molecules have greater freedom of movement. They’re able to move around and flow from one place to another. However, they still stick together, which is why liquid water forms little beads on a car windshield when it rains.

In the gas phase (known as water vapor), water molecules move around a lot—and they don’t stay right next to each other at all. Water vapor doesn’t stay where you put it! To learn more about some of the unusual ways water behaves in its different phases, choose one of the chapters that follow.



Water can take three different forms: liquid water, a gas called water vapor, and solid ice.

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## Chapter 2

# Flash Floods in Slot Canyons

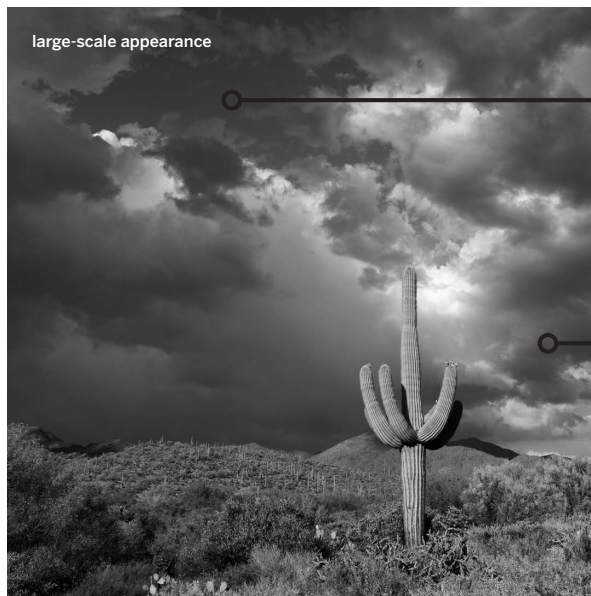
Imagine hiking in Antelope Canyon, a very tall, narrow slot canyon in the Arizona desert. The walls of Antelope Canyon are steep and curving and made of deep red rock. The canyon looks as if it was carved by a flowing river, but the floor of the canyon is bone-dry. What formed Antelope Canyon? If you're very unlucky, you might find out firsthand. The canyon was formed by flash floods.

Even in the desert, there is water vapor in the air—molecules of water in the gas phase. These molecules have a lot of freedom of movement and can move apart from each other, so water

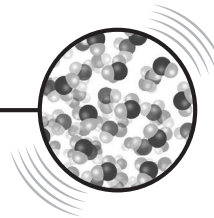


Slot canyons like this one are carved by flash floods.

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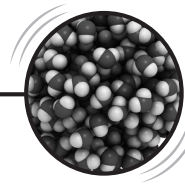


large-scale appearance



**molecular scale: gas**

Even dry desert air contains some water vapor.



**molecular scale: liquid**

When water vapor in the air is forced high into the sky, where temperatures are cooler, it changes phase into a liquid and forms droplets that make up clouds. Those droplets may come together and form rain drops.

Deserts may be dry, but certain conditions can lead them to have flash floods.



**During a flash flood, water rushes through a canyon.**

vapor is invisible. Even though you can't see it, the water vapor is still there. When conditions are right, hot air forces this water vapor upward, high above the desert floor, where temperatures are cooler. As the water vapor cools, it changes phase and condenses into droplets of liquid water. These droplets gather to form huge storm clouds. Soon, big drops of rain fall on the dry desert. The hard, dry desert ground can't absorb all the water, so the water flows quickly across the desert floor, becoming a flash flood.

Rainwater flows across the ground because the rainwater is liquid. In the liquid phase, water molecules have enough freedom of

movement that they can flow and move together. Liquid water also flows into any cracks in the ground. As the water flows through the cracks, it washes away bits of rock, making the cracks wider and wider. Over millions of years, one flash flood after another widens the crack more and more, and digs it deeper and deeper, carving a slot canyon.

Flash floods happen quickly. Inside slot canyons, flash floods are especially dangerous: they can quickly fill the whole canyon with water, drowning anyone caught inside.

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## Chapter 3 **Glacier Caves of Iceland**

In a country named Iceland, you might expect to find glaciers—huge sheets of ice that may be thousands of feet thick and stretch for miles. Iceland does have glaciers—lots of them—but this country is also known for its fiery volcanoes. These volcanoes often erupt, sending out hot lava and ash. Hot volcanic rock lies very close to the surface in Iceland.

The combination of glaciers and hot rock creates some of Iceland’s most spectacular features: glacier caves. Iceland’s glacier caves form when ice at the bottom of a glacier comes into contact with volcanically heated rock below. The heat of the rock causes some of the ice to melt into liquid water and flow downhill, creating tunnels under the glacier.

The cave walls and the water flowing through the center are all made of water molecules, and



**Iceland is known for its volcanoes as well as its glaciers.**

it’s the behavior of the water molecules that makes these wonders possible. In the ice walls of the cave, the water molecules have very little freedom of movement. Since the molecules of water are held in place, the ice is rigid and



**Streams of liquid water flow underneath glacier caves, heated by the rock below.**

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## “Weird Water Events” articles cont.

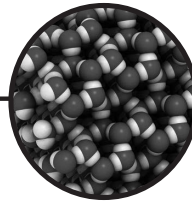
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keeps its shape. These hard, shiny walls of ice sparkle in the light from visitors’ flashlights.

In spots where this ice meets hot rock, the ice changes phase. As the solid ice melts into liquid water, its molecules gain more freedom to move around. The molecules of liquid water become free to slide around each other. Because of what’s happening on the molecular level, the liquid water is able to flow, forming streams and cutting tunnels through the ice.

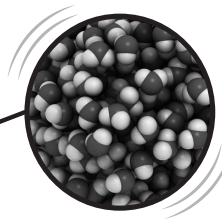


Ice caves form when the ice in glaciers is heated by volcanic rocks underneath. Some of the ice changes phase into liquid water and flows away, leaving a cave.



### **molecular scale: solid**

In solid ice, the molecules are locked together and can only move in place. This gives ice its rigid shape and allows it to form solid shapes, like giant ice caves.



### **molecular scale: liquid**

The molecules in liquid water can move around each other, allowing liquid water to form streams and flow from one place to another.

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**For the water in Niagara Falls to freeze, the weather must be very cold.**

## Chapter 4 **Frozen Niagara Falls**

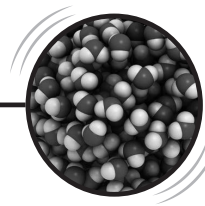
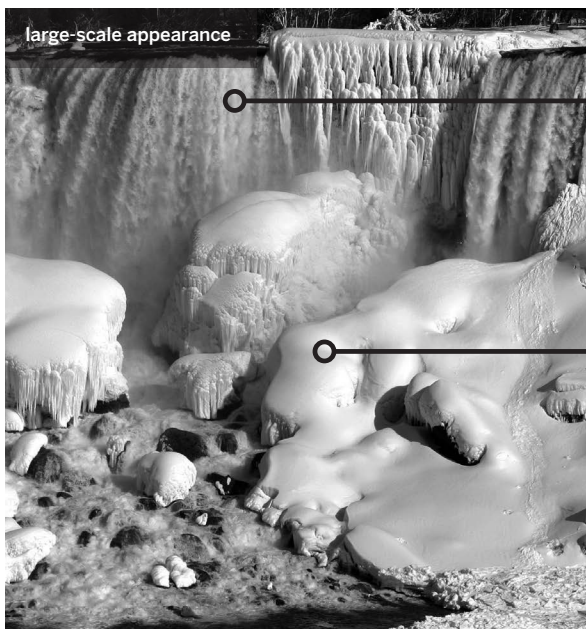
More than 283,900 liters (75,000 gallons) of water flow over Niagara Falls every second. A gallon of water is made up of trillions and trillions of molecules, so that's an unimaginable number of water molecules flowing over the falls! It's the molecules' freedom of movement that makes this spectacle possible. The water in the falls is liquid, so the molecules are free to move around each other and flow. However, they don't fly apart the way molecules of a gas do. Because of this, all that water stays in the river channel and falls down to fill the basin at the bottom of the falls.

