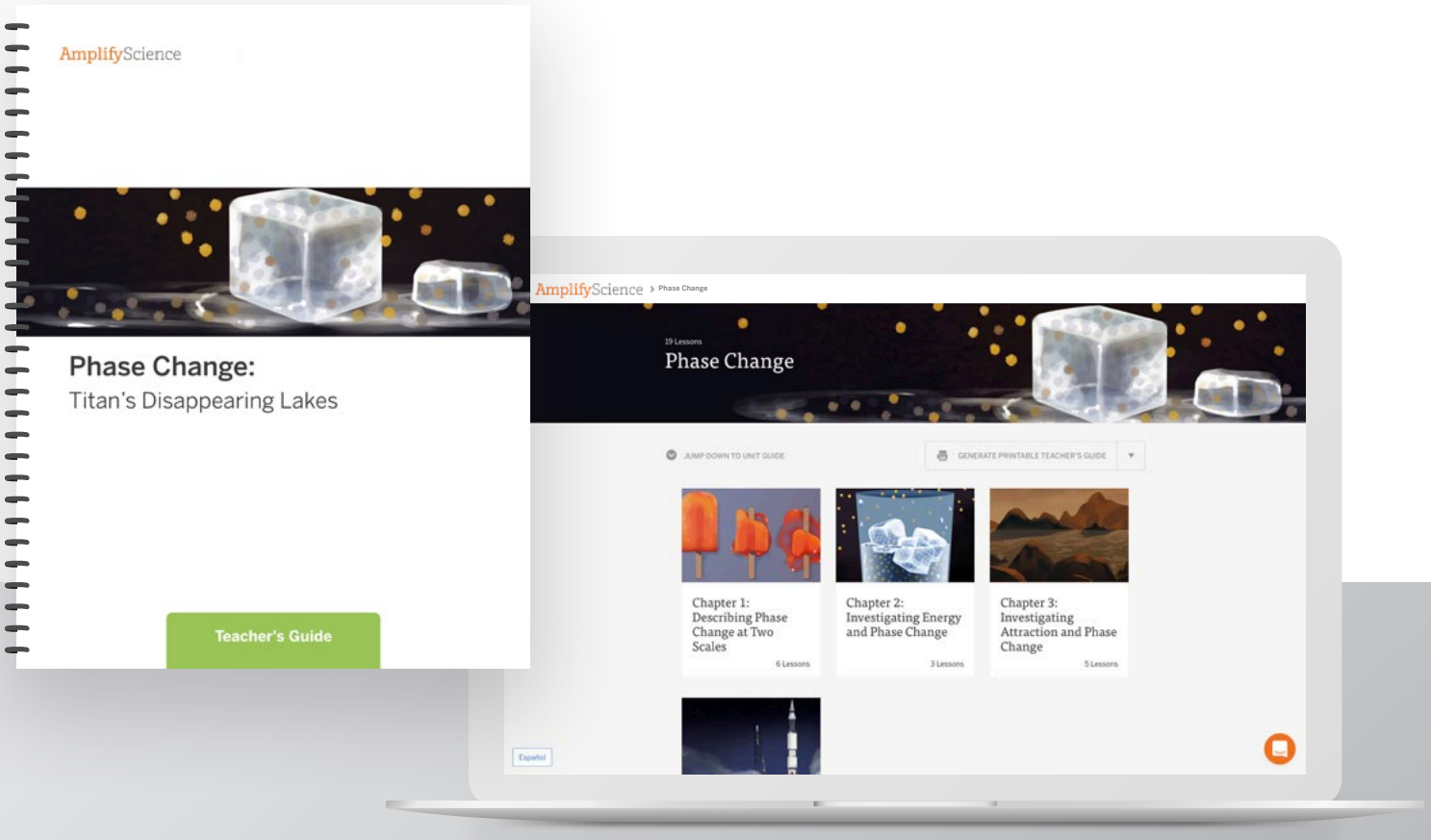
Amplify Science

Grade 7

UNIT GUIDE

Phase Change



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All students. All standards. 14

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THE LAWRENCE HALL OF SCIENCE
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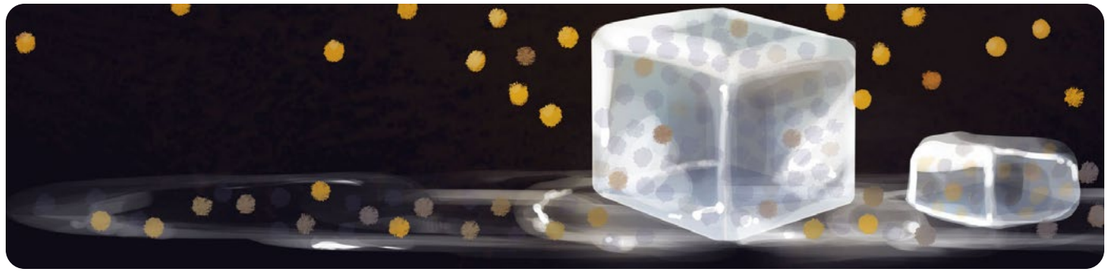


