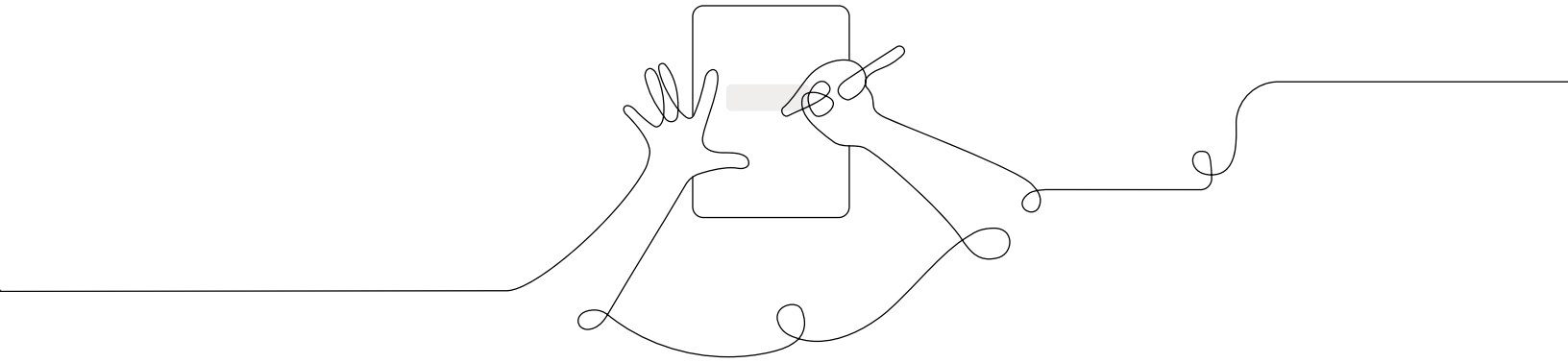
AmplifyScience

Participant Notebook

Grade 4: Waves Energy and Information
Unpacking for Hybrid Learning



Unit Guide resources

Once a unit is selected, select **JUMP DOWN TO UNIT GUIDE** in order to access all unit-level resources in an Amplify Science unit.

Planning for the unit

Unit Overview	Describes what's in each unit, the rationale, and how students learn across chapters
Unit Map	Provides an overview of what students figure out in each chapter, and how they figure it out
Progress Build	Explains the learning progression of ideas students figure out in the unit
Getting Ready to Teach	Provides tips for effectively preparing to teach and teaching the unit in your classroom
Materials and Preparation	Lists materials included in the unit's kit, items to be provided by the teacher, and briefly outlines preparation requirements for each lesson
Science Background	Adult-level primer on the science content students figure out in the unit
Standards at a Glance	Lists Next Generation Science Standards (NGSS) (Performance Expectations, Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts), Common Core State Standards for English Language Arts, and Common Core State Standards for Mathematics

Teacher references

Lesson Overview Compilation	Lesson Overview of each lesson in the unit, including lesson summary, activity purposes, and timing
Standards and Goals	Lists NGSS (Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts) and CCSS (English Language Arts and Mathematics) in the unit, explains how the standards are reached
3-D Statements	Describes 3-D learning across the unit, chapters, and in individual lessons
Assessment System	Describes components of the Amplify Science Assessment System, identifies each 3-D assessment opportunity in the unit
Embedded Formative Assessments	Includes full text of formative assessments in the unit
Books in This Unit	Summarizes each unit text and explains how the text supports instruction
Apps in This Unit	Outlines functionality of digital tools and how students use them (in grades 2-5)

Printable resources

Copymaster Compilation	Compilation of all copymasters for the teacher to print and copy throughout the unit
Investigation Notebook	Digital version of the Investigation Notebook, for copying and projecting
Multi-Language Glossary	Glossary of unit vocabulary in multiple languages
Print Materials (8.5" x 11")	Digital compilation of printed cards (i.e. vocabulary cards, student card sets) provided in the kit
Print Materials (11" x 17")	Digital compilation of printed Unit Question, Chapter Questions, and Key Concepts provided in the kit

Unit Map

How can a mother dolphin and her calf communicate underwater when they cannot see each other? How can humans use patterns to communicate?

