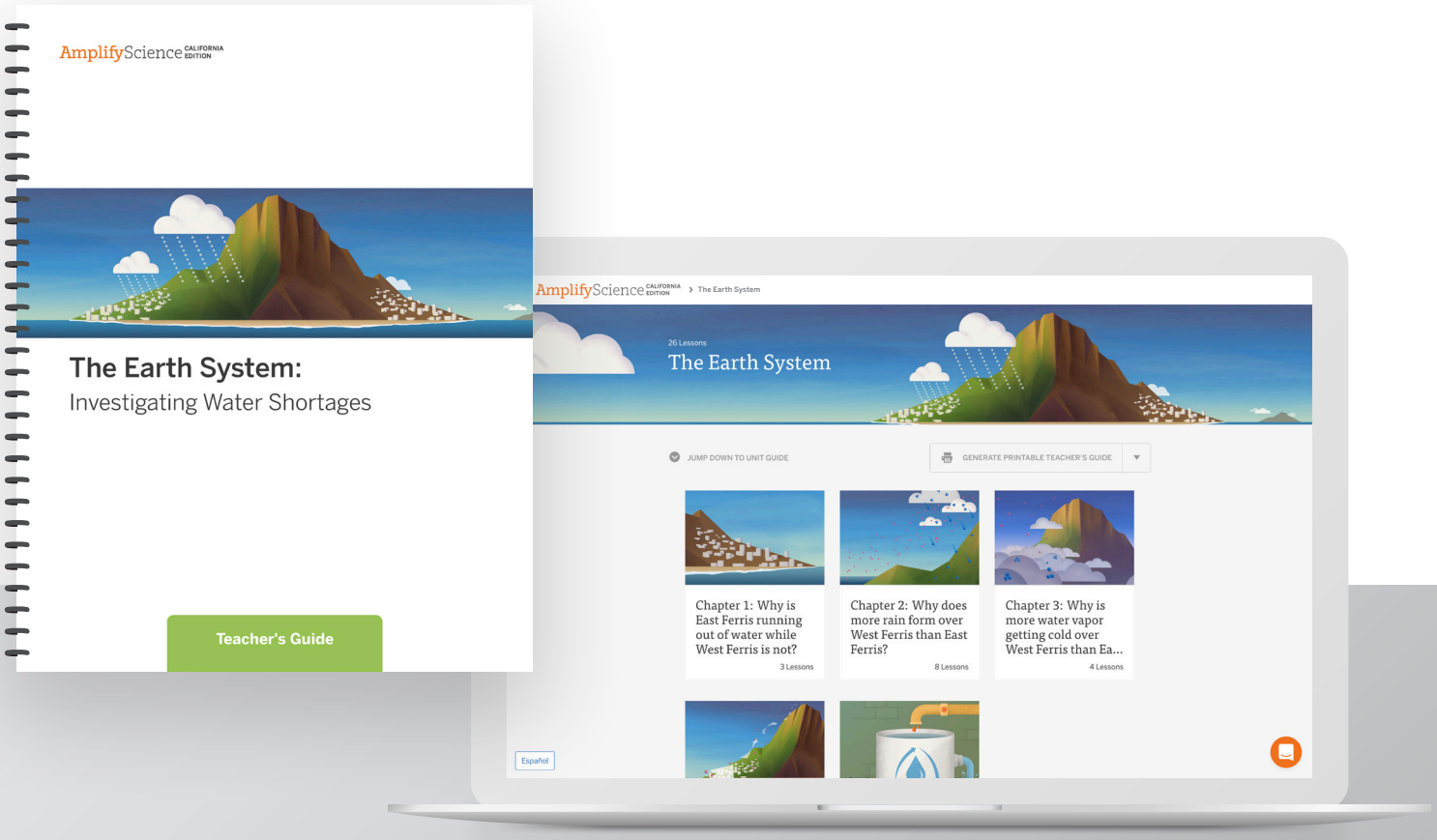
Amplify Science
CALIFORNIA

Grade 5

UNIT GUIDE

The Earth System



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THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

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Welcome to The Earth System

Water scarcity currently affects about one-fifth of the world's population, and the number of people facing water shortages is growing. Despite the major problem that water scarcity presents, many students lack knowledge of water distribution, the natural factors that determine water availability, and how people impact water supplies. Amplify Science California helps students recognize the myriad interactions, cycles, and processes that take place within the Earth system, and how natural and human factors affect water availability. It also gives students an opportunity to reframe their understanding about freshwater, seeing it as a limited resource on Earth that people must use mindfully.