Niagara Falls lies on the border between the U.S. and Canada. That far north, winters are often extremely cold. The cold

weather causes a phase change. Niagara Falls freezes—not completely, but large parts of it. The spectacle of the partially frozen falls is thanks to the behavior of water molecules. When it gets cold enough, the water changes phase from liquid to solid. The molecules lose some of their freedom of movement, becoming stuck in place. They still move back and forth a little, but they can't move around each other. Because of what's happening on the molecular scale, the flowing liquid freezes into solid ice. It forms huge icicles, ice columns, and a shelf of ice at the base of the falls.

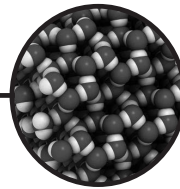
The frozen falls may look like sculpted rock, but they are still made up of water molecules. As warmer weather arrives, the ice melts into liquid water and the falls flow freely again.

“Weird Water Events” articles cont.



**molecular scale: liquid**

In liquid water, the molecules can move around each other and flow over the falls.



**molecular scale: solid**

In solid ice, water molecules are locked together and can only move in place.

During cold winters, Niagara Falls partially freezes.



About 283,900 liters (75,000 gallons) of liquid water flow over Niagara Falls every second.

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## Chapter 5

# Old Faithful Geyser

Old Faithful is a famous geyser—a natural feature that shoots streams of water high into the air. In each eruption, thousands of gallons of water spray more than 100 feet high. A few minutes later, the fountain stops...only to start again, faithfully, about 90 minutes later. Why does Old Faithful do this? The answer has to do with the behavior of water molecules.

Old Faithful lies in Yellowstone National Park, an area where an ancient volcano still heats up rock close to the surface. This hot rock heats up water that trickles down through cracks. The water is able to trickle because of the behavior of its molecules. Molecules in liquid water are free to move around each other and flow down into a container—in this case, underground spaces made by cracks in the rock.

Inside its rock container, the water becomes extremely hot, causing some of the water at the bottom to change phase. The liquid water changes into a gas called water vapor. The molecules in a gas have more freedom of movement than molecules in a liquid. Molecules in gas are free to move away from each other, so gas can expand to fill its container. As the gas expands to fill the cracks, it meets liquid




**Old Faithful erupts when liquid water is forced out of the ground by heated water vapor below.**

water still trickling down from the surface. In geysers like Old Faithful, the cracks in the rock have narrow sections that partially block the gas and water from escaping, trapping them in the cracks. The expanding gas forces the liquid water up and out through the narrow spaces in the cracks, bursting to the surface and shooting into the air until the underground space is empty. Then the liquid water flows back down through the cracks, refilling the underground container and beginning to heat up, restarting the cycle. Once the water heats up enough to change phase, Old Faithful will erupt again.

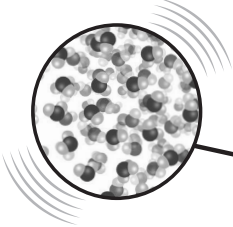
## “Weird Water Events” articles cont.

**large-scale appearance**



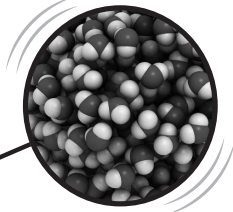
**molecular scale: gas**

Deep in underground cracks, liquid water is heated by volcanic rock and changes phase to become gas. Molecules in a gas can move apart from one another. Because of this, the gas can expand to fill the space. It pushes up on the liquid water above it.

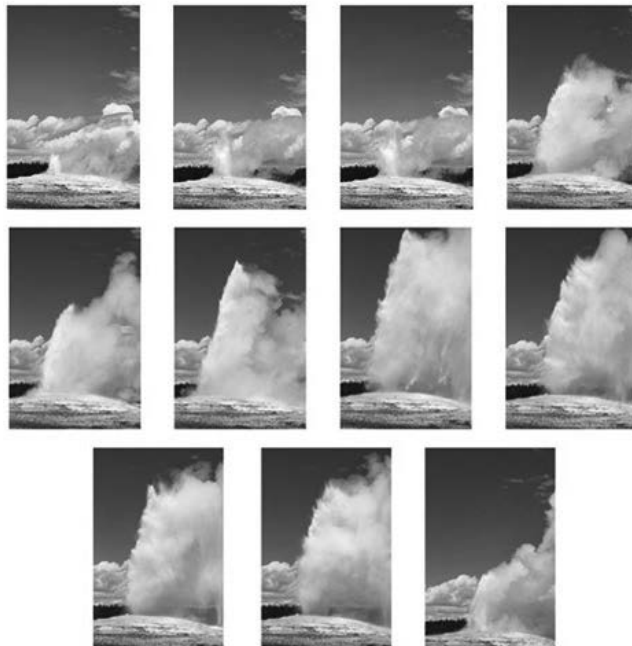


**molecular scale: liquid**

Pushed up by the expanding gas below, liquid water flows upward and out of the geyser. The liquid is able to flow because its molecules have the freedom to move around one another.



**Geysers erupt when water vapor (a gas) pushes liquid water up and out of the ground.**



**Old Faithful erupts out of the ground every 90 minutes.**

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# Connecting key concepts to chapter explanations

## Phase Change

### Directions:

1. For each chapter, read the key concepts, then the explanation.
2. With a partner, discuss how the key concepts connect to the explanation.
3. Make annotations about the connections.

Ch	Key concepts	Explanation
1	<ul style="list-style-type: none"><li>• A solid holds its shape and does not take the shape of its container. (1.2)</li><li>• A gas has no visible shape and fills its container. (1.2)</li><li>• A liquid flows and can take the shape of its container. (1.2)</li><li>• A solid keeps its shape because its molecules only move in place, not around each other. (1.5)</li><li>• A liquid can flow because its molecules move around, not away from each other. (1.5)</li><li>• A gas does not have a visible shape because gas molecules can move away from each other. (1.5)</li><li>• A phase change is when the molecules that make up a substance experience a change to their freedom of movement. This phase change involves a macro-scale change in appearance. (1.5)</li><li>• A change that can be observed at the macro-scale can be explained by a change at the molecular scale, which cannot be observed with the naked eye. (1.6)</li></ul>	<p>The methane lake on Titan began as a liquid. The liquid methane could flow because the molecules can move around one another, but not apart from one another. If the lake froze, the liquid methane would become a solid. Solid methane would keep its shape because the molecules in a solid can only move in place, but they cannot move around one another or apart. If the lake evaporated, the liquid methane would have become a gas. Methane gas would not have a visible shape because gas molecules can move away from one another.</p>
2	<ul style="list-style-type: none"><li>• When energy is transferred to or from a substance, it can change the molecules' freedom of movement. (2.1)</li><li>• Temperature is a measure of the average kinetic energy of the molecules of a substance. (2.2)</li><li>• Transferring energy to a substance increases the kinetic energy of that substance's molecules. Transferring energy from a substance decreases the kinetic energy of that substance's molecules. (2.2)</li></ul>	<p>If the lake on Titan evaporated, energy would have to have been transferred into the methane. This would increase the kinetic energy of the methane molecules. Eventually this could increase the molecules' freedom of movement and the methane could change from a liquid to a gas. If the lake on Titan froze, energy would have to have been transferred out of the methane. This would decrease the kinetic energy of the methane molecules. Eventually this could decrease the molecules' freedom of movement and the methane could change from a liquid to a solid.</p>
3	<ul style="list-style-type: none"><li>• Whether or not a phase change occurs is determined by the interaction between the kinetic energy of the molecules and the attraction pulling the molecules together. (3.2)</li><li>• The molecular attraction of a substance never changes. (3.2)</li><li>• A phase change occurs when the kinetic energy increases enough to overcome the attraction between molecules. (3.3)</li><li>• A phase change occurs when the kinetic energy decreases enough so that the attraction between molecules pulls them together. (3.3)</li><li>• Different substances can have either weaker or stronger molecular attraction. (3.3)</li></ul>	<p>In 2007, the attraction between the molecules of methane in the lake was holding them together. When the sun transferred energy into the liquid methane, the molecules began to increase in kinetic energy, but this was still not enough to overcome the molecular attraction or change the molecules' freedom of movement. In 2009, the methane was invisible and floating in the atmosphere of Titan. The molecules could move away from one another. Sometime between 2007 and 2009, enough energy must have been transferred into the methane lake for the kinetic energy of the molecules to overcome the attraction holding them together.</p>

# Reflecting on the progression of ideas

---

## **Directions:**

### **Part 1: Reflecting on the progression**

1. Using the key concepts and explanations, reflect on how ideas build throughout the unit.
2. With your group, discuss the following questions:
  - Which ideas are revisited over multiple chapters?
  - What new ideas are added in each chapter?
3. Make notes about the progression of ideas in the space below.

