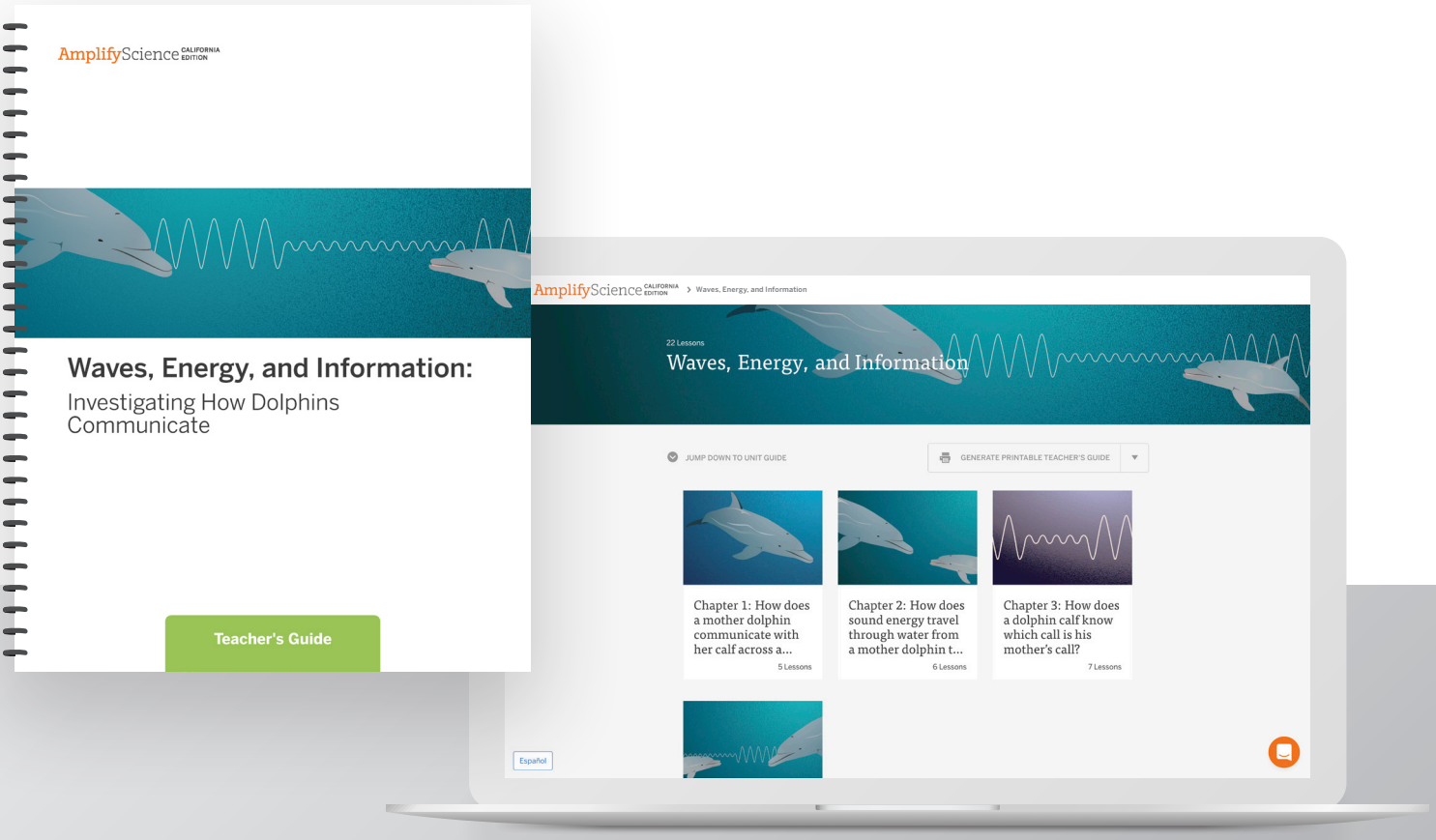
Amplify Science
CALIFORNIA

Grade 4

UNIT GUIDE

Waves, Energy, and Information



Amplify.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

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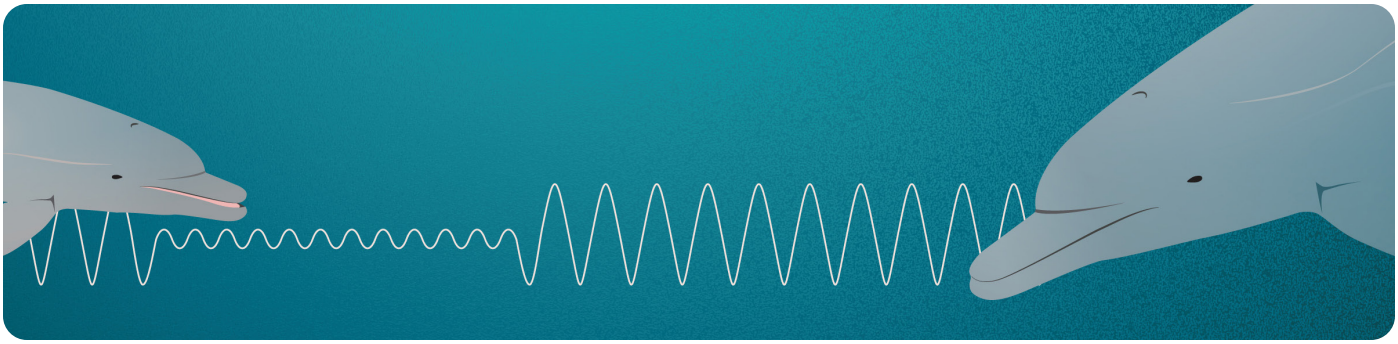


Welcome to Waves, Energy, and Information

The concepts of waves, sound energy, and patterns in communication are abstract in nature, so understanding them requires a great deal of firsthand exploration and sensemaking. Amplify Science makes this concept more tangible by inviting students to investigate the patterns that different animals use to communicate. In particular, they learn about bottlenose dolphins—a particularly intriguing example of animals who use patterns in communication.