Working in their role as marine scientists, students figure out how mother dolphins communicate with their calves. They write a series of scientific explanations with diagrams to demonstrate their growing understanding of how sound waves travel. Then they apply what they've learned about waves, energy, and patterns in communication to figure out how to create patterns that can communicate information over distances, transferring data from one place to another.

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

Students 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: Students use models to investigate waves, read about tsunamis, and explore different sounds with a digital simulation. They create sound diagrams and, using these diagrams as a resource, create a scientific explanation of the phenomenon.

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

Students 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: Students investigate how sound travels through different materials using hands-on activities, physical models, and digital models, as well as information they gather from books. They create models showing how energy travels through materials. Students revise their sound diagrams and write a revised scientific explanation.

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

Students 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: Students use a digital model to manipulate waveforms and hear the resulting sound waves, enabling them to intuit the concepts of amplitude and wavelength. They read about dolphins' use of unique patterns in sound and apply their understanding as they create and recognize sounds from waveforms, and vice versa. Students revise their sound diagrams and explanations one last time so they represent their deeper understanding of how a mother dolphin and her calf communicate.

Chapter 4: How can humans use patterns to communicate?

Students 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: Students read about various methods of distance communication through history. They are then challenged to use a digital device to efficiently and accurately transmit a message across a distance using binary code.

Progress Build

A Progress Build describes the way in which students' explanations of the central phenomenon is expected to develop and deepen over the course of a unit. It is an important tool in understanding the design of the unit and in supporting students' learning. A Progress Build organizes the sequence of instruction, defines the focus of the assessments, and grounds inferences about students' understanding of the content, specifically at each of the Critical Juncture Assessments found throughout the unit. Critical Junctures signify points in the unit at which it is especially important that all students understand the content before continuing. This document serves as an overview of the *Waves, Energy, and Information: Investigating How Dolphins Communicate* Progress Build. Since each level of the Progress Build is an increasingly complex yet integrated explanation, we represent it below by including the new ideas for each level in bold.

In the *Waves, Energy, and Information* unit, students learn to construct scientific explanations of the central phenomenon: how a mother dolphin communicates with her calf when they are separated.

Prior knowledge and experience (preconceptions) Students are likely to have encountered the idea that sound happens when a source vibrates. They will also likely know that there are many different sounds, and that a sound can be heard at a point away from where it originated. While these ideas are not necessary for students to participate fully in the unit, having exposure to them will prepare students well for what they will be learning.

Progress Build Level 1: A wave is a pattern of motion.

A wave is a pattern of motion. The wave's energy travels away from the source. When a wave travels through something (e.g., water or air), the thing it travels through can move up and down or back and forth. Sound energy travels as a wave from source to listener. The thing the sound energy travels through moves only a little. When the sound wave gets to a listener, the listener hears the sound.

Progress Build Level 2: Sound energy travels through a material as a series of particle collisions.

A wave is a pattern of motion. The wave's energy travels away from the source. When a wave travels through something (e.g., water or air), the thing it travels through can move up and down or back and forth. Sound energy travels as a wave from source to listener. **In a sound wave, the particles of the material the energy travels through move only a little. Sound energy travels through different kinds of materials. Materials are made of particles that are too small to see and are somewhat free to move. When a sound source vibrates, it collides with the nearest particles of the material, transfers its energy, and causes the particles to move. Those particles collide with the particles next to them, transfer their energy, and cause the next particles to move. This results in the sound wave—the pattern of motion when particles collide and spread apart—that travels through the material. When the collisions reach the listener, the listener hears the sound.**

Progress Build Level 3: Sound waves can differ in amplitude and wavelength.