### **Part 2: Creating a visual**

1. With your group, use the provided materials to create a visual to represent your ideas. You can use words or pictures, or a mix of both. The following questions may help you plan your visual:
  - How can you represent the new information that is added throughout the progression?
  - How can you represent foundational ideas that are revisited throughout the unit?





## Progress Build

Each Amplify Science Middle School unit is structured around a unit-specific learning progression, which we call the Progress Build. The unit's Progress Build describes the way students' explanatory understanding of the unit's focal phenomena is likely to develop and deepen over the course of a unit. It is an important tool in understanding the structure of a unit and in supporting students' learning: it organizes the sequence of instruction (generally, each level of the Progress Build corresponds to a chapter), defines the focus of assessments, and grounds the inferences about student learning progress that guide suggested instructional adjustments and differentiation. By aligning instruction and assessment to the Progress Build (and therefore to each other), evidence about how student understanding is developing may be used during the course of the unit to support students and modify instruction in an informed way.

The *Phase Change* Progress Build consists of three levels of science understanding. To support a growth model for student learning progress, each level encompasses all of the ideas of prior levels and represents an explanatory account of unit phenomena, with the sophistication of that account increasing as the levels increase. At each level, students add new ideas and integrate them into a progressively deeper understanding of about what happens to a substance when it changes phase. Since the Progress Build reflects an increasingly complex yet integrated explanation, we represent it by including the new ideas for each level in bold.

**Prior knowledge (preconceptions).** At the start of the *Phase Change* unit, middle school students will likely have some everyday experience with the phase changes of water. However, few students will have experience thinking about the molecular-scale changes that characterize phase changes. Students often think of molecular motion as being mirrored by macroscopic movement. For example, students may think that the molecules of a fluid are only moving when students can see macroscopic flow. From the *Thermal Energy* unit, students will be familiar with how energy transfer changes the kinetic energy of the molecules in a substance and how this affects a substance's temperature, though they will not have had experience thinking about how energy transfers relate to phase changes. This experience and prior knowledge can be built on and refined, which the *Phase Change* Progress Build and unit structure are designed to do.

**Progress Build Level 1: When a substance changes phase, the freedom of movement of its molecules has changed.**

A phase change is a change in the appearance of a substance due to a change in the freedom of movement of its molecules relative to one another. For solids, the molecules don't move past one another or apart, they just move in place, causing the substance to be rigid and have a fixed shape. For liquids, the molecules move past one another, but not apart, causing the substance to flow and take the shape of the container. For gases, the molecules move apart causing the substance to fill its container.

**Progress Build Level 2: Energy transfers cause phase changes.**

A phase change is a change in the appearance of a substance due to a change in the freedom of movement of its molecules relative to one another. For solids, the molecules don't move past one another or apart, they just move in place, causing the substance to be rigid and have a fixed shape. For liquids, the molecules move past one another, but not apart, causing the substance to flow and take the shape of the container. For gases, the molecules move apart causing the substance to fill its container. **Transferring energy into or out of a substance can cause a phase change by increasing or decreasing the kinetic energy (and speed) of the molecules so that the freedom of movement of the molecules changes.**

## Phase Change

### Planning for the Unit

Progress Build



#### **Progress Build Level 3: Molecular attraction affects the amount of energy transfer required for a phase change.**

A phase change is a change in the appearance of a substance due to a change in the freedom of movement of its molecules relative to one another. For solids, the molecules don't move past one another or apart, they just move in place, causing the substance to be rigid and have a fixed shape. For liquids, the molecules move past one another, but not apart, causing the substance to flow and take the shape of the container. For gases, the molecules move apart causing the substance to fill its container. Transferring energy into or out of a substance can cause a phase change by increasing or decreasing the kinetic energy (and speed) of the molecules so that the freedom of movement of the molecules changes. **Attraction between molecules pulls molecules toward one another. If an energy transfer into or out of a substance results in a phase change, either the molecular attraction overcomes the decreasing kinetic energy or the increasing kinetic energy overcomes the molecular attraction, and the freedom of movement changes.**

# Middle School: *Phase Change: Titan’s Disappearing Lakes*

## Rubrics for Assessing Students’ Final Written Arguments

Argumentation is an important practice in science; scientists use arguments to convince an audience that the explanation being proposed is the best one supported by evidence. To assess students’ written arguments—as an opportunity for demonstrating their understanding of science concepts and for demonstrating the *practice* of constructing arguments—we have provided three rubrics. The first rubric may be used summatively to assess students’ understanding of science concepts from the unit. The second rubric may be used summatively to assess students’ application of the crosscutting concept of Scale, Proportion, and Quantity as applied to a specific phenomenon. The third rubric is designed to formatively assess the practice of constructing arguments, which includes the associated practices of constructing explanations and obtaining, evaluating, and communicating information; students’ facility with this practice takes time to develop, and students will have opportunities to practice argumentation in each unit. Rubric 3 provides possible student responses that illustrate how a student’s written work may demonstrate different levels of understanding. A full response for each claim is provided in the Possible Responses tab in the instructional guide for the activity in which students write their scientific arguments.

**Prompt for final written argument:** *Why is the liquid oxygen machine producing less liquid oxygen than normal?*

- **Claim 1:** There is frozen water in tank 2, which is blocking some of the oxygen from going into tank 3.
- **Claim 2:** Some of the liquid oxygen evaporated in tank 3.
- **Claim 3:** Some of the oxygen didn’t condense in tank 2.

### **Rubric 1: Assessing Students’ Understanding of Science Concepts**

The rubric (on page 2) may be used to assess students’ written arguments from Lesson 4.3 for how well the writing demonstrates mastery of core science concepts from the unit. The science concepts described in the rubric build in complexity with each row.

Rubric 1: Assessing Students' Understanding of Science Concepts	
Score	Description
0	Response is off-target or does not yet demonstrate understanding of key concepts identified in the Progress Build.
1	Response correctly describes: how energy transfers would affect the phase of the substances.
2	Response correctly describes: how energy transfers would affect the phase of the substances.  AND EITHER  the way the energy transfer in the tanks would affect the kinetic energy of molecules of the substances.  OR  how the molecular attraction of each substance, and differences between them, determines the phases of the substances in each tank.
3	Response correctly describes: how energy transfers would affect the phase of the substances.  AND  the way the energy transfer in the tanks would affect the kinetic energy of molecules of the substances.  AND  how the molecular attraction of each substance, and differences between them, determines the phases of the substances in each tank.

## Rubric 2: Assessing Students' Understanding of the Crosscutting Concept of Scale, Proportion, and Quantity

This rubric (below) considers how well students are able to apply the crosscutting concept of Scale, Proportion, and Quantity to a specific phenomenon.

Rubric 2: Assessing Students' Understanding of the Crosscutting Concept of Scale, Proportion, and Quantity	
Score	Description
0	Response is off-target or does not yet demonstrate understanding that a change that can be observed at the macroscale can be explained by a change at the molecular scale, which cannot be observed with the naked eye.
1	Response correctly describes that:  When water or oxygen changes phase, that means that something is happening with the molecules of that substance.
2	Response correctly describes that:  When water or oxygen changes phase, that means that something is happening with the molecules of that substance.  AND  That characteristics of molecules, such as their kinetic energy and attraction, can be inferred and described based on macroscale observations.



### Rubric 3: Assessing Students' Performance of the Practice of Constructing Scientific Arguments

This rubric (beginning on page 5) may be used to assess students' written arguments from Lesson 4.3. The purpose of this rubric is to guide support for students as they develop the scientific practice of argumentation and come to appreciate that science, as a field, advances through argumentation. The rubric is grounded in the principle that ideas in science are based on evidence and that students are doing science when they are making explanations and arguments—just as scientists use evidence to justify why a particular explanation is the best one available. The rubric is designed to guide formative feedback that:

- supports students in understanding science as a collaborative process of knowledge building, using evidence derived from the natural world.
- helps students feel capable as they build on the skills they already have for evaluating possible answers in relation to available evidence.
- develops students who can skillfully construct and critique arguments in science and bring those skills to other areas.