> 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 marine scientists. Their job is to investigate how bottlenose dolphin mothers and their calves in the fictional Blue Bay National Park use patterns of sound to communicate across distances. Working together, students build models to visualize how sound waves travel at the particle level and how a sound's volume and pitch correspond to the amplitude and wavelength of the sound wave. By the end of the unit, students apply these concepts to investigate and explain the patterns that humans use to communicate across distances.

Unit Type: Modeling

Student Role: Marine scientists

Phenomenon: Mother dolphins in the fictional Blue Bay National Park seem to be communicating with their calves when they are separated at a distance underwater.

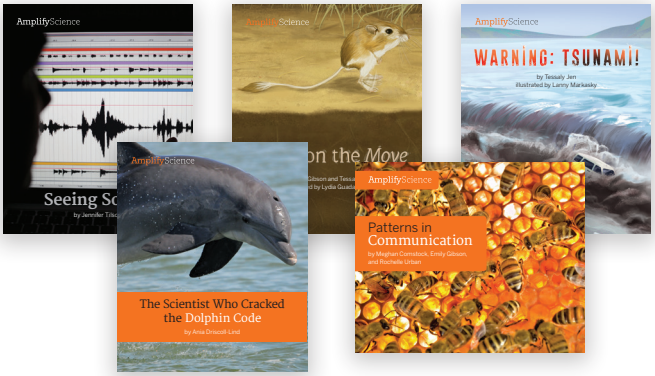
Core Concepts: Understanding how a mother dolphin communicates with her calf when they are separated

Target Performance Expectations:

- 4-PS3-2 Energy Can Be Transferred
- 4-PS3-3: Collisions
- 4-PS4-1: Waves
- 4-PS4-3: Patterns to Transfer Information
- 4-LS1-2: Info, Senses and the Brain
- 4ESS3-2: Reduce Impacts of Earth Processes
- 3-5-ETS1-1: Defining the Problem
- 3-5-ETS1-2: Developing Possible Solutions

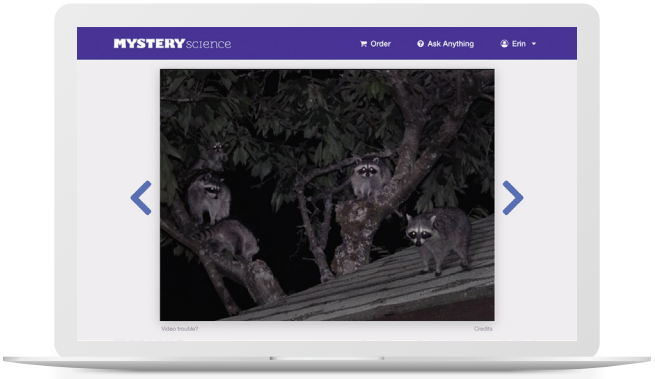
Students figure out the unit phenomenon through the use of a variety of resources.

Student Books

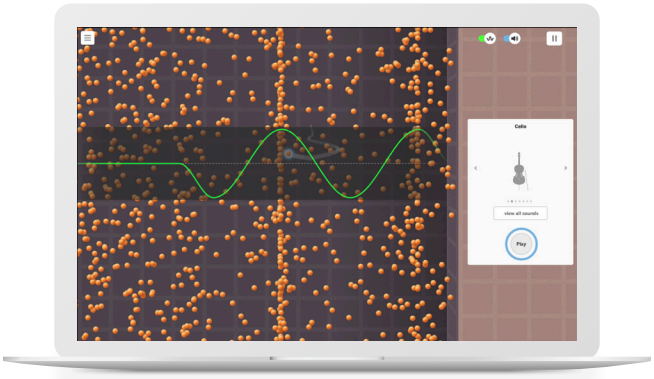


Hands-On Kit

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 4, technology-based activities include Practice Tools and digital Simulations. In this particular unit, 12 of the 22 lessons incorporate the use of devices with 16% 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:

How does a mother dolphin communicate with her calf across a distance?

What they figure out:

Dolphins communicate through sound. When a mother dolphin makes a sound, that sound travels away from her in a pattern of motion called a wave. The sound energy moves through the water all the way to her calf even though the water itself only moves a little.

How they figure it out:

- Using models to investigate waves
- Learning about sound waves and tsunamis as they read the student books *Sound is a Wave* and *Warning: Tsumami*!
- Exploring different sounds using the Sim
- Creating sound diagrams and, using these diagrams as a resource, creating a scientific explanation of the phenomenon

KEY


HANDS-ON


MODELING


READING


SIM


STUDENT-TO-STUDENT DISCUSSION


TEACHER


TEACHER-LED DISCUSSION


WRITING

DAY 1 | LESSON 1.1

Pre-Unit Assessment

- Introducing the Scientific Phenomenon (15 min)
- Thinking About Forms of Communication (10 min)
- Dolphin Communication (10 min)
- Writing Initial Explanations (20 min)

Pre-Unit Assessment

DAY 2 | LESSON 1.2

Exploring Waves

- *Sound Is a Wave* (10 min)
- Discussing Initial Ideas (15 min)
- Exploring Waves (25 min)
- Sharing Observations (10 min)

On-the-Fly Assessment

DAY 3 | LESSON 1.3

Warning: Tsunami!