Welcome to Phase Change

Most curricula that address the topic of phase change do so by presenting the concept to students in a decontextualized and fairly superficial way. In many cases, students are asked to memorize the names of characteristics of each phase and the temperatures at which water changes phase, but nothing more. As a result, students end up with a limited understanding of what is actually happening when a substance changes phase. In contrast, Amplify Science motivates students to understand phase change more deeply by conducting physical investigations, gathering evidence from articles and simulations, and testing their own hypothesis.

> Unlike a typical curriculum, Amplify Science anchors learning by inviting students to take on the role of scientists and engineers.

In this unit, students take on the role of chemists. Their job is to help the fictional Universal Space Agency investigate the mysterious disappearance of a lake on Titan. Working together, students figure out that the lake evaporated, and the reasons why. The unit concludes with a Science Seminar in which students use what they have learned to analyze evidence and participate in a discussion about why a liquid oxygen device used to fuel rockets is malfunctioning.

Unit Type: Geology

Student Role: Chemists

Phenomenon: A methane lake on Titan no longer appears in images taken by a space probe two years apart.

Core Concept: Understanding what happens to a substance when it changes phases

Target Performance Expectations:

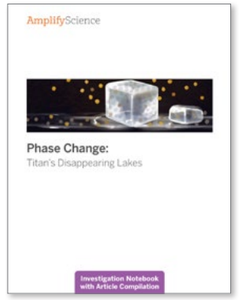
- PS1-4: Phase Change

Related Performance Expectations:

- PS1-1: Atomic Theory/Molecules
- PS3-4: Energy and Temperature
- PS3-5: Motion and Energy Transfer
- ESS1-3: Scale in the Solar System
- ESS2-4: The Water Cycle

Students figure out the unit phenomenon through the use of a variety of resources.

Student Investigation Notebook



Hands-On Kit

Videos

Digital Tools

About technology in this unit:
All Amplify Science lessons were designed with device sharing in mind, and never assume that every student has a separate device.

In grade 7, student-facing technology includes Practice Tools and digital Simulations. When the use of a digital tool is called for in a lesson, teachers have several implementation options:

If limited student devices are available—teachers can have students do activities in pairs or small groups.

If no student devices are available—teachers can project the digital tool to the class and either "drive" the digital tool themself or invite students to "drive" by using their device.

If internet access is unavailable—teachers can "pre-load" the digital tool on their device for use offline.

Chapter 1:
The storyline begins

What students investigate:

What happened to the liquid in Titan's lake?

What they 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

How they figure it out:

- Analyzing the movement of molecules during each of the phases in the Sim
- Reading articles about Titan and how the freedom of movement of molecules varies in each phase
- Conducting hands-on investigations related to evaporation and condensation
- Creating visual models to represent possible phase changes in the lake

KEY

- CLASS
- HANDS-ON
- HOMEWORK
- MODELING
- READING
- SIM
- STUDENT-TO-STUDENT DISCUSSION
- TEACHER
- TEACHER-LED DISCUSSION
- WARM-UP
- WRITING

DAY 1 | LESSON 1.1

Pre-Unit Assessment

- Multiple-Choice Questions (25 min)
- Written-Response Question #1 (10 min)
- Written-Response Question #2 (10 min)

Pre-Unit Assessment

DAY 2 | LESSON 1.2

Introducing Titan's Disappearing Lake

- Warm-Up (5 min)
- Investigating Methane on Titan (10 min)
- Introducing Phase and Phase Change (10 min)
- Discussing Difference in Appearance (15 min)
- Reading "Titan Fact Sheet" (5 min)
- Homework
- Family Homework Experience (Optional)

DAY 3 | LESSON 1.3

Investigating the Molecular Scale

- Warm-Up (5 min)
- Considering Molecules and Phase Change (15 min)
- Introducing a Simulation (10 min)
- Investigating the Molecular Scale (15 min)
- Homework

DAY 4 | LESSON 1.4

"Weird Water Events"

- Warm-Up (10 min)
- Reading "Weird Water Events" (25 min)
- Discussing Annotations (10 min)
- Homework