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

In this unit, students take on the role of water resource engineers. Their job is to investigate what makes East Ferris, a city on one side of the fictional Ferris Island, prone to water shortages while a city on the other side is not. Working together, students explore how parts of the Earth system interact and investigate what determines how much water is available for human use. By the end of the unit, students figure out how water is distributed within the hydrosphere, how water moves between the hydrosphere and the atmosphere to cause rain, how the geosphere can interact with the hydrosphere and atmosphere to create patterns of rain, and how life forms in the biosphere depend on the hydrosphere.

Unit Type: Engineering Design

Student Role: Water Resource Engineers

Phenomenon: East Ferris, a city on one side of the fictional Ferris Island, is experiencing a water shortage, while West Ferris is not.

Core Concept: Understanding how parts of the Earth system interact

Target Performance Expectations:

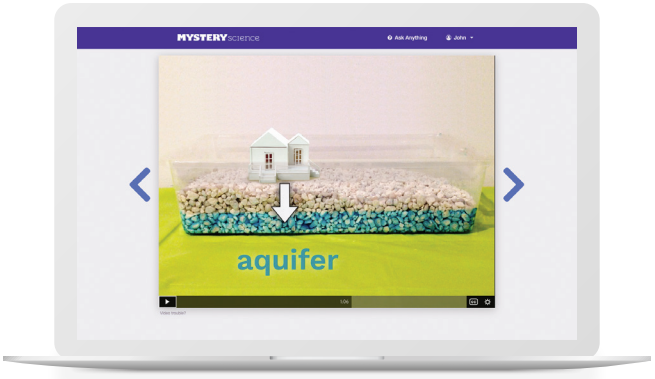
- 5-ESS2-1: Interaction of Spheres
- 5-ESS2-2: Distribution of Water on Earth
- 5-ESS3-1: Protecting Earth
- 5-PS1-1: Matter is Made of Particles
- 5-PS1-2: Conservation of Matter
- 5-PS1-3: Properties of Materials
- 5-PS1-4: Mixing Substances
- 3-5-ETS1-1: Defining Problems
- 3-5-ETS1-2: Developing Possible Solutions
- 3-5-ETS1-3: Improving Solutions

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

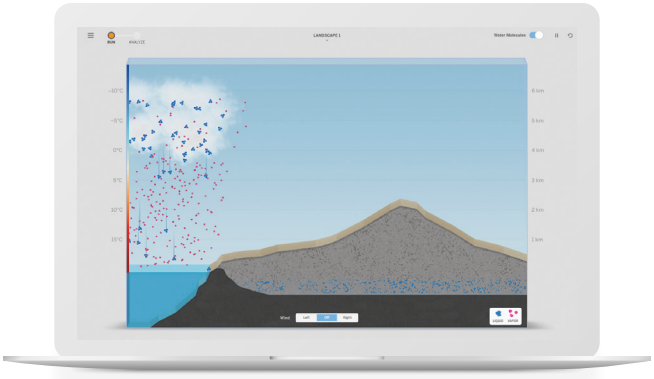
Student Books

Hands-On Kit

Videos



Simulations



About technology in this unit:
Amplify Science California gives you the flexibility to use technology in the way that meets your needs best. In 3–5, teachers have the option of using:

- **Student digital licenses** that allow for online completion of work, teacher feedback and grading, and digital class management.
- **Traditional consumable resources** that allow for a more familiar paper and pencil experience.

Whether students use the student digital experience or print workbooks, there are some technology-based activities all students will experience from time to time.

In grade 5, technology-based activities include Practice Tools and digital Simulations. In this particular unit, 8 of the 22 lessons incorporate the use of devices with 12% of the unit's activities involving the use of a digital tool.

