

# Waves, Energy, and Information Coherence Flowchart

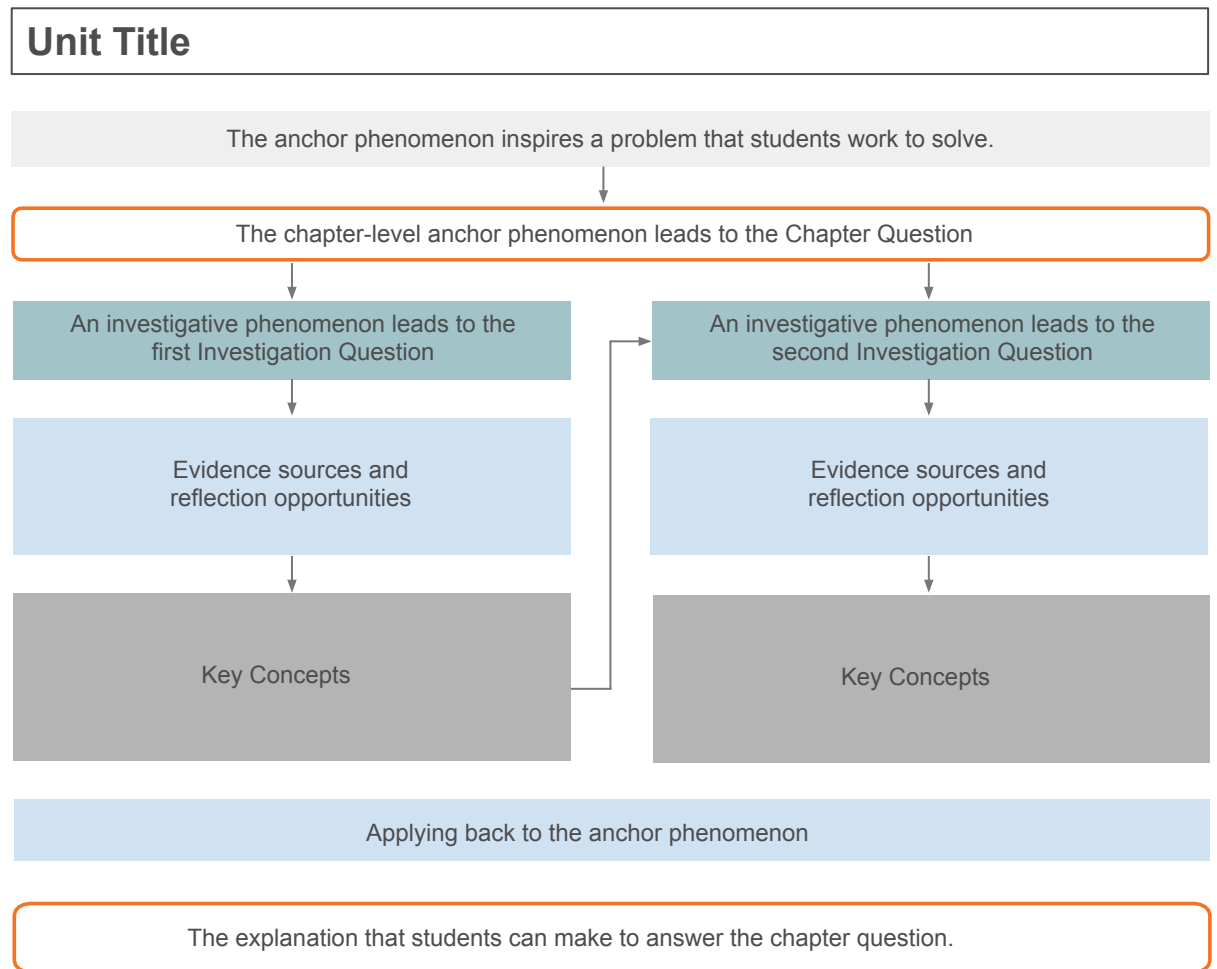
## The storyline of the unit

In each Amplify Science unit, students figure out a phenomenon by asking questions, gathering evidence, and coming up with an explanation of how the phenomenon works. The Coherence Flowchart visually represents the storyline of the unit, showing the coherent flow of questions based on phenomena, evidence, and ideas that support students as they build complex explanations of the unit's anchor phenomenon. The Coherence Flowchart on the following pages (one chapter per page) can be used to see the connections between the phenomena and questions that drive students' experiences, the evidence they gather, the ideas they figure out, and the new questions that those ideas generate. The diagram to the right explains the structure of a chapter in the Coherence Flowchart.