In this unit, a strong written argument meets the following criteria:

- **takes a stance** by stating a claim that directly addresses the question
- **explanatory** by identifying a cause for the phenomenon in question *and* explaining the mechanism by which it is a cause
- **justified by the reasoned use of evidence** that is likely to convince a scientific audience
- **employs high-quality information** as evidence to support the claim
- **clear and well-organized** by following conventions and being structured in a way that clearly communicates to the intended audience why the proposed claim is the one most likely to be true
- **going further: engages with alternative claims** by acknowledging and challenging competing ideas

Rubric 3 describes how these criteria may be applied to students' written arguments in this unit and suggests feedback to help students advance the practice of argumentation.

Rubric 3: Assessing Students' Performance of the Practice of Constructing Scientific Arguments		
Criteria	Score	Description and possible feedback
<b>takes a stance</b> Does the argument propose a claim that directly answers the question?	0	No claim is proposed, or proposed claim does not answer the question. (e.g., the claim is off-topic)  Possible feedback: <i>What question are we trying to answer? What kinds of things might cause that to happen? How can you make sure that your proposed answer is clear to your audience?</i>
	1	Argument proposes a claim that answers the question.  Note that students who select one of the provided claims would receive a score of 1 for this criterion.
<b>explanatory</b> Does the argument fully address the question by identifying a cause for the phenomenon and by explaining the mechanism or process by which it is a cause?	0	Argument does not offer an explanatory account to answer the question. A cause is not identified, and a mechanism is not described.
	1	Argument identifies a cause of the observed phenomenon without indicating the mechanism.  Example (Claim 1): There is less liquid oxygen than normal because frozen water in tank 2 is blocking some of the oxygen from going into tank 3. This happened because tank 1 was warmer than usual.  Possible feedback: <i>You wrote that tank 1 was warmer than usual, but how would this cause there to be frozen water in tank 2?</i>  OR  Summarizes the mechanism without identifying the cause.  Example (Claim 1): There is less liquid oxygen than normal because frozen water in tank 2 is blocking some of the oxygen from going into tank 3. This is because water vapor in tank 1 didn't condense into a liquid, so it moved into tank 2, where it froze into a solid.  Possible feedback: <i>You've told me that water vapor was able to move from tank 1 to tank 2, but why didn't it condense in tank 1 like it usually does?</i>

Rubric 3: Assessing Students' Performance of the Practice of Constructing Scientific Arguments		
Criteria	Score	Description and possible feedback
<b>explanatory</b> Does the argument fully address the question by identifying a cause for the phenomenon and explaining the mechanism or process by which it is a cause?	2	<p>Argument proposes an explanation that identifies the cause but does not explain the mechanism in appropriate depth, or argument explains only part of the mechanism.</p> <p>Example (Claim 1): There is less liquid oxygen than normal because frozen water in tank 2 is blocking some of the oxygen from going into tank 3. There was frozen water blocking oxygen in tank 2 because tank 1 was warmer than usual, so not as much water vapor condensed into liquid and it moved into tank 2 instead.</p> <p>Possible feedback: <i>You've told me how water vapor moved into tank 2, but how would the water block the oxygen in tank 2?</i></p>
	3	<p>Argument proposes a complete and thorough explanation that identifies the causes and fully describes the mechanism.</p> <p>Example (Claim 1): There is less liquid oxygen than normal because frozen water in tank 2 is blocking some of the oxygen from going into tank 3. There was frozen water blocking oxygen in tank 2 because tank 1 was warmer than usual, so not as much water vapor condensed into a liquid to be drained away, and the vapor moved into tank 2. In tank 2, the temperature was lowered to its normal temperature, so it was very cold and the water froze into a solid, which blocked the liquid oxygen and nitrogen from moving into tank 3.</p>
<b>justified by the reasoned use of evidence</b> Is evidence connected to the claim in a way that is likely to convince the audience that the proposed explanation is the best one?	0	<p>Argument does not support the claim with any of the available information (data or science ideas).</p> <p>Possible feedback: <i>How could you convince your audience that the claim you made is the best one?</i></p>

Rubric 3: Assessing Students' Performance of the Practice of Constructing Scientific Arguments		
Criteria	Score	Description and possible feedback
<p><b>justified by the reasoned use of evidence</b></p> <p>Is evidence connected to the claim in a way that is likely to convince the audience that the proposed explanation is the best one?</p>	1	<p>Argument includes information to support the claim but does not explain <i>how</i> that information supports the claim.</p> <p>Example (specific data but not science ideas) (Claim 2): There is less liquid oxygen than normal because some liquid oxygen evaporated in tank 3. Some of the liquid oxygen evaporated in tank 3 because tank 3 was slightly warmer than usual (Evidence Card C).</p> <p>Possible feedback: <i>How do these specific data support your claim? Why does the information you provide matter? Why is the information you provided evidence for your claim? Why would tank 3's warmer temperature cause the liquid oxygen to evaporate?</i></p> <p>OR</p> <p>Example (science ideas but not specific data) (Claim 2): There is less liquid oxygen than normal because some liquid oxygen evaporated in tank 3. Some of the liquid oxygen evaporated in tank 3 because the kinetic energy of the molecules increased enough for the oxygen molecules to overcome their attraction and change freedom of movement, so some of the oxygen changed from liquid to gas.</p> <p>Possible feedback: <i>How do you know that this is what happened in this specific case? What malfunction in the Liquid Oxygen machine could cause liquid oxygen to change phase into a gas?</i></p>
	2	<p>Argument includes information to support the claim and explains how some of the information supports the claim.</p> <p>Example (Claim 1): There is less liquid oxygen than normal because frozen water in tank 2 is blocking some of the oxygen from going into tank 3. The temperature of tank 1 was slightly higher than normal (Evidence Card A). That means that not enough energy was transferred out of the water for the attraction to overcome the decreased kinetic energy of its molecules. Therefore, it remained a gas and was able to move into tank 2. When the water vapor was in tank 2, a lot of energy was transferred out. Tank 2 was cooled to the correct temperature to condense oxygen into a liquid (Evidence Card B).</p>

**Rubric 3: Assessing Students' Performance of the Practice of Constructing Scientific Arguments**

Criteria	Score	Description and possible feedback
<p><b>justified by the reasoned use of evidence</b> Is evidence connected to the claim in a way that is likely to convince the audience that the proposed explanation is the best one?</p>	2	<p>(continued)</p> <p>Possible feedback: <i>You explained how the temperature of tank 1 could lead to water vapor moving into tank 2, but why would the normal cooling of tank 2 support your claim?</i></p> <p>Argument includes information to support the claim and explains how <i>all</i> the information supports the claim.</p> <p>Example (Claim 2): There is less liquid oxygen than normal because some liquid oxygen evaporated in tank 3. Some of the liquid oxygen evaporated in tank 3 because tank 3 was slightly warmer than usual (Evidence Card C), which could cause some of the oxygen molecules to increase their kinetic energy enough to overcome their attraction to change their freedom of movement into a gas. This is further supported by data which shows that more gas came out of tank 3 than normal (Evidence Card E).</p> <p>Possible feedback: <i>Are there other ways or reasons why this could have happened? Does all the available information support your claim? Does any available information support other claims? How might you refute one of the other claims?</i></p>
<p><b>employs high-quality information as evidence</b> This unit's criterion for quality of evidence involves using data from reliable sources.</p>	0	<p>Argument prioritizes information and evidence sources that are not from reliable sources presented in the <i>Phase Change</i> unit.</p> <p>Example: <i>I saw in a movie that oxygen is always a gas.</i></p>
<p><b>employs high-quality information as evidence</b> This unit's criterion for quality of evidence involves using data from reliable sources.</p>	1	<p>Argument includes high-quality information that could be used as evidence to support the claim.</p> <p>Example: <i>Liquid nitrogen evaporates at a lower temperature than liquid oxygen.</i></p>