When the use of a digital tool is called for in a lesson, teachers have several implementation options:

- **If limited student devices are available,** students can do activities in pairs or small groups.
- **If no student devices are available,** teachers can project the digital tool to the class and create a whole class experience.

Chapter 1: The storyline begins

What students investigate:

Why is East Ferris running out of water while West Ferris is not?

What they figure out:

Ferris Island is surrounded by ocean, but salt water is unusable for most human purposes. East Ferris's growing population is using up their only freshwater source, a groundwater reservoir, whereas West Ferris has an additional source of freshwater—rain.

How they figure it out:

- Learning what makes water available for human use as well as various causes of water shortages
- Exploring where water exists on Earth through a hands-on activity
- Examining graphs of global water distribution
- Determining that most of the water on Earth is salt water in the ocean and is therefore not available for the majority of people's water needs
- Exploring causes of water shortages in a variety of locations around the world and the ways that people are dealing with these shortages as they read the student book *Water Shortages, Water Solutions*
- Watching a video that shows water flowing into water reservoirs and human consumption from reservoirs
- Explaining why the groundwater reservoir that people in East Ferris rely on is being depleted
- Discussing the water shortage as an interaction between the hydrosphere and biosphere

KEY


CLASS


HANDS-ON


MODELING


READING


SIM


STUDENT-TO-STUDENT DISCUSSION


TEACHER


TEACHER-LED DISCUSSION


WRITING

DAY 1 | LESSON 1.1

Pre-Unit Assessment

- Introducing the Unit (10 min)
- Writing Initial Explanations (20 min)
- Water and Land on Earth (10 min)
- Water Distribution on Earth (20 min)

Pre-Unit Assessment

DAY 2 | LESSON 1.2

Water Shortages, Water Solutions

- Discussing Water Use (5 min)
- Introducing Synthesizing (15 min)
- Partner Reading (25 min)
- Synthesizing Ideas About Water Shortages (15 min)

On-the-Fly Assessment

Optional Flextension: Modeling Water Movement

DAY 3 | LESSON 1.3

Explaining the East Ferris Water Shortage

- East Ferris's Water Shortage (10 min)
- Human Impact on Water (10 min)
- Diagramming Ferris Island (15 min)
- Writing a Scientific Explanation (25 min)

On-the-Fly Assessment

Self-Assessment

Chapter 2: The storyline builds

What students investigate:

Why does more rain form over West Ferris than East Ferris?

What they figure out:

More rain forms over West Ferris because more water vapor condenses there. During condensation, water vapor gets colder and turns into liquid water. There is a lot of water getting cold in West Ferris, so a lot of rain forms. There is not a lot of rain forming over East Ferris, so there is not a lot of water vapor getting colder and condensing into liquid water there.

How they figure it out:

- Investigating condensation and evaporation, and how these processes create rain
- Observing evidence of condensation and learning that water vapor from the air condenses into liquid water when it gets cold
- Observing what happens at the nanoscale when water vapor condenses into liquid water using the Sim
- Considering the continual movement of water around Earth as they read the student book *Drinking Cleopatra's Tears*
- Discussing how the hydrosphere, atmosphere, and biosphere interact on Ferris Island
- Designing and testing freshwater collection systems as a possible solution for a water shortage

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WRITING

DAY 4 | LESSON 2.1

Investigating Water Drop Formation

- A New Message from East Ferris (15 min)
- Water Drop Formation Investigation (30 min)
- Where the Water Drops Come From: Investigation 1 (10 min)
- Discussing How Water Drops Form (10 min)

Optional Flextension: *Investigating Water Drop Formation*

DAY 5 | LESSON 2.2

From Water Vapor to Liquid Water

- Where The Water Drops Come From: Investigation 2 (20 min)
- What's in the Air? (15 min)
- Recording Investigation Results (15 min)
- Discussing How Raindrops Form (10 min)

On-the-Fly Assessment

DAY 6 | LESSON 2.3

A Nanoscale View of Condensation

- Reading About Phases of Water (15 min)
- Exploring The Earth System Simulation (15 min)
- Investigating Condensation in the Sim (15 min)
- Reflecting on Raindrops (15 min)