- Setting a Purpose for Reading (20 min)
- Partner Reading (30 min)
- Reflection (10 min)

On-the-Fly Assessment

DAY 4 | LESSON 1.4

Exploring Sounds Waves

- Rereading *Warning: Tsunami!* (20 min)
- Demonstrating a Tsunami Wave (10 min)
- Exploring the Sound Waves Simulation (25 min)
- Discussing Sounds Waves (5 min)

On-the-Fly Assessment

DAY 5 | LESSON 1.5

Introducing Scientific Explanation

- Framing the Lesson (10 min)
- Reading About How Dolphins Communicate (20 min)
- Critical Juncture: How Does a Wave Travel? (15 min)
- Writing a Scientific Explanation (15 min)

Critical Juncture Assessment
Self-Assessment

Chapter 2: The storyline builds

What students investigate:

How does sound energy travel through water from a mother dolphin to her calf?

What they figure out:

Sound energy travels by way of water particles. The water that the sound energy travels through is made of tiny particles that are too small to be seen individually but can move a little. When the mother dolphin makes a sound, the vibration from the sound hits the water particles near her and transfers energy, which makes those particles move. Those particles collide with particles next to them and transfer their energy, which makes the next particles move, and so on. This results in a wave—a pattern of motion that occurs when particles collide (compress) and then spread back apart. When the sound wave reaches the calf, the calf hears the sound.

How they figure it out:

- Investigating how sound travels through different materials using hands-on activities, physical models, digital models, and reading the student book *Sound on the Move*
- Creating models showing how energy travels through materials
- Revising their sound diagrams and writing a revised scientific explanation

KEY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STUDENT-TO-STUDENT DISCUSSION


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TEACHER-LED DISCUSSION


WRITING

DAY 6 | LESSON 2.1

Sound on the Move

- Prior Knowledge About Sound Underwater (5 min)
- Investigating What Sound Travels Through (25 min)
- Visualizing Sound Traveling (10 min)
- Partner Reading (20 min)

On-the-Fly Assessment

DAY 7 | LESSON 2.2

Visualizing How Sound Travels

- Observing Sound Traveling in the Sim (20 min)
- Visualizing Particles (20 min)
- Revising Sound Diagrams (15 min)
- Reflection (5 min)

On-the-Fly Assessment

DAY 8 | LESSON 2.3

Investigating Particles

- Observing Particle Collisions in the Sim (15 min)
- Partner Reading (25 min)
- Observing Sound Waves in the Sim (10 min)

On-the-Fly Assessment

DAY 9 | LESSON 2.4

Investigating Collisions

- Modeling Traveling Waves (20 min)
- Revising Sound Diagrams (10 min)
- Investigating Energy Transfer (20 min)
- Debriefing Coin Collision Investigations (10 min)

On-the-Fly Assessment

DAY 10 | LESSON 2.5

Modeling Energy Transfer

- Particle Collision Models (20 min)
- Diagramming Sound Energy (30 min)
- Reflection (10 min)

On-the-Fly Assessment

DAY 11 | LESSON 2.6

Explaining How Sound Energy Travels

- Evidence of Energy Transfer (15 min)
- Preparing to Write (15 min)
- Critical Juncture: Explaining How Sound Energy Travels (30 min)

Critical Juncture Assessment
Self-Assessment

Chapter 3:
The storyline goes deeper

What students investigate:

How does a dolphin calf know which call is his mother's call?

What they figure out:

The sound waves that the mother dolphin makes have a certain amplitude and wavelength. When the amplitude of a sound is different, dolphins hear sound at a different volume. Sound with a larger amplitude is louder. This means that if the amplitude of the sound that the mother dolphin makes is large enough, the calf will be able to hear it. Dolphins make their own signature whistles. Each signature whistle has a certain pattern of wavelengths. When the wavelength of a sound is different, dolphins hear the sound at a different pitch. This means that dolphins hear certain patterns of pitches when they hear a signature whistle. The calf recognizes his mother's signature whistle and knows to respond.