On-the-Fly Assessment

DAY 5 | LESSON 1.5

Investigating Evaporation and Freezing

- Warm-Up (5 min)
- Reading About Molecular Movement (10 min)
- Reasoning About Freedom of Movement (15 min)
- Modeling a Phase Change (15 min)

On-the-Fly Assessment

DAY 6 | LESSON 1.6

Modeling the Molecular Scale

- Warm-Up (5 min)
- Creating a Freedom of Movement Dance (10 min)
- Write and Share: Explaining Everyday Phase Change (15 min)
- Modeling Evaporating and Freezing (15 min)
- Homework
- Self-Assessment (Optional)

On-the-Fly Assessment
Self-Assessment

Chapter 2:
The storyline builds

What students investigate:

What could cause liquid methane to change phase?

What they 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.

How they figure it out:

- Investigating how adding or removing energy can affect molecules' freedom of movement in the Sim
- Creating a physical model of their thinking using magnetic marbles
- Reading an article about the difference between melting and burning

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DAY 7 | LESSON 2.1

Causing Freedom of Movement Changes

- Warm-Up (5 min)
- Recreating Weird Water Events in the Sim (20 min)
- Modeling Weird Water Events (20 min)

DAY 8 | LESSON 2.2

Understanding Energy Transfers

- Warm-Up (5 min)
- Experimenting with Magnetic Marbles (10 min)
- Using the Sim to Observe Energy Transfer (20 min)
- Playing Zooming in on Phase Change (3 min)
- Explaining Zooming in on Phase Change (7 min)
- Homework

On-the-Fly Assessment
Optional Flextension: ***Investigations with Dry Ice***

DAY 9 | LESSON 2.3

Evaluating Evidence and Claims

- Warm-Up (15 min)
- Interpreting Evidence About Phase Change (15 min)
- Reasoning About Phase Change on Titan (10 min)
- Writing a Scientific Argument (5 min)
- Self-Assessment (Optional)

On-the-Fly Assessment
Self-Assessment

Chapter 3: The storyline goes deeper

What students investigate:

Why didn't the liquid methane change phase before 2007?

What they 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:

- Investigating why some substances do not change phase as easily as others thru hands-on investigations and using the Sim
- Reading an article about molecular attraction, its role in phase change, and how it can be used to turn oxygen from a gas to a liquid
- Comparing a physical model to the Sim to help explain differences between substances
- Creating visual models with the Modeling Tool to represent their thinking

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- WRITING

DAY 10 | LESSON 3.1

"Liquid Oxygen"

- Warm-Up (5 min)
- Reading "Liquid Oxygen" (30 min)
- Discussing Annotations (10 min)
- Homework

On-the-Fly Assessment

DAY 11 | LESSON 3.2

Focusing on Molecular Attraction

- Warm-Up (5 min)
- Investigating Molecular Attraction (10 min)
- Rereading "Liquid Oxygen" (12 min)
- Exploring Attraction in the Sim (18 min)
- Homework

On-the-Fly Assessment

DAY 12 | LESSON 3.3

Modeling Attraction

- Warm-Up (5 min)
- Playing the Magnetic Marbles Model Video (5 min)
- Explaining Attraction (20 min)
- Modeling Attraction (15 min)
- Homework

On-the-Fly Assessment

DAY 13 | LESSON 3.4

Critical Juncture Assessment

- Multiple-Choice Questions (25 min)
- Written-Response Question #1 (10 min)
- Written-Response Question #2 (10 min)

Critical Juncture Assessment Self-Assessment

DAY 14 | LESSON 3.5

Investigating Office Mysteries

- Warm-Up (5 min)
- Preparing for the Sim Activity (3 min)
- Investigating Office Mysteries (22 min)
- Sharing Office Mystery Evidence (15 min)
- Homework
- Self-Assessment (Optional)

Chapter 4:
Application to a new storyline

What students investigate:

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. In fact, it's producing less liquid oxygen than normal. What is causing the device to malfunction?

What they figure out:

Scientists must communicate how their claims and evidence are supported with reasoning in a convincing scientific argument. A written scientific argument needs to state a claim, describe specific evidence, and explain how the evidence supports the claim to convince its reader. A claim can sometimes be supported more effectively if you consider the combination of several different pieces of evidence.