On-the-Fly Assessment

DAY 7 | LESSON 2.4

Investigating Evaporation

- Exploring Water Vapor in the Sim (25 min)
- Water Vapor Demonstration (10 min)
- Freshwater and Saltwater Drops Investigation (15 min)
- Discussing Water Vapor in the Air (10 min)

On-the-Fly Assessment

DAY 8 | LESSON 2.5

Drinking Cleopatra's Tears

- Evidence for Evaporation (10 min)
- Introducing *Drinking Cleopatra's Tears* (15 min)
- Partner Reading (20 min)
- Synthesizing Ideas About Water on Earth (15 min)

On-the-Fly Assessment

DAY 9 | LESSON 2.6

Explaining How Raindrops Form

- Roundtable Discussion Routine (25 min)
- Explaining How Raindrops Form (25 min)
- Reflecting on Interacting Parts of the Earth System (10 min)

Critical Juncture Assessment

DAY 10 | LESSON 2.7

Designing Freshwater Collection Systems

- Introducing Freshwater Collection Systems (10 min)
- Brainstorming Ideas (10 min)
- Planning Solutions (15 min)
- Building Solutions (25 min)

DAY 11 | LESSON 2.8

Engineering Clean Water

- Discussing Freshwater Collection Systems (15 min)
- Partner Reading (30 min)
- Discussing *Engineering Clean Water* (15 min)

Self-Assessment

Chapter 3:
The storyline goes deeper

What students investigate:

Why is more water vapor getting cold over West Ferris than East Ferris?

What they figure out:

There is more water vapor getting cold over West Ferris because on that side of the island more water vapor moves upward in the atmosphere where it is colder. This means that more water vapor can condense and fall as rain.

How they figure it out:

- Learning about the atmosphere and examining diagrams showing that the atmosphere is colder higher up as they read the student book *Water Encyclopedia*
- Visualizing condensation at different heights in the atmosphere by using the Modeling Tool and as they reread the student book *Drinking Cleopatra's Tears*
- Gathering and analyzing data
- Writing more complete explanations of why a lot of rain falls over West Ferris while not much rain falls over East Ferris
- Iterating on their freshwater collection system designs

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TEACHER-LED DISCUSSION


WRITING

DAY 12 | LESSON 3.1

Investigating Where Raindrops Form

- Ferris Island Weather Reports (10 min)
- Reading About the Atmosphere (15 min)
- Condensation in the Atmosphere Models (15 min)
- Reading More About Water Vapor (20 min)
- Discussing the Models (5 min)

DAY 13 | LESSON 3.2

Making Sense of Where Raindrops Form

- Predicting Where Water Vapor Will Condense (5 min)
- Investigating Where Water Vapor Condenses (25 min)
- Graphing Data from the Sim (25 min)
- Reflecting on Condensation in the Atmosphere (5 min)

On-the-Fly Assessment

DAY 14 | LESSON 3.3

Explaining Why It Rains

- Word Relationships (15 min)
- Modeling Where Raindrops Form (20 min)
- Explaining Why It Rains (25 min)

Critical Juncture Assessment

DAY 15 | LESSON 3.4

Iterating on Freshwater Collection Systems

- Evaluating Freshwater Collection Systems (15 min)
- Engineers' Jigsaw (15 min)
- Planning Iterations (10 min)
- Building New Systems (20 min)

On-the-Fly Assessment
Self-Assessment

Chapter 4:
The storyline gets more complex

What students investigate:

Why is there more water vapor high up over West Ferris than East Ferris?

What they figure out:

More water vapor moves up in the atmosphere over West Ferris because a mountain directs the wind blowing from the ocean upward. This causes water vapor in the air to cool, condense, and fall as rain over West Ferris. Air that continues on over the mountain does not have enough water vapor left to condense and fall as rain over East Ferris.