Rubric 3: Assessing Students' Performance of the Practice of Constructing Scientific Arguments		
Criteria	Score	Description and possible feedback
<p><b>clear and well-organized</b></p> <p>Does the argument follow conventions and is it structured in a way that clearly communicates to the intended audience why the proposed claim is the best and most likely to be true?</p>	0–3	<p>This criterion, scored on a scale of 0–3, is intended to be applied to the written argument as a whole to formatively assess how clearly students' writing communicates why the proposed claim is most likely to be true. The questions below are intended to guide scoring and formative feedback for students to support their development of academic writing and language as it relates to scientific argumentation. Does the argument begin with a clearly articulated claim?</p> <ul style="list-style-type: none"> <li>• Is the argument logically organized (e.g., by focusing on one causal factor at a time)?</li> <li>• Does the argument follow grade-appropriate conventions for academic writing?</li> <li>• Does the argument use transition words to organize ideas?</li> </ul>
<p><b>going further: engages with alternative claims</b></p> <p>Does the argument adequately address counterclaims? (While refutation is not a practice that is explicitly supported in this unit, some students may engage with alternative claims. This rubric can help provide feedback for students who do so.)</p>	0	<p>Alternative claims are not acknowledged.</p> <p>Possible feedback: <i>Have you considered what other claims might have some support?</i></p>

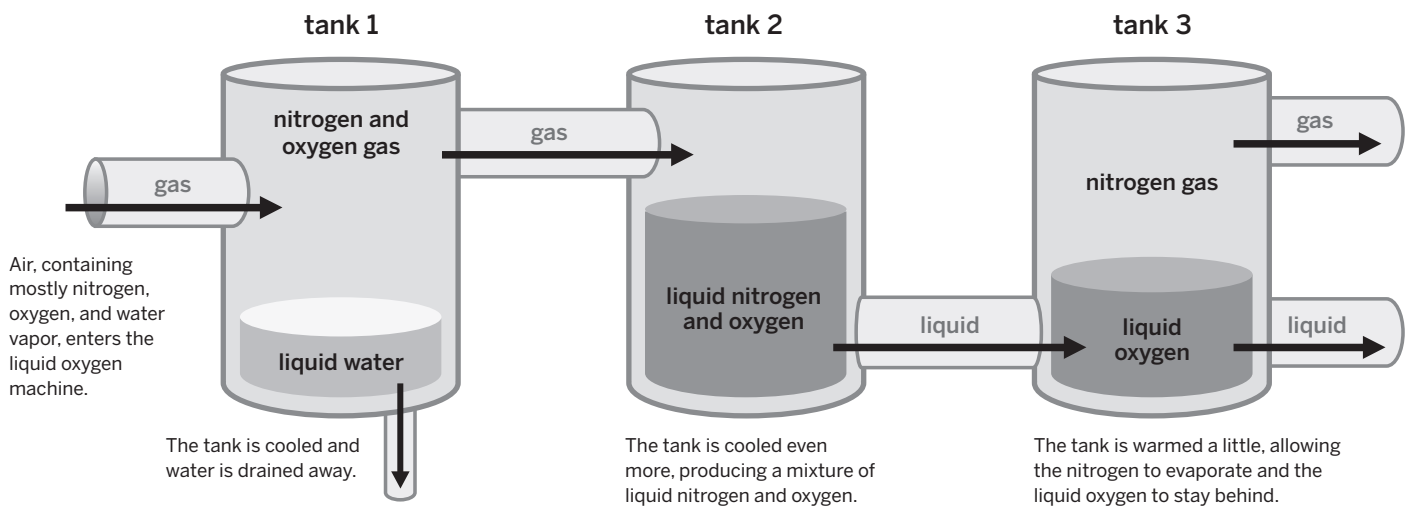
Rubric 3: Assessing Students' Performance of the Practice of Constructing Scientific Arguments		
Criteria	Score	Description and possible feedback
<p><b>going further: engages with alternative claims</b></p> <p>Does the argument adequately address counterclaims? (While refutation is not a practice that is explicitly supported in this unit, some students may engage with alternative claims. This rubric can help provide feedback for students who do so.)</p>	1	<p>Alternative claims are acknowledged, but evidence against those claims is not leveraged.</p> <p>Example: Another claim is that some oxygen didn't condense in tank 2, but this is not what happened.</p> <p>Possible feedback: <i>You mentioned that another claim might not be as strong. Can you provide evidence for why that claim might not be as strong?</i></p>
	2	<p>Alternative claims are acknowledged, and evidence against those claims is leveraged.</p> <p>Example: Another claim is some oxygen didn't condense in tank 2, but this is not what happened because tank 2 was cooled to its normal temperature (Evidence Card B), and at its normal temperature all the oxygen gas condenses into liquid.</p> <p>Possible feedback: <i>You mentioned evidence that supports your claim. Is there any evidence that could support the other claim? If so, what is your reason for discarding it?</i></p>

## Annotating the Liquid Oxygen Machine

Before you can identify what is wrong with the liquid oxygen machine, you will need to understand how the machine is supposed to work. Read paragraph 7 of the “Liquid Oxygen” article in the section called “Using Attraction to Make Liquid Oxygen.” Then, refer to the Liquid Oxygen Machine diagram included on the sheet in front of you. Write or draw annotations on the sheet, explaining how the liquid oxygen machine works. As you annotate, consider the following:

- Did kinetic energy increase or decrease in each tank? Why?
- What role did attraction play in whether or not a phase change occurred?
- What questions or ideas do you have about what might have gone wrong?

### Liquid Oxygen Machine





## Modeling Liquid Oxygen Tanks

Work with your group to use the Modeling Tool to show what happens in tanks 1, 2, and 3. If you have been assigned tank 2, turn to page 107. If you have been assigned tank 3, turn to page 108.

### Tank 1

1. Open the *Phase Change* Modeling Tool activity: Oxygen in Tank 1.
2. When your model is complete, press HAND IN. If you worked with a partner, write their name here:

**Goal:** Show what happens to oxygen gas in tank 1.

#### Do:

- Drag out two Substance Descriptions and describe the oxygen before and after.
- Move the Substance Descriptions up or down to compare the kinetic energy before and after the change.
- Use the arrows to compare the actual change of kinetic energy to the change needed for a phase change.
- Label the arrows.

#### Tips:

- Attach the tail end of the arrows to the Substance Description Before.
- The arrowheads can touch the line but don't need to.

#### Possible Student Response:

Hand In Instructions Help Save Changes Reset Undo Redo

Show what happens to oxygen gas in tank 1.

Substance: Phase: Oxygen Gas

Molecules: Appearance: Fills Container No visible shape

Can move apart

Attraction: Low

Substance: Phase: Oxygen Gas

Molecules: Appearance: Fills Container No visible shape

Can move apart

Attraction: Low

Substance Description

Change in Kinetic Energy

Actual change in Kinetic Energy

A Transfers energy in

B Transfers energy out

Change in Kinetic Energy needed for phase change

Y Allows attraction to overcome energy

Z Allows energy to overcome attraction

14.4 fps

Average Kinetic Energy Substance Description Before Change in KE Actual Needed Substance Description After

### Phase Change—Lesson 4.1—Activity 3

## Modeling Liquid Oxygen Tanks (continued)

### Tank 2

1. Open the *Phase Change Modeling Tool* activity: Oxygen in Tank 2.
  2. When your model is complete, press HAND IN. If you worked with a partner, write their name here:
- 

**Goal:** Show what happens to oxygen gas in tank 2.

**Do:**

- Drag out two Substance Descriptions and describe the oxygen before and after.
- Move the Substance Descriptions up or down to compare the kinetic energy before and after the change.
- Use the arrows to compare the actual change of kinetic energy to the change needed for a phase change.
- Label the arrows.

**Tips:**

- Attach the tail end of the arrows to the Substance Description Before.
- The arrowheads can touch a line but don't need to.