How they figure it out:

- Analyzing the device and the process by which it makes liquid oxygen
- Considering three claims about why the device is malfunctioning
- Reviewing available evidence to make an argument
- Engaging in oral argumentation in a student-led discourse routine called a Science Seminar
- Writing final arguments

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DAY 15 | LESSON 4.1

Introducing the Liquid Oxygen Problem

- Playing Rocket Launch (3 min)
- Warm-Up (7 min)
- Annotating the Liquid Oxygen Machine (15 min)
- Modeling Liquid Oxygen Tanks (20 min)

On-the-Fly Assessment

DAY 16 | LESSON 4.2

Analyzing Claims and Evidence

- Warm-Up (5 min)
- Interpreting the Claims (10 min)
- Interpreting the Evidence (15 min)
- Sorting the Evidence Cards (15 min)
- Homework

On-the-Fly Assessment

DAY 17 | LESSON 4.3

Science Seminar

- Warm-Up (5 min)
- Preparing for the Science Seminar (15 min)
- Introducing the Science Seminar (5 min)
- Participating in the Science Seminar (20 min)

DAY 18 | LESSON 4.4

Writing a Scientific Argument

- Warm-Up (5 min)
- Using the Reasoning Tool (15 min)
- Preparing to Write (10 min)
- Writing a Scientific Argument (15 min)
- Homework
- Self-Assessment (Optional)

On-the-Fly Assessment
Self-Assessment

DAY 19 | LESSON 4.5

End-of-Unit Assessment

- Multiple-Choice Questions (25 min)
- Written-Response Question #1 (10 min)
- Written-Response Question #2 (10 min)

End-of-Unit Assessment

All students. All standards.

Rather than treating the standards simply as a list of topics to cover, we designed Amplify Science to allow for truly in-depth and integrated coverage of the disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCCs). Unlike other programs, however, ours makes the NGSS' vision of "all students, all standards" a reality by creating a unit-specific learning progression for every unit called a Progress Build.

Each Progress Build defines several levels of understanding of the unit's anchoring phenomenon, with each level integrating and building upon the knowledge and skills from lower levels. In this way, each Progress Build provides a clear roadmap for how students' understanding of the phenomenon is expected to deepen and develop with each successive chapter and lesson.

What's more, the program's system of assessments is also tied to these Progress Builds. This carefully crafted integration provides teachers with credible, actionable, and timely diagnostic information about student progress toward the unit's learning goals and grade-level performance expectations. Armed with this powerful data, teachers have the ultimate flexibility to decide when to move on and when to slow down and dive deeper.

Phase Change Progress Build

The Progress Build in this unit consists of three levels of understanding. At each level, students add new ideas and integrate them into a progressively deeper understanding about what happens to a substance when it changes phases.

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

Progress Build Level 2:
Energy transfers cause phase changes.

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

Examples of differentiation in this unit

In addition to providing unit-specific Progress Builds that break learning goals into smaller, more achievable levels of understanding, Amplify Science makes learning accessible for all students through a variety of scaffolds, supports, and differentiation strategies for every lesson. **For a complete list of strategies, see the Differentiation section of every Lesson Brief**.

Below are a few examples of strategies embedded in this unit.

For English learners:

Simplifying claims and providing additional visual representations (Example from Lesson 2.2)
Some English learners may struggle with the complex language found in the claims and evidence. Consider creating simplified versions of the claims for students. (e.g., for the last claim you might write, "Transferring energy into or out of a substance makes the molecules move faster, which can change the freedom of movement.") Also, making connections between words and visuals can help English learners (and all learners) remember words, reinforce concepts, and build on prior knowledge. You may wish to have students draw and annotate a picture or diagram of words and processes associated with the question or claim before they begin the activity.

For students needing more support:

Focus on analyzing visual representations (Example from Lesson 3.2)
Another avenue for supporting students is to focus on the visual representations in the text. Many of the visual representations illustrate core ideas from the articles. You may want to ask students who need more support with reading to begin by viewing and annotating one central visual representation. Students often feel more confident thinking about and commenting on a visual representation rather than commenting on a traditional text. In addition, you could ask these students to read the accompanying paragraphs that are supplemental to the focal visual representation instead of expecting them to read the entire article. This will allow students to access the focal content and to add annotations in a way that is similar to what their peers are doing.

For students ready for a challenge:

Challenging writing prompt (Example from Lesson 1.6)
Students who need more challenge can consider the implications of the Modeling Tool diagrams they create in this lesson. Have students write about the following prompt, using evidence from the Modeling Tool: "Examine your Modeling Tool diagrams. What is the main difference between what would have happened if the lake froze versus what would have happened if the lake evaporated? What evidence would you need to have in order to know which most likely happened?"

3-D Statements

In order to help teachers recognize the three-dimensional structure of every unit, chapter, and lesson, each unit contains a 3-D Statement document that makes the integration clear.