In some units a design problem drives the investigations of the unit or of specific lessons. In these cases the design problem will be noted in place of the phenomenon.

Note: The Coherence Flowchart is a tool for teachers and is not meant to be distributed to students.

Typical structure of one chapter in a Coherence Flowchart



Instruction is framed by questions about the unit's anchor phenomenon and the related problem students are solving. Chapter Questions then guide students in figuring out the phenomenon, piece by piece. Within each chapter, investigative phenomena lead to Investigation Questions that focus students on a manageable piece of content that will help them figure out the Chapter Question. Each phenomenon leads to a question which motivates activities, and each activity provides specific evidence related to the Investigation Question. Students synthesize the understanding constructed over multiple activities, and this understanding is formalized through key concepts. Often a key concept leads students to an additional investigative phenomenon and Investigation Question students need to pursue to answer the Chapter Question. At the end of the chapter, students' new understanding is applied back to the unit's anchor phenomenon and leads students to a new Chapter Question or a final explanation.

# Waves, Energy, and Information: Investigating How Dolphins Communicate

## Unit Anchor Phenomenon

Problem students work to solve

## Chapter-level Anchor Phenomenon

Chapter 1 Question

## Investigative Phenomena

Investigation Questions

Evidence sources and reflection opportunities

Key concepts

Application of key concepts to the problem

Explanation that students can make to answer the Chapter 1 Question

Even when dolphin calves are very far from their mothers, they are able to find one another.  
*How can a mother dolphin and her calf communicate underwater when they cannot see each other?*

Dolphin calves and mothers can find each other, even when they are too far apart to see each other.  
*How does a mother dolphin communicate with her calf across a distance?*

Sounds can be heard at a distance from the source.  
*How does sound get from one place to another? (1.2-1.5)*

- Read about communication in *Patterns of Communication* (1.2)
- Observe and discuss rope and spring toy waves (1.2)
- Read *Warning: Tsunami!* (1.3)
- Engage in kinesthetic model of tsunami wave (1.4)
- Explore the Sim (1.4)
- Discuss sound waves (1.4)

- A wave is a pattern of motion that travels away from a source. (1.3)
- Sound energy travels as a wave. The thing it travels through moves only a little. (1.4)

- Gather evidence from *Patterns of Communication* in preparation for answering the Chapter 1 Question (1.5)
- Draw Sound Diagrams and write about sound waves (1.5)
- Shared write an explanation to answer Chapter 1 Question (1.5)

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.

# Waves, Energy, and Information: Investigating How Dolphins Communicate

## Unit Anchor Phenomenon

Problem students work to solve

## Chapter-level Anchor Phenomenon

Chapter 2 Question

## Investigative Phenomena

Investigation Questions

Evidence sources and reflection opportunities

Key concepts

Application of key concepts to the problem

Explanation that students can make to answer the Chapter 2 Question

Even when dolphin calves are very far from their mothers, they are able to find one another.  
*How can a mother dolphin and her calf communicate underwater when they cannot see each other?*

Sounds from a mother dolphin can be heard by her calf.  
*How does sound energy travel through water from a mother dolphin to her calf?*

Sounds can be heard at a distance from the source when there is water between source and listener.  
*What can sound travel through? (2.1-2.2)*

- Investigate what sound travels through (2.1)
- Read the first half of *Sound on the Move* (2.1)
- Observe sound traveling in the Sim (2.2)
- Discuss and visualize particles (2.2)
- Revise Sound Diagrams (2.2)

- Materials are made of particles that are too small to see. (2.2)
- Sounds can travel through different kinds of materials. (2.2)