How they figure it out:

- Using a digital model to manipulate waveforms and hear the resulting sound waves, enabling them to intuit the concepts of amplitude and wavelength
- Learning about dolphins' use of unique patterns in sound as they read the student book *The Scientist Who Cracked the Dolphin Code*
- Creating and recognizing sounds from waveforms, and vice versa
- Revising their sound diagrams and explanations one last time so they represent their deeper understanding of how a mother dolphin and her calf communicate

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STUDENT-TO-STUDENT DISCUSSION

TEACHER

TEACHER-LED DISCUSSION

WRITING

DAY 12 | LESSON 3.1

Investigating Amplitude

- New Information About Dolphin Communication (10 min)
- Investigating Amplitude (20 min)
- Analyzing Amplitude (25 min)
- Reflection (5 min)

On-the-Fly Assessment

DAY 13 | LESSON 3.2

Investigating Wavelength

- Explaining Amplitude (15 min)
- Exploring Pitch (20 min)
- Investigating Wavelength in the Sim (25 min)

On-the-Fly Assessment

DAY 14 | LESSON 3.3

How Sounds Can Differ

- Describing Sounds and Waveforms (5 min)
- Reading About Wavelength and Amplitude (20 min)
- Sorting Sounds (25 min)
- Visualizing Waveforms (15 min)

On-the-Fly Assessment

DAY 15 | LESSON 3.4

Seeing Sound

- Setting a Purpose for Reading (15 min)
- Partner Reading (30 min)
- Discussing the Crosscutting Concept of Patterns (15 min)

On-the-Fly Assessment

DAY 16 | LESSON 3.5

The Scientist Who Cracked the Dolphin Code

- Observing Differences in Dolphin Sounds (10 min)
- Partner Reading (25 min)
- Reflection (10 min)
- Revisiting Dolphin Whistles (15 min)

Critical Juncture Assessment

DAY 17 | LESSON 3.6

Discussing Dolphin Communication

- Simulating Dolphin Signature Whistles (20 min)
- Modeling Dolphin Communication (20 min)
- Science Forum (20 min)

On-the-Fly Assessment

DAY 18 | LESSON 3.7

Explaining How Dolphins Communicate

- Revising Sound Diagrams (15 min)
- Critical Juncture: Explaining How Dolphins Communicate (35 min)
- Reflection (10 min)

Critical Juncture Assessment
Self-Assessment

Chapter 4:
The storyline gets more complex

What students investigate:

How can humans use patterns to communicate?

What they figure out:

There are multiple ways to transmit information across a distance, all of which involve using patterns as well as coding and decoding information.

How they figure it out:

- Exploring various methods of distance communication through history as they read the student book *Patterns in Communication*
- Using a digital device to efficiently and accurately transmit a message across a distance using binary code

KEY


HANDS-ON


MODELING


READING


SIM


STUDENT-TO-STUDENT DISCUSSION


TEACHER


TEACHER-LED DISCUSSION


WRITING

DAY 19 | LESSON 4.1

Human Communication

- Introduction to Human Communication (10 min)
- Sending an Image (25 min)
- Reading About Human Communication (25 min)

On-the-Fly Assessment

DAY 20 | LESSON 4.2

Patterns in Codes

- Introducing Codes (15 min)
- Using Binary Code to Decode an Image (20 min)
- Exploring the Code Communicator Tool (25 min)

On-the-Fly Assessment

DAY 21 | LESSON 4.3

Communicating with Codes

- Introducing the Code Challenge (10 min)
- Encoding an Image (25 min)
- Designing a Communication Plan (25 min)

On-the-Fly Assessment

DAY 22 | LESSON 4.4

End-of-Unit Assessment

- Completing the Code Challenge (20 min)
- Reflection (10 min)
- Writing Final Scientific Explanations (25 min)
- Concluding the Unit (5 min)

End-of-Unit Assessment
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.

Waves, Energy, and Information 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 how a mother dolphin communicates with her calf when they are separated

Progress Build Level 1:

A wave is a pattern of motion.

Progress Build Level 2: 

Sound energy travels through a material as a series of particle collisions.