How they figure it out:

- Investigating how water vapor gets to different areas in the atmosphere through a hands-on activity and by using the Sim
- Discovering that mountains can redirect wind upward, which causes water vapor to move higher in the atmosphere
- Learning about the rain shadow effect—an uneven pattern of rainfall that often occurs on coastal mountains
- Exploring the interactions between the biosphere, hydrosphere, geosphere, and atmosphere as they read the student book *How the Earth System Explains Dinosaur Extinction*
- Identifying interactions between parts of the Earth system that are involved in the creation of the rain shadow on Ferris Island
- Iterating once again on their freshwater collection system designs, applying what they learned from testing their earlier iterations

KEY


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READING


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STUDENT-TO-STUDENT DISCUSSION


TEACHER


TEACHER-LED DISCUSSION


WRITING

DAY 16 | LESSON 4.1

Investigating the Movement of Water Vapor

- Revisiting Ferris Island (5 min)
- Investigating Water Vapor in the Sim (25 min)
- Redirecting Air Investigation (20 min)
- Reflecting on the Movement of Water Vapor (10 min)

On-the-Fly Assessment

DAY 17 | LESSON 4.2

Investigating Rainfall Distribution

- Investigating Rain (20 min)
- Rain Shadow Model (20 min)
- Modeling Rainfall Patterns (20 min)

Critical Juncture Assessment

DAY 18 | LESSON 4.3

End-of-Unit Assessment Part 1

- Roundtable Discussion (20 min)
- End-of-Unit Assessment Part 1 (30 min)
- Solutions for East Ferris's Water Shortage (10 min)

End-of-Unit Assessment Part 1

DAY 19 | LESSON 4.4

How the Earth System Explains Dinosaur Extinction

- Partner Reading (25 min)
- Synthesizing Ideas About the Earth System (10 min)
- Labeling Interactions on Ferris Island (10 min)
- Word Relationships (15 min)

On-the-Fly Assessment

DAY 20 | LESSON 4.5

Final Design Iterations

- Evaluating Freshwater Collection Systems (20 min)
- Engineer's Jigsaw (20 min)
- Planning Final Design Iterations (20 min)

On-the-Fly Assessment
Self-Assessment

Chapter 5: Application to a new context

What students investigate:

How can East Ferris turn wastewater into clean freshwater?

What they figure out:

East Ferris can add substances to wastewater that react with harmful substances in the water. The reaction creates new substances that are easier to remove from the water, so East Ferris can get clean freshwater.

How they figure it out:

- Observing the reaction when mixing baking soda, calcium chloride, and phenol red
- Learning that when a chemical reaction occurs, the properties of the substances change as they read the student book *Chemical Reactions Everywhere*
- Investigating changes at the nanoscale
- Exploring what happens to molecules during a chemical reaction by using the Modeling Tool
- Explaining how chemical reactions can help people get rid of the harmful substances in wastewater
- Participating in a mock town hall meeting to discuss what the people of East Ferris might do to solve their water shortage problem

KEY


CLASS


HANDS-ON


MODELING


READING


SIM


STUDENT-TO-STUDENT DISCUSSION


TEACHER


TEACHER-LED DISCUSSION


WRITING

DAY 21 | LESSON 5.1

Investigating Wastewater Treatment

- Discussing Wastewater Treatment (15 min)
- Observing Substances (15 min)
- Mixing Substances Investigation (20 min)
- Debriefing the Investigation (10 min)

DAY 22 | LESSON 5.2

Chemical Reactions Everywhere

- Partner Reading (25 min)
- Evidence of Chemical Reactions (15 min)
- Synthesizing Ideas About Reactions (10 min)
- Did a Chemical Reaction Happen? (10 min)

DAY 23 | LESSON 5.3

Chemical Reactions at the Nanoscale

- Exploring Chemical Reactions at the Nanoscale (25 min)
- Substances and Mixtures at the Nanoscale (10 min)
- Modeling Chemical Reactions (25 min)

On-the-Fly Assessment

DAY 24 | LESSON 5.4

Controlling Chemical Reactions

- Discussing Chemical Reactions (10 min)
- Controlling Reactions (40 min)
- Discussing Results (10 min)

DAY 25 | LESSON 5.5

End-of-Unit Assessment Part 2

- Chemical Reactions in Wastewater Treatment (20 min)
- Word Relationships (10 min)
- End-of-Unit Assessment Part 2 (30 min)

End-of-Unit Assessment Part 2

DAY 26 | LESSON 5.6

Reflecting on Water Availability

- Preparing for the Town Hall Meeting (20 min)
- Town Hall Meeting (35 min)
- Concluding the Unit (5 min)

Self-Assessment

All students. All standards.