Sounds can be heard at a distance from the source when there is material between source and listener.  
*How does sound energy travel through a material? (2.3-2.6)*

- Observe particle collisions and wave patterns in the Sim (2.3)
- Read the second half of *Sound on the Move* (2.3)
- Discuss spring toy as a model of particle collisions (2.4)
- Revise Sound Diagrams (2.4)
- Use coins to investigate energy transfer in collisions (2.4)
- Develop kinesthetic models of particle collisions (2.5)
- Use the Diagramming Tool to create diagrams of sound energy (2.5)
- Find evidence of energy transfer in the Sim (2.6)

- Scientists make models to help them answer questions and visualize things that are difficult to see. (2.3)
- Sound energy travels as a wave. The particles of the material it travels through move only a little. (2.4)
- Sound travels as a series of collisions between particles. (2.4)
- When particles collide they transfer energy, and that changes how they move. (2.6)

- Write an explanation to answer the Chapter 2 Question (2.6)

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 see 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 transfers 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.

# Waves, Energy, and Information: Investigating How Dolphins Communicate

## Unit Anchor Phenomenon

Problem students work to solve

## Chapter-level Anchor Phenomenon

Chapter 3 Question

## Investigative Phenomena

Investigation Questions

Evidence sources and reflection opportunities

Key concepts

Application of key concepts to the problem

Explanation that students can make to answer the Chapter 3 Question

Even when dolphin calves are very far from their mothers, they are able to find one another.  
*How can a mother dolphin and her calf communicate underwater when they cannot see each other?*

When a mother dolphin whistles, only her calf swims to her.  
*How does a dolphin calf know which call is his mother's call?*

There are different sounds in the world.  
Why are some sounds different from other sounds? (3.1-3.4)

- Discuss how sounds can differ (3.1)
- Investigate amplitude and volume in the Sim (3.1)
- Reflect on the Investigation Question (3.1)
- Reflect on amplitude and dolphin communication (3.2)
- Explore pitch with straw reeds (3.2)
- Investigate wavelength and pitch in the Sim (3.2)
- Read about amplitude and wavelength in Patterns of Communication (3.3)
- Use the Sorting Tool to sort sounds by amplitude and wavelength (3.3)
- Draw and discuss waveforms for a sound (3.3)
- Read Seeing Sound (3.4)

- When sound waves have different amplitudes, we hear sounds with different volumes. (3.1)
- When sound waves have different wavelengths, we hear sounds with different pitches. (3.2)

- Discuss the Chapter 3 Question in a Science Forum (3.6)
- Write explanations to answer the Chapter 3 Question (3.6)

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 know to respond.

When a mother dolphin whistles, only her calf swims to her.  
*How can dolphins use different sounds to communicate with one another? (3.5- 3.7)*

- Observe differences in dolphin sounds (3.5)
- Read *The Scientist Who Cracked the Dolphin Code* (3.5)
- Reflect on the Investigation Question (3.5)
- Use the Sim to create dolphin signature whistles (3.6)
- Participate in a model of dolphin communication (3.6)

# Waves, Energy, and Information: Investigating How Dolphins Communicate

## Unit Anchor Phenomenon

Another problem students work to solve

## Chapter-level Anchor Phenomenon

Chapter 4 Question

Evidence sources and reflection opportunities

Key concepts

Application of key concepts to the problem

Explanation that students can make to answer the Chapter 4 Question

Humans communicate with one another.  
*How do humans communicate?*

Humans use patterns to communicate with one another.  
*How can humans use patterns to communicate?*

- Create, send, and receive images in partners (4.1)
- Read about human communication in Patterns in Communication (4.1)
- Discuss codes (4.2)
- Use binary code to decode an image (4.2)
- Encode images in the Code Communicator Tool (4.3)
- Design communication plans (4.3)
- Send and receive message across the classroom (4.4)
- Reflect on parallels between Code Challenge and communication via digital devices (4.4)

• Humans use patterns to communicate information and use technology to communicate those patterns across long distances. (4.4)

• Write to explain ways humans communicate across distances (4.4)

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