Progress Build Level 3: 

Sound waves can differ in amplitude and wavelength.

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:

Creating word maps (Example from Lesson 2.3)
One way to provide additional practice with the words *collision* and *particle* is to invite students to complete the Word Maps on pages 32–33 in the Investigation Notebook. Creating a word map gives students additional practice with new vocabulary as they learn scientific language and practice using it to describe what they are learning. When creating a word map, students use familiar language to generate a definition of the word. They practice using the word in context by writing a sentence and thinking of familiar examples of the word. Adding a diagram helps students deepen their understanding of the word and gives them a cue to recall its meaning. You can invite English learners to translate the word into their primary languages and write it in the center of the map. They can also complete the word map entirely in their primary languages.

For students needing more support:

Additional review, using the Waves Diagram projections (Example from Lesson 1.4)
These diagrams provide a visual summary of key ideas in the unit. Some students may benefit from time to review and discuss the representation of waves in these projections. Invite students to describe the different parts of the visual representations and ask them to connect these representations to the physical materials they have used.

For students ready for a challenge:

Reading about animal communication (Example from Lesson 3.3)
Patterns in Communication provides many opportunities for students to read further about animal communication and sound. Invite students to return to the reference book to learn more about how animals communicate. Have them use the book's table of contents and index to search for one animal that they will read about further. They can take notes about how the animal communicates using sound or other methods of communication. You can also invite students to refer to other science books or the Internet to find additional information about how their selected animals communicate.

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.

Waves, Energy, and Information 3-D Coverage

SEPs
Science and Engineering Practices

DCIs
Disciplinary Core Ideas

CCCs
Cross-Cutting Concepts

Unit Level

Using physical and computer models to observe and analyze patterns (patterns), students figure out how sound travels as a wave (energy and matter). They apply that knowledge to explain how dolphins in the fictional Blue Bay send and receive signals underwater when separated (energy and matter) and how humans encode, send, and receive patterns of information for efficient communication across distances (patterns; scale, proportion, and quantity).

Chapter Level

Chapter 1: How does a mother dolphin communicate with her calf across a distance?

Students use models to investigate waves and how sound travels (patterns, energy and matter). They figure out that sound energy travels as a wave from a source to a listener (patterns, energy and matter). Students create initial Sound Diagrams, and the class constructs an initial scientific explanation about how a mother dolphin uses sound to communicate underwater with her calf across a distance (energy and matter; scale, proportion, and quantity).

Chapter 2: How does sound energy travel through water from a mother dolphin to her calf?

Students use models and conduct hands-on investigations to figure out more about the idea that sound can travel through different kinds of materials—solids, gases, and liquids—and that these materials are made of particles too small to see (energy and matter; scale, proportion and quantity). Students investigate the idea that sound travels as a series of collisions between particles (patterns, energy and matter), and they revise their Sound Diagrams. They also construct their own scientific explanations to show that when particles collide, they transfer energy and that changes how they move (energy and matter).