Making the 3-D statement document all the more effective, the three dimensions are color-coded for easy recognition.

Phase Change 3-D Coverage

SEPs
Science and Engineering Practices

DCIs
Disciplinary Core Ideas

CCCs
Cross-Cutting Concepts

Unit Level

Students investigate phase change at the macroscale and molecular scale (scale, proportion, and quantity) by by using physical and digital models and hands-on experiences in order to construct explanations about how energy transfer and molecular attraction determine whether a substance will change phase (energy and matter).

Chapter Level

Chapter 1: Describing Phase Change at Two Scales

Students use hands-on experiences and a digital model to investigate phase changes at the macroscale and molecular scale (scale, proportion, and quantity) in order to construct explanations about what happens to molecules in a phase change.

Chapter 2: Investigating Energy and Phase Change

Students gather evidence from reading and using a digital model to make arguments about how a transfer of energy (energy and matter) caused changes at the molecular scale (scale, proportion, and quantity), which led to the liquid in a lake on Titan changing phase and turning into gas.

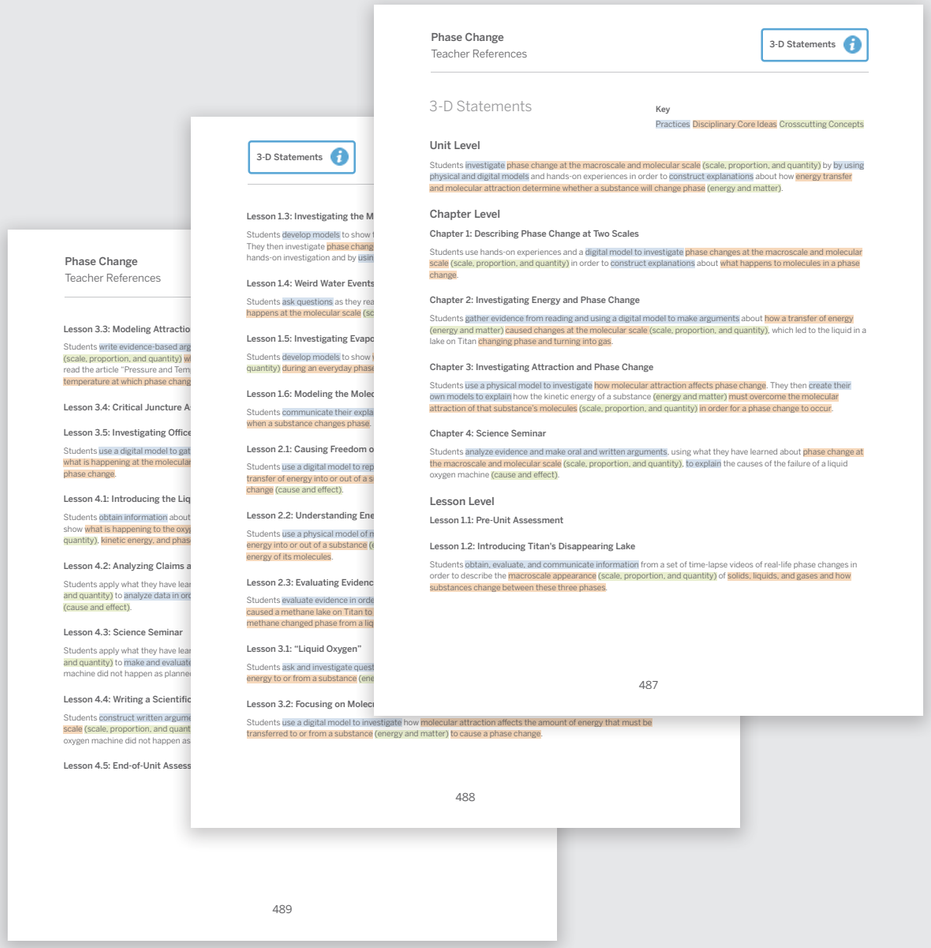
Chapter 3: Investigating Attraction and Phase Change

Students use a physical model to investigate how molecular attraction affects phase change. They then create their own models to explain how the kinetic energy of a substance (energy and matter) must overcome the molecular attraction of that substance's molecules (scale, proportion, and quantity) in order for a phase change to occur.

Chapter 4: Science Seminar

Students analyze evidence and make oral and written arguments, using what they have learned about phase change at the macroscale and molecular scale (scale, proportion, and quantity), to explain the causes of the failure of a liquid oxygen machine (cause and effect).

To review the 3-D Statements at the lesson level, see the Lesson Brief section of every lesson.



Notes

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For more information on Amplify Science, visit **amplify.com/science**.

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