**Possible Student Response:**

## Modeling Liquid Oxygen Tanks (continued)

### Tank 3

1. Open the *Phase Change Modeling Tool* activity: Oxygen in Tank 3.
  2. When your model is complete, press HAND IN. If you worked with a partner, write their name here:
- 

**Goal:** Show what happens to oxygen in tank 3.

**Do:**

- Drag out two Substance Descriptions and describe the oxygen before and after.
- Move the Substance Descriptions up or down to compare the kinetic energy before and after the change.
- Use the arrows to compare the actual change of kinetic energy to the change needed for a phase change.
- Label the arrows.

**Tips:**

- Attach the tail end of the arrows to the Substance Description Before.
- The arrowheads can touch a line but don't need to.

**Possible Student Response:**

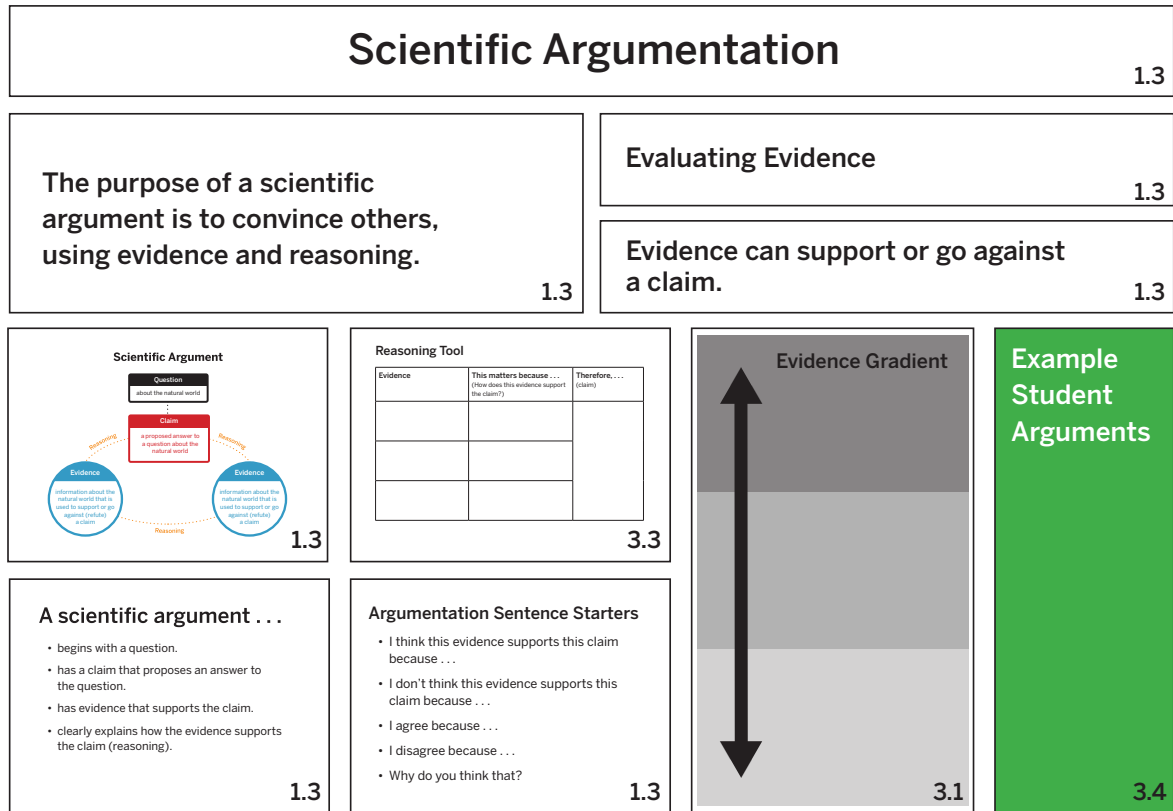
# Science Seminar Observations

Write a check mark in the right-hand column every time you hear one of your peers say or do something listed in the left-hand column. If you hear an interesting idea, write it in the last row of the table.

OBSERVATIONS DURING THE SEMINAR	CHECK MARKS
I heard a student use evidence to support a claim.	
I heard a student respectfully disagree with someone else's thinking.	
I heard a student explain how her evidence is connected to her claim.	
I heard a student evaluate the quality of evidence.	
I heard an idea that makes me better understand one of the claims. That idea is: _____ _____	

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# Completed Scientific Argumentation Wall Diagram



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## Using the Reasoning Tool

1. In the right column of the table on the next page, record the claim you have selected.
2. After reviewing your Science Seminar Evidence Cards, select the evidence you feel best supports or refutes this claim. Record this evidence in the left column. Then, in the rows below, record up to three pieces of additional evidence you feel could further support or refute your claim.
3. In the middle column, explain how each piece of evidence either supports or refutes your claim.

**Question:** *Why is the liquid oxygen machine producing less liquid oxygen than normal?*

**Claim 1:** There is frozen water in tank 2, which is blocking some of the oxygen from going into tank 3.

**Claim 2:** Some of the liquid oxygen evaporated in tank 3.

**Claim 3:** Some of the oxygen didn't condense in tank 2.

**Reference information from the "Liquid Oxygen" article:**

- Water has a stronger attraction between molecules than oxygen or nitrogen.
- Oxygen has a stronger attraction than nitrogen.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Using the Reasoning Tool (continued)

<b>Evidence</b>	<b>This matters because . . .</b> (How does this evidence support or refute the claim?)	<b>Therefore, . . .</b> (claim)

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Preparing to Write

Before writing your final argument to the Universal Space Agency, answer the questions below. You may want to refer to your completed Reasoning Tool on page 126.

What is your most convincing piece of evidence?

---

---

Is there any evidence you will not be using? Explain below.

---

---

Are there two pieces of evidence that work together to make a stronger argument? If so, list them below.

---

---

---

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## Writing a Scientific Argument

When you write your scientific argument to Dr. Flores:

1. Remember to explain how your evidence supports or refutes the claim you selected and why your evidence is significant.
2. Review your Reasoning Tool and annotations on the Liquid Oxygen Machine Diagram on page 105.
3. Use the sentence starters below to help explain your thinking.

**Question:** *Why is the liquid oxygen machine producing less liquid oxygen than normal?*

**Claim 1:** There is frozen water in tank 2, which is blocking some of the oxygen from going into tank 3.

**Claim 2:** Some of the liquid oxygen evaporated in tank 3.

**Claim 3:** Some of the oxygen didn't condense in tank 2.

**Reference information from the “Liquid Oxygen” article:**

- Water has a stronger attraction between molecules than oxygen or nitrogen.
- Oxygen has a stronger attraction than nitrogen.

### Scientific Argument Sentence Starters

Describing evidence	Explaining how the evidence supports the claim
The evidence that supports (or refutes) my claim is . . .	If _____, then . . .
My first piece of evidence is . . .	This is important because . . .
Another piece of evidence is . . .	Since, . . .
Scientists found . . .	Based on the evidence, I conclude that . . .
	This claim is stronger (or weaker) because . . .

### Word Bank

energy	evaporation	freedom of movement	freezing
kinetic energy	molecule	phase change	temperature





# Targeted small group work time

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- i. Analyzing the End-of-Unit Assessment
- ii. Deepening understanding of content
- iii. Formative assessment and differentiation
- iv. Internalizing the upcoming unit

# Analyzing the End-of-Unit Assessment

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## Phase Change

**Goal:** Deepen understanding of how student responses in the End-of-Unit Assessment reflect the conceptual learning progression.

### Reflect

In your teaching, how have you used summative assessments in the past?

In what format have you conducted an End-of-Unit Assessment or summative assessment (i.e. short answer, multiple choice, performance tasks)? What do students do to show what they've learned?

## Analyzing the End-of-Unit Assessment cont.

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### Analyze the End-of-Unit Assessment

In Amplify Science, the End-of-Unit Assessment is a summative assessment that provides students an opportunity to demonstrate their understanding of a unit's content. It's designed to reveal students' understanding along the unit's Progress Build.

A unit's Progress Build defines a progression of student understanding. Let's analyze the Progress Build for Phase Change in order to deepen our understanding of the End-of-Unit Assessment.