Rather than treating the standards simply as a list of topics to cover, we designed Amplify Science California 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.

The Earth System 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 of the atmosphere and its interactions with other parts of the Earth system.

Progress Build Level 1:

Rain can happen when water vapor gets cold and condenses into liquid water.

Progress Build Level 2:

Water vapor condenses as it moves higher, to where the atmosphere is colder.

Progress Build Level 3:

Mountains can redirect water vapor higher in the atmosphere.

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 California 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:

Strategic partnering (Example from Lesson 2.5)
This lesson includes extended partner work as students read *Drinking Cleopatra's Tears* and engage in partner discussion. Extended academic discourse that is equitable (that is, all students have an opportunity to engage) is critical for developing both language and content knowledge. Strategic partnering is essential for English learners as they develop understanding of new content. Therefore, consider carefully which partner to assign for each English learner in your class and assign a partner who has slightly higher English language skills than the student in question. Opportunities for English learners to engage in conversations that are slightly above their language-proficiency levels can accelerate second-language learning and increase students' confidence when engaging in science discourse. Try to assign each English learner a partner who will be likely to engage in discussion at the appropriate language level. We suggest you assign different partners over the course of the unit so an English learner who serves as a language mentor for another English learner in one lesson gets a partner with more advanced English in another lesson.

For students needing more support:

Additional discussion (Example from Lesson 2.7)
Discussing materials can help students understand how to design their systems. After you explain the instructions for the activity, hold up a material from a tray, such as a plastic cup. Ask students what they might consider using the cup for in their designs. Encourage students to be creative; their designs can be different from other groups' designs. Avoid giving the impression that there is a right or wrong way to use the materials.

For students ready for a challenge:

Create a concept map(Example from Lesson 4.1)
You could challenge students to create a map showing links between words used in this lesson: *atmosphere*, *condensation*, *water vapor*, and *mountain*. Have students record the words spaced out across a large sheet of paper, then have them draw a line connecting each pair of words they think go together. Each word should have at least one connection to another word. Students can write linking words and phrases along each connection line that explain why the two words go together. Have students explain their concept map to a partner or a small group.

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.

The Earth System 3-D Coverage

SEPs
Science and Engineering Practices

DCIs
Disciplinary Core Ideas

CCCs
Cross-Cutting Concepts

Unit Level

Students investigate how interactions between the parts of the Earth system affect the movement and distribution of water (systems and system models), and they apply their understanding to design solutions for a water shortage. Students also obtain information from firsthand investigations, models, and text to figure out how new substances can form through chemical reactions, even though no matter is created or destroyed (energy and matter).

Chapter Level

Chapter 1: Why is East Ferris running out of water while West Ferris is not?

Students work to define the problem by analyzing the water shortage in East Ferris and discussing the water shortage as interactions of the Earth system's biosphere and hydrosphere (systems and system models).

Chapter 2: Why does more rain form over West Ferris than East Ferris?

Students conduct investigations and use digital models to figure out how water cycles from bodies of water to the atmosphere and back (energy and matter). Students apply what they learn to design a freshwater collection system (systems and system models).

Chapter 3: Why is more water vapor getting cold over West Ferris than East Ferris?

Students gather and analyze data from a digital model and obtain information from books to figure out that water vapor condenses when it moves higher to where the atmosphere is colder (energy and matter).