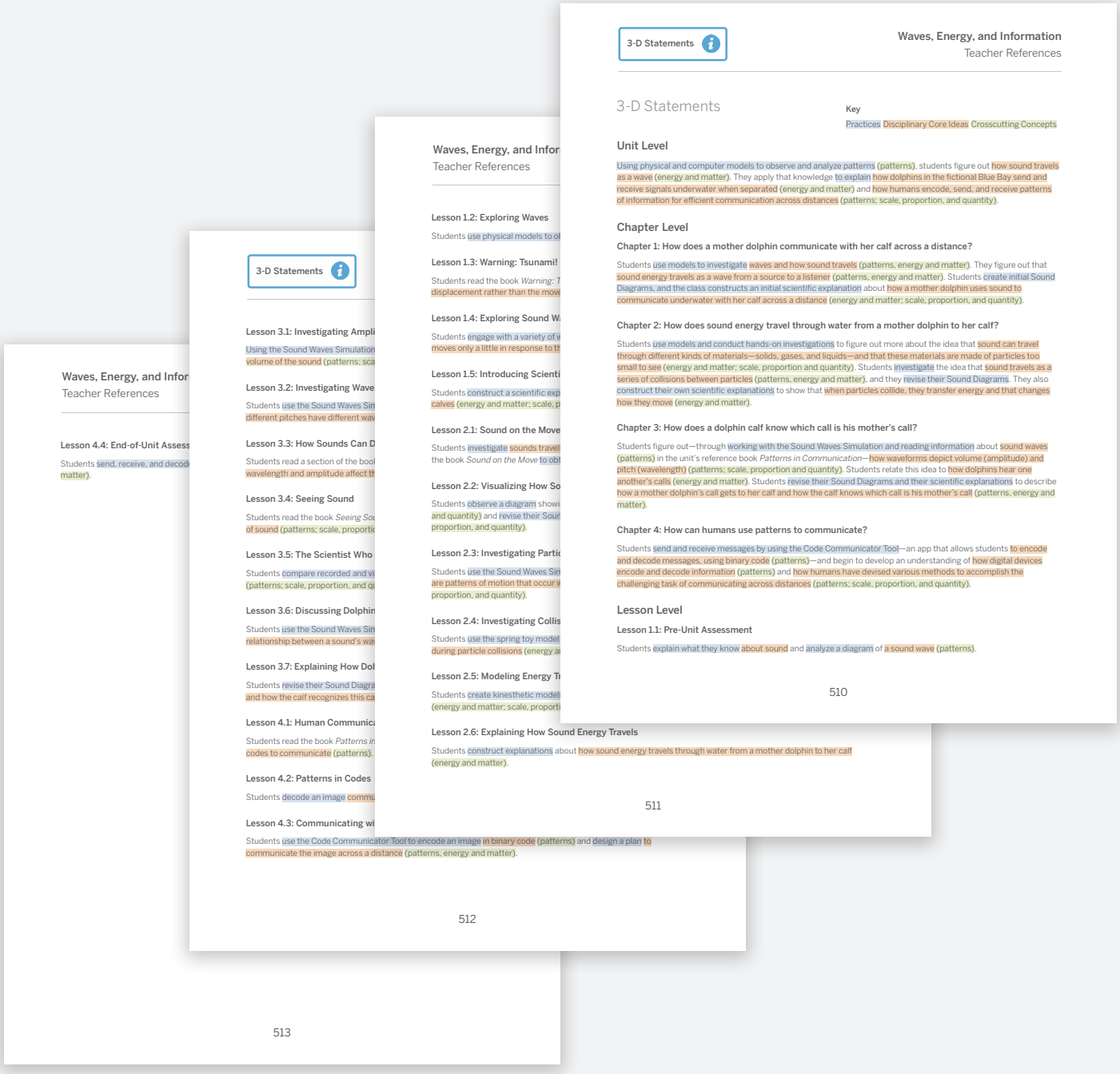
Chapter 3: How does a dolphin calf know which call is his mother's call?

Students figure out—through working with the Sound Waves Simulation and reading information about sound waves (patterns) in the unit's reference book *Patterns in Communication*—how waveforms depict volume (amplitude) and pitch (wavelength) (patterns; scale, proportion and quantity). Students relate this idea to how dolphins hear one another's calls (energy and matter). Students revise their Sound Diagrams and their scientific explanations to describe how a mother dolphin's call gets to her calf and how the calf knows which call is his mother's call (patterns, energy and matter).

Chapter 4: How can humans use patterns to communicate?

Students send and receive messages by using the Code Communicator Tool—an app that allows students to encode and decode messages, using binary code (patterns)—and begin to develop an understanding of how digital devices encode and decode information (patterns) and how humans have devised various methods to accomplish the challenging task of communicating across distances (patterns; scale, proportion, and quantity).

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



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

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