<b>Level 1</b> When a substance changes phase, the freedom of movement of its molecules has changed.	<b>Level 2</b> Energy transfers cause phase changes.	<b>Level 3</b> Molecular attraction affects the amount of energy transfer required for a phase change.
<b>Between Level 1 and Level 2, what new ideas were integrated into students' deep understanding of what happens to a substance when it changes phases?</b>		<b>Between Level 2 and Level 3, what new ideas were integrated into students' deep understanding of what happens to a substance when it changes phases?</b>

### Check your understanding!

Navigate to the Phase Change unit landing page and select [Jump Down to Unit Guide](#). Click to open the Progress Build and read each level of the expanded Progress Build to better understand how student learning progresses throughout the unit. Add any new ideas to the diagram above.

### Part 1: Assessment design

Navigate to lesson 4.5 in the Phase Change unit. To view the multiple choice items, either select Activity 1 in the Lesson Map or select Phase Change End-of-Unit Assessment copymaster from Digital Resources. Spend the next 5 minutes reading through the multiple choice items. Record any patterns or observations in the space below:

## Analyzing the End-of-Unit Assessment cont.

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You might have noticed that the assessment items follow a pattern. Each assessment item is aligned to a particular level of the Progress Build:

- 4 items focusing on each level
- Answering at least 3 out of the 4 items correctly represents full, explanatory understanding of that level

Return to the Phase Change Progress Build on page 34 in your Participant Notebook. Then, reread multiple choice items 1-3 in the End-of-Unit Assessment and reflect on which Progress Build level is being assessed for each question. Record in your responses in the table below:

Multiple choice item	Corresponding Progress Build level	Evidence
1		
2		
3		

### Check your understanding!

Open the Phase Change End-of-Unit Assessment Answer Key and Scoring Guide in the Digital Resources of Lesson 4.5. Refer to the Item-PB Mapping table on page 3 to check your responses above.

### Supporting concepts

Next, turn to page 2 of the of the End-of-Unit Answer Key and Scoring Guide. What supporting concepts are assessed in this unit? Which items are aligned in these supporting concepts?

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## Analyzing the End-of-Unit Assessment cont.

### Part 2: Analyzing student responses

Navigate to Lesson 4.5, Activity 2 and read Written-Response Question #1. Below you will find three different student responses to the question. Using your analysis of the Progress Build, determine which Progress Build level (Level 0 to Level 3) each response reflects. You may want to annotate the student response or use the space provided to include the rationale for your choice.

<b>Written-response question #1:</b> A truck was carrying a substance in a tank. The molecules of that substance were moving away from each other. The truck parked overnight in a place where energy transferred out of the substance. In the morning, the substance was a gas. How were the molecules moving in the morning? Explain why the molecules were moving that way after energy was transferred out of them.	
<b>Student A response</b> In the morning, the molecules were moving away from each other in the same way the molecules of a gas move. This means the molecules' movement (or freedom of movement) didn't change overnight. I know this because the molecules were moving away from each other at night and in the morning. However, because energy was transferred out of the substance overnight, the kinetic energy of the molecules did change— the energy decreased and the molecules were moving slower. The reason the energy transfer didn't cause the molecules' freedom of movement to change is because the molecules didn't slow down enough for the attraction between them to overcome their kinetic energy.	<b>Progress Build level:</b> ____  <b>Rationale:</b>
<b>Student B response</b> I think the molecules were moving away from each other in the night and in the morning. Moving away from each other is the same movement as the molecules of a gas move. This means the molecules' movement didn't change overnight.	<b>Progress Build level:</b> ____  <b>Rationale:</b>
<b>Student C response</b> The molecules' movement didn't change overnight. I know this because the molecules were moving away from each other both at night and in the morning. The molecules were moving away from each other in the morning in the same way the molecules of a gas move. The energy of the substance decreased and molecules of the substance were moving slower.	<b>Progress Build level:</b> ____  <b>Rationale:</b>



## Analyzing the End-of-Unit Assessment cont.

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### Check your understanding!

Open the Phase Change End-of-Unit Assessment Answer Key and Scoring Guide in the Digital Resources of Lesson 4.5. Refer to Science Content Rubrics on page 7-8 to check your responses above.

What are the advantages of using a summative assessment to determine where a student's understanding falls on the Progress Build at the conclusion of a unit?



# Deepening understanding of content

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**Goal:** Deepen my own content knowledge.

**Step 1:** Navigate to the Science Background located in the suite of Unit Guide Planning for the Unit resources

- Read today's deep dive unit's Science Background Planning for the Unit doc. The purpose of this active reading activity is for you to pay attention to concepts that you want more support with and, in turn, about which you feel hesitant in supporting students (i.e. your "challenge concepts").
- As you read, note these concepts in the "My challenge concepts" column in the table below.
- Also consider concepts that you feel particularly comfortable with. Your expertise in these areas may support your colleagues later in this activity. Note these concepts in the "My comfort concepts" portion of the table (at the bottom).

**Step 2:** Share your challenge areas (5 mins)

- Working in a group of 4, take turns sharing your challenge concepts. Note who is sharing similar concepts to yours. You will want to partner with them in a moment.

**Step 3:** Find your challenge concepts within the unit (25 mins)

- Use the Coherence Flowchart to identify where your personal challenge concepts arise during the unit. Look at the Investigation Questions and key concepts to consider which moments in the unit students grapple with ideas related to your challenge concepts. Record the lesson(s) when this happens (indicated on the Coherence Flowchart) in the "Location in Unit" column.
- Navigate to the identified lessons, and explore the activities during which students build these key concepts. Try to dive into a variety of modalities, including a Sim activity, active reading, and using a modeling tool, etc. Record the activity in the "Activity that helps construct this concept" column in the table below. In the last column of the table, note how this activity helps students figure out this concept (much like how we annotated the Coherence Flowchart earlier in the day).

Deepening understanding of content cont.

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My challenge concepts	Location in unit (lesson-level)	Activity that helps construct this concept	How does this activity help construct this concept?
<b>My comfort concepts</b>			

## Deepening understanding of content cont.

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**Reflect:** Discuss these questions with a partner, and record your thoughts. (5 mins)

- What steps will I take to ensure that I am prepared enough to teach this concept effectively and accurately?
  
- What are my resources for deeper learning around these concepts?
  
- How will I know if I am teaching these concepts effectively?

### **OPTIONAL: Identifying student preconceptions**

**Goal:** Get to know possible student preconceptions in your upcoming unit, and identify where your challenge concepts and theirs align.

**Step 1:** Re-read Science Background doc with preconception focus. (5 mins)

- Return to the Science Background document. The purpose here is to identify possible student preconceptions that may require extra support during teaching. Skim through the document, stopping where you come to a “Note: Preconceptions” paragraph. Read and record brief notes in the associated column in the table below.

**Step 2:** Identify associated key concepts.

- Using the Coherence Flowchart, identify and record the associated key concepts, including the location in which these preconceptions may arise.

**Step 3:** Consider how to best support your students.

- Navigate to these locations in the digital platform, and use the Differentiation tab in the Lesson Brief and the Teacher Support tabs within the activities to research ideas for extra support at these points. Record in the “Extra support ideas from Amplify Science” column in the table below.
- Discuss other ideas with a partner about how to identify when these preconceptions arise, and how to support your students. Record in the “Your ideas” column in the table which follows.

Deepening understanding of content cont.

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Possible student preconceptions	Associated concepts	Location(s) in unit	Extra support ideas from Amplify Science	Your ideas

**Reflect:**

- Review your two tables constructed during these activities. Where do your challenge concepts and possible student preconceptions overlap? How will you use this information during your implementation?

# Formative assessment and differentiation

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## Phase Change

**Goal:** Examine embedded formative assessment opportunities in order to plan for differentiated instruction.

### Step 1: How do we assess learning?

In Amplify Science, students can demonstrate what they've learned through embedded formative assessments (e.g., On-the-Fly Assessments, Critical Juncture Assessments, Student Self-Assessments). These assessments represent the most opportune moments for a glimpse into students' developing conceptual understanding and their facility with the practices.

First, let's analyze an embedded assessment opportunity we experienced earlier in the day. During our Phase Change deep dive sequence, you used the Modeling Tool to demonstrate your understanding of phase change at both macro and molecular scale. Follow the steps below to navigate to the On-the-Fly Assessment in Lesson 1.6.