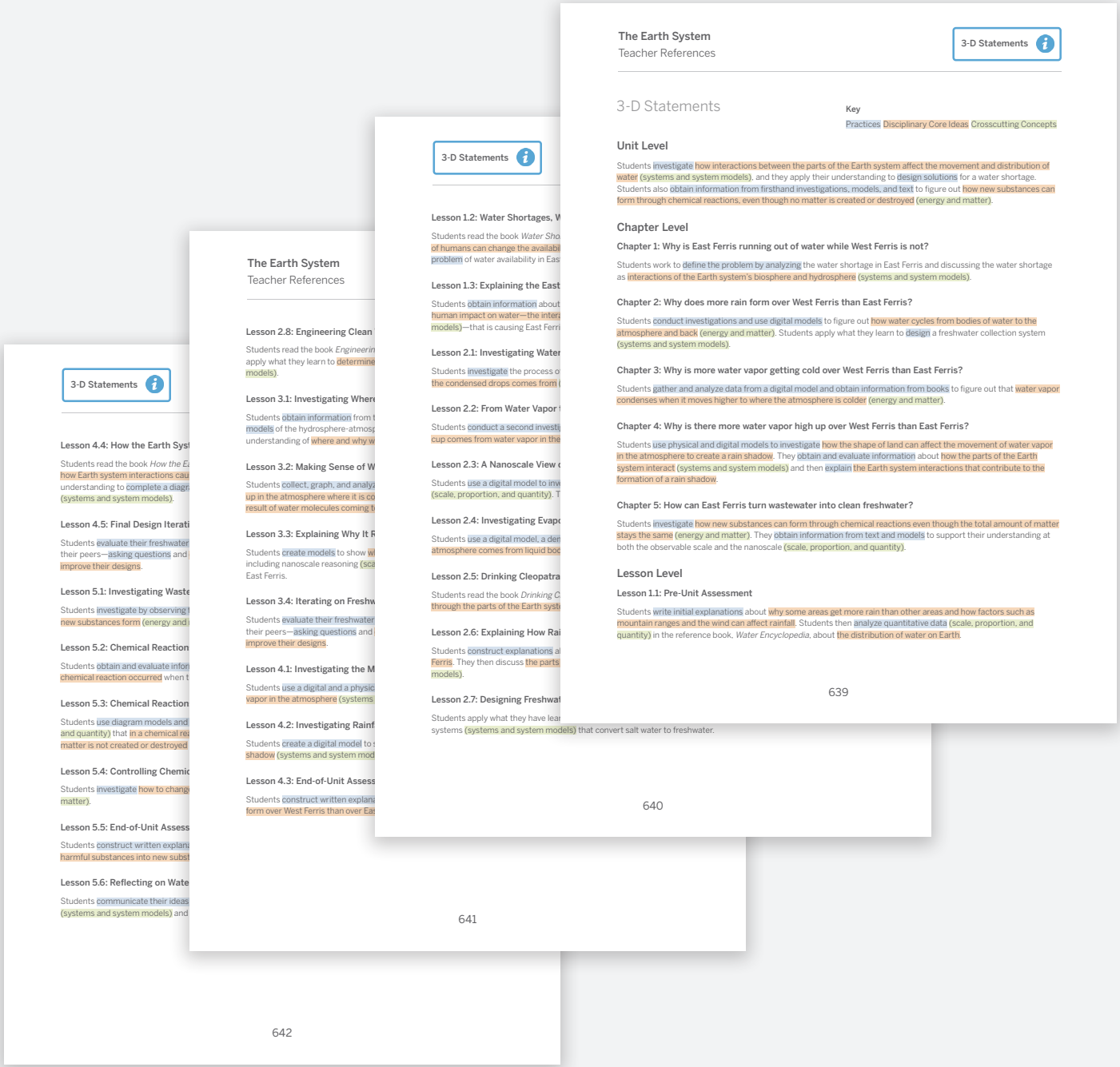
Chapter 4: Why is there more water vapor high up over West Ferris than East Ferris?

Students use physical and digital models to investigate how the shape of land can affect the movement of water vapor in the atmosphere to create a rain shadow. They obtain and evaluate information about how the parts of the Earth system interact (systems and system models) and then explain the Earth system interactions that contribute to the formation of a rain shadow.

Chapter 5: How can East Ferris turn wastewater into clean freshwater?

Students investigate how new substances can form through chemical reactions even though the total amount of matter stays the same (energy and matter). They obtain information from text and models to support their understanding at both the observable scale and the nanoscale (scale, proportion, and quantity).

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



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