A wave is a pattern of motion. The wave's energy travels away from the source. When a wave travels through something (e.g., water or air), the thing it travels through can move up and down or back and forth. Sound energy travels as a wave from source to listener. In a sound wave, the particles of the material the energy travels through move only a little. Sound energy travels through different kinds of materials. Materials are made of particles that are too small to see and are somewhat free to move. When a sound source vibrates, it collides with the nearest particles of the material, transfers its energy, and causes the particles to move. Those particles collide with the particles next to them, transfer their energy, and cause the next particles to move. This results in the sound wave—the pattern of motion when particles

collide and spread apart—that travels through the material. When the collisions reach the listener, the listener hears the sound. **Waves can differ in two ways: the height of the wave and the distance between the peaks of the wave. Amplitude is the height of the wave. When sound waves have different amplitudes, the listener hears sounds with different volumes. Wavelength is the distance between the peaks of a wave. When sound waves have different wavelengths in the same material, the listener hears sounds with different pitches.**

Applying conceptual understanding to explain the phenomenon

Use ideas from the Progress Build and Unit Map to make notes about the conceptual and explanatory builds in your unit.

	Science concepts	Explanation of the phenomenon
	Students figure out...	*So they can explain...*
Chapter 1	Sound travels away from the source. In a pattern of motion called a wave. The sound energy moves through the water.	Dolphins communicate through sound.
Chapter 2	The sound vibration hits the water particles and transfers energy which cause the particles to move. This movement of particles results in a sound wave.	The mother dolphin makes a sound that vibrates. That vibration makes a sound wave that reaches the calf and the calf hears the sound
Chapter 3	The amplitude of a sound is the volume and the wavelength determines the sound's pitch.	Dolphins make their own signature whistles. Each whistle has a certain wavelength (pitch) and amplitude (volume). The calf recognizes his mother's whistle.
Chapter 4	Coding and decoding information as well as patterns are some of the multiple ways to transmit information across a distance.	Humans communicate using different patterns.

Applying conceptual understanding to explain the phenomenon

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	Students figure out…	*So they can explain…*
Chapter 1		
Chapter 2		
Chapter 3		
Chapter 4		
Chapter 5		

Amplify Science@Home resources reference

Use this guide to keep track of the different resources available for remote and hybrid learning.

Instructional materials: Click Remote and hybrid learning resources, then select your grade level from the dropdown menu. Select your unit.	
@Home Unit resources: These will appear when you select your unit.	
Teacher Overview	General information for teaching with @Home Units, planning information, chapter and lesson outlines
Lesson Index	Lists the original Amplify Science lessons associated with each @Home lesson, and the Investigation Notebook pages, copymasters, and print materials associated with the @Home Unit Student Sheets
Family Overview	Information to send home to families to help them support students with remote learning
Student lesson materials for @Home Units	Printable or digital lessons condensed to be about 30 minutes long. You can access compilations of all student materials for your unit, or select from individual lessons.
@Home Video resources: After selecting your grade level and unit, select the @Home Videos tab below your unit title.	
@Home Video links	Links to video lessons that include all activities from the original units. Lesson playlists are on YouTube, and they autoplay in a playlist form.
Additional remote and hybrid instructional materials: These can be accessed from the tabs below your unit title.	
Hands-on investigations support	Videos of every unit's hands-on activities (note, these videos also appear in the student lesson materials).
Read-aloud videos	Link to a YouTube playlist of read-aloud videos of all books in your unit.
Orientation and Tutorials: Click Remote and hybrid learning resources, then select your grade from the dropdown menu. Click Orientation and Tutorials. You'll not only find videos to help you use the resources, but also videos you can share with students and caregivers.	

Suggestions for synchronous time

The following are some ideas for making the most of synchronous time with your students. As a general rule, the best way to use your synchronous time is to provide students opportunities to talk to one another, or to observe or visualize things they could not do independently.