- Navigate to Phase Change → Chapter 1 → Lesson 1.6 → Activity 4 → Select Next at the bottom of the page.
- Select Embedded Formative Assessment
- Select On-the-Fly Assessment 4: Modeling the Titan Claims
- Read the Look for and Now what? sections and then complete the table below.

Phase Change Lesson 1.6, Activity 4	
Which disciplinary core ideas, science and engineering practices, and/or crosscutting concepts are being assessed?	
What data can be collected from this assessment opportunity?	
How could you collect data?	
What will this formative assessment opportunity tell you about student understanding?	

## Formative assessment and differentiation cont.

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### Step 2: Reflecting on differentiated instruction

Based on student responses to embedded formative assessments, you may need to differentiate instruction in the next activity or lesson. Differentiated instruction is a powerful classroom practice that recognizes that students bring a wide variety of skills, talents, and needs to their daily learning. When you differentiate instruction, it enables you to address varying degrees of proficiency and skill while also meeting identifiable differences in learning styles and interests. There are various ways to differentiate instruction—what you teach, how you teach, and/or how students demonstrate their learning.

**How do you currently respond to students' needs, styles, or interests in your classroom?**

## Formative assessment and differentiation cont.

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### Step 3a: Determine strategies to differentiate instruction.

First, let's read about the variety of differentiation strategies which are embedded in the Amplify Science curriculum. Follow the steps below to access the Program Guide:

1. Navigate to the Science Program Guide using the Global Navigation Bar.
2. Select Access and Equity.
3. Choose Differentiation Strategies.
4. Explore the description and associated strategies for the student groups listed.
5. Use the space below to record strategies you could use to differentiate instruction for each group of students.

Student population	Strategies for support
English learners	
Students with disabilities	
Standard English learners	
Girls and young women	
Advanced learners and gifted learners	
Students living in poverty, foster children and youth, and migrant students	

### Step 3b: Review Lesson Brief

Navigate to the 1.6 Lesson Brief and select the drop-down arrow to expand the Differentiation section. Read the Embedded Supports for Diverse Learners. Are there any additional strategies noted in this brief that you would like to capture in the table above?



## Formative assessment and differentiation cont.

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### Step 4: Preparing to differentiate

Now it's time to draft a plan to implement differentiated instruction.

**What is one strategy you just reviewed and/or recorded which you feel most comfortable implementing after the next embedded formative assessment opportunity?**

**How will you prepare your students for the implementation of this new strategy?**

(Ex: Expected student behavior for group work, step-by-step directions)

**How will you prepare your classroom for the implementation of this new strategy?**

(Ex: Classroom arrangement, organizing materials)

# Internalizing the upcoming unit

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**Goal:** Gain familiarity with an upcoming unit, and start to plan how you will teach it!

**Step 1:** Begin by reading the general guidance in Planning for the Unit: Getting Ready to Teach.  
(Navigate to the unit landing page, select Jump Down to Unit Guide, then select Getting Ready to Teach).

**Step 2:** Use the following questions and workspace to guide you as you get to know a new unit.

Question to ask yourself	Resources Note: resources in italics are names of documents
<b>Getting to know the unit overall</b>	
What is the problem students have to solve, and how is it introduced?	<ul style="list-style-type: none"> <li>• <i>Planning for the Unit: Unit overview</i></li> <li>• Grades 6-8: lesson 1.2</li> </ul>
<b>My notes:</b>	
What are the learning goals (NGSS) for this unit? <ul style="list-style-type: none"> <li>• DCIs</li> <li>• SEPs</li> <li>• CCCs</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Planning for the Unit: Standards at a Glance</i></li> <li>• <i>Teacher Reference: Standards and Goals</i></li> <li>• <i>Teacher Reference: 3-D Statements</i></li> </ul>
<b>My notes:</b>	
How does the unit unfold chapter by chapter?	<ul style="list-style-type: none"> <li>• Chapter Overviews</li> <li>• <i>Planning for the Unit: Unit Overview</i></li> <li>• <i>Planning for the Unit: Unit Map</i></li> <li>• <i>Teacher Reference: Lesson Overview Compilation</i></li> </ul>
<b>My notes:</b>	
What is the Progress Build and how will students demonstrate their progress? (Core units only)	<ul style="list-style-type: none"> <li>• <i>Planning for the Unit: Progress Build</i></li> <li>• <i>Teacher Reference: Assessment System</i></li> <li>• <i>Teacher Reference: Embedded Formative Assessments</i></li> </ul>
<b>My notes:</b>	

## Internalizing the upcoming unit cont.

What is some of the underlying science background that will help you teach this unit?	<ul style="list-style-type: none"> <li>• <i>Planning for the Unit: Science Background</i></li> </ul>
<b>My notes:</b>	
<b>Gathering evidence to make explanations and arguments</b>	
What are some of the types of activities students do to gather evidence?	<ul style="list-style-type: none"> <li>• <i>Planning for the Unit: Unit Overview</i></li> </ul>
<b>My notes:</b>	
<p><b>Articles:</b> What articles do students read? Students engage with some of the articles during two active reading sessions; generally the students read and annotate for the first read to get to know the unit. What is the focus for the second read of the same article?</p>	<ul style="list-style-type: none"> <li>• <i>Teacher Reference: Articles in this Unit</i></li> <li>• Lessons with the article title as the lesson title</li> </ul>
<b>My notes:</b>	
What are the explanations or arguments students come to at the end of each chapter? What is the topic of the Science Seminar?	<ul style="list-style-type: none"> <li>• <i>Planning for the Unit: Unit Map</i></li> <li>• Download the Investigation Notebook</li> <li>• Look in end-of-chapter lessons</li> </ul>
<b>My notes:</b>	
<b>Digital apps</b>	
<p><b>Sims:</b> Every unit has a Sim (except Geology on Mars which uses Google Mars.) Get to know the Sim and how it's used throughout the unit.</p>	<ul style="list-style-type: none"> <li>• Go to the Global Navigation menu to find the Sim with the same name as your unit.</li> <li>• <i>Teacher Reference: Apps in this Unit.</i></li> </ul>
<b>My notes:</b>	

## Internalizing the upcoming unit cont.

<p><b>Modeling tool:</b> All core units have a modeling tool. Is it paper or digital? When and how is it used?</p>	<ul style="list-style-type: none"> <li>• For units with digital modeling tools, <i>Teacher Reference: Apps in this Unit</i></li> <li>• Otherwise, first lesson where modeling tool is used</li> </ul>
<p><b>My notes:</b></p>	
<p><b>Materials management for your unit</b></p>	
<p>What physical materials and print materials come in your kit? What is considered “teacher provided?”</p>	<ul style="list-style-type: none"> <li>• <i>Planning for the Unit: Materials and Preparation</i></li> </ul>
<p><b>My notes:</b></p>	
<p>What days will you need more time to prep and set up?</p>	<ul style="list-style-type: none"> <li>• <i>Planning for the Unit: Materials and Preparation (“Preparation at a Glance” section)</i></li> </ul>
<p><b>My notes:</b></p>	
<p>How often will students need the digital devices?</p>	<ul style="list-style-type: none"> <li>• <i>Planning for the Unit: Materials and Preparation (“Preparation at a Glance” section)</i></li> <li>• “Unplugged?” section in each lesson’s Lesson Brief</li> </ul>
<p><b>My notes:</b></p>	



# Amplify Science support

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## Program Guide

Glean additional insight into the program's structure, intent, philosophies, supports, and flexibility.

[my.amplify.com/programguide](http://my.amplify.com/programguide)


## Amplify Help

Find lots of advice and answers from the Amplify team.

[my.amplify.com/help](http://my.amplify.com/help)

## Customer care

Seek information specific to enrollment and rosters, technical support, materials and kits, and teaching support, weekdays 7AM-7PM EST.

 800-823-1969

 [scihelp@amplify.com](mailto:scihelp@amplify.com)

 Amplify Chat

### When contacting customer care, be sure to:

- Identify yourself as an Amplify Science user.
- Note the unit you are teaching.
- Note the type of device you are using (Chromebook, iPad, Windows laptop, etc.).
- Note the web browser you are using (Chrome or Safari).
- Include a screenshot of the problem, if possible.
- Cc: your district or site IT contact.