Online synchronous time	Notes
Online discussions: It's worthwhile to establish norms and routines for online discussions in science to ensure equity of voice, turn-taking, etc. **Digital tool demonstrations:** You can share your screen and demonstrate, or invite your students to share their screen and think-aloud as they use a Simulation or other digital tool. **Interactive read-alouds**: Screen share a digital book or article, and pause to ask questions and invite discussion as you would in the classroom. **Shared Writing:** This is a great opportunity for a collaborative document that all your students can contribute to. **Co-constructed class charts:** You can create digital charts, or create physical charts in your home with student input.	

Questioning Strategies for Grades 2–5

Overview of the Role of Open-Ended Questioning

Repeated opportunities for students to listen to and speak with others are essential for promoting deep thinking and learning in science. Meaningful teacher-initiated questions create a rich context for promoting open-ended student dialogue and discussion. The *Science Framework for California Public Schools* explains that "Simply providing opportunities to talk is not enough. Effective questioning can scaffold student thinking" (*California Science Framework*, 2016, Chapter 11, p. 21). The Framework suggests that "Teacher-initiated questions are key to helping students expand their communication, reasoning, arguments, and representation of ideas in science" (*California Science Framework*, 2016, Chapter 11, p. 21). The types of questions that teachers pose are instrumental in supporting student understanding. The Framework calls for more open-ended teacher questioning that "prompts and facilitates students' discourse and thinking" and less teacher questioning that prompts "students to seek a confirmatory right answer" (*California Science Framework*, 2016, Chapter 11, p. 6).

The Amplify Science Teacher's Guide is infused with opportunities for students to discuss their developing ideas in response to open-ended prompts. Questions to promote student thinking and discussion are purposefully built into the Teacher's Guide instructional steps and Teacher Support notes that surround all our hands-on and reading activities. In addition, all units include discourse routines (e.g., Shared Listening, Think-Draw-Pair-Share, Write and Share, Word Relationships) that provide opportunities for students to use focal unit vocabulary as they think and talk with partners and the class about their understanding of key science content and practices. Many of the On-the-Fly Assessment suggestions provided throughout each unit offer open-ended follow-up questions that can be used to probe student thinking and formatively assess student understanding of the content. In addition, each unit includes multiple opportunities for students to respond to open-ended questions through additional modalities (e.g., in writing, with diagrams, through a kinesthetic model).

While the prompts embedded in each of the opportunities mentioned above provide fertile ground for student discussion, continued use of flexible, open-ended questions is invaluable for assessing students' knowledge and skills, promoting student-to-student discourse, and guiding student learning. A collection of grade-appropriate questions follows that can be used for these purposes. You will also find a list of activity types included within the Amplify Science curriculum that are particularly conducive to the use of these questions. You may choose to print out these questions and activity types for reference throughout your instruction.

Open-Ended Questions to Facilitate Student Thinking and Discourse

Questions to assess students' knowledge and skills:

- Why do you think X?
- How did you (or Could we) figure that out?
- What are you wondering?
- What questions do you have?
- Can you give an example of X?
- What is your evidence for X?
- Can you explain what (or why X) happened?

Questions to promote student-to-student discourse:

- Do you agree or disagree with (that idea)? Why?
- Can you add to what (name of student) shared?
- Do you have any questions for (student who shared)?
- Is there some evidence you can share about X?

Questions to guide student learning:

- What did you notice?
- What else do we need to figure out?
- How are X and Y similar/different?
- What does this remind you of?
- Can you explain that idea by using the vocabulary words XX and YY?
- What kind of evidence would we need to answer our question?

Activity Types Within the Amplify Science Curriculum That Are Especially Suited for Additional Teacher Questioning

The activity types listed below are student-centered and often contain prompts for pairs or small groups of students to use to discuss content or to vet evidence together. As you circulate through the classroom during these activities, you can use the open-ended questions to assess students' knowledge and skills, promote student-to-student discourse, and guide student learning.

- Hands-on activities
- Partner Reading of unit texts
- Discussion before/during/after reading unit texts
- Discussion of photographs and videos
- Discourse routines (e.g., Thought Swap, Think-Draw-Pair-Share)
- Science Practice Tool activities (modeling, sorting, graphing, diagramming, data)
- Simulation activities (grades 4–5)
- Evidence Card sorts
- Evidence Circles
- Roundtable Discussions

Multi-day planning, including planning for differentiation and evidence of student work

Day @Home Lesson 1

Minutes for science: 15 min.

Instructional format:
- [x] Asynchronous
- [ ] Synchronous

Lesson or part of lesson:
Introduce, student role (marine biologists)n and unit context (slides 1-13)

Mode of instruction:
- [x] Preview
- [ ] Review
- [ ] Teach full lesson live
- [ ] Teach using synchronous suggestions
- [x] Students work independently using:
  - [ ] Printed @Home Slides
  - [x] Digital @Home Slides
  - [ ] @Home Videos

Students will...	Teacher will...
View slides and learn about the Blue Bay National Park and studying dolphin communication. Jot down initial ideas about dolphin communication.	Assign slides 1-15 in Schoology and provide direction for students to jot down their ideas about the unit problem to share when the class meets together.

Minutes for science: 30 min

Instructional format:
- [ ] Asynchronous
- [x] Synchronous

Lesson or part of lesson:
Summarize the introduction to the unit. Introduce the chapter question and vocabulary and glossary resource. Have students listen to dolphin sounds (Slides 14-26)

Mode of instruction:
- [ ] Preview
- [ ] Review
- [ ] Teach full lesson live
- [x] Teach using synchronous suggestions
- [ ] Students work independently using:
  - [ ] Printed @Home Slides
  - [ ] Digital @Home Slides
  - [ ] @Home Videos

Students will...	Teacher will...
Discuss their initial ideas about dolphin communication and their role as marine biologists. Students jot down ideas on "Ideas about Dolphin Communication" page.	Introduce the unit question Present slides 14-20 Introduce the different dolphin sounds and direct students to jot their ideas on the sheet that is assigned in schoology. (student sheets @Home lesson 1) Introduce pre writing assessment and have students complete as after hours work.

Look at the *Students will* columns. What are students working in the lesson(s) that you could collect, review, or provide feedback on?
See Some Types of Written Work in Amplify Science to the right for guidance.

If there isn't a work product listed above, do you want to add one? Make notes below.

Asynchronous: students jot down their initial ideas

Synchronous: record observations of dolphin sounds.

Some Types of Written Work in Amplify Science

- Daily written reflections
- Homework tasks
- Investigation notebook pages
- Written explanations (typically at the end of Chapter)
- Diagrams
- Recording pages for Sim uses, investigations, etc

How will students submit this work product to you?
See the Completing and Submitting Written Work tables to the right for guidance on how students can complete and submit work.

Asynchronous: students jot initial ideas on paper or digitally to bring with them to the asynchronous lesson

Synchronous: Students will use the student sheets to record their observations and complete the pre unit assessment and submit through Schoology.

Completing Written Work	Submitting Written Work
• Plain paper and pencil (videos include prompts for setup) • (6-8) Student platform • Investigation Notebook • Record video or audio file describing work/answering prompt • Teacher-created digital format (Google Classroom, etc)	• Take a picture with a smartphone and email or text to teacher • Through teacher-created digital format • During in-school time (hybrid model) or lunch/materials pick-up times • (6-8) Hand-in button on student platform

How will you differentiate this lesson for diverse learners? (Navigate to the lesson level on the standard Amplify Science platform and click on differentiation in the left menu.)

Supports:

- Encourage students to engage in student-to-student discussion
- Provide students with the Multi-Language Glossary where appropriate, add images
- Leverage primary language for discussions
- Strategic grouping
- You may want to extend the lesson and provide more whole class time to talk about the dolphin sounds.
- You may choose to use a computer program or website to convert sounds into visual representations of waveforms.

Multi-day planning, including planning for differentiation and evidence of student work

<table>
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