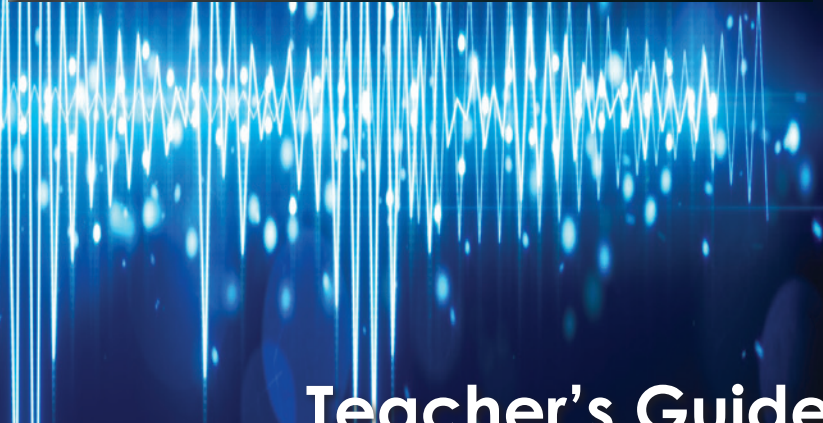


Riding the Waves of Information



Teacher's Guide

Waves and Information

Teacher's Guide

Published by BOCES 4 Science

Genesee Valley Educational Partnership

Monroe 1 BOCES

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Written by teachers and administrators
from public school districts within
the borders of the NYS Midwest Joint
Management Team in conjunction with
the BOCES 4 Science Educators

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Riding the Waves of Information

Foreword

BOCES 4 Science is a collaboration between four New York State BOCES (Board of Cooperative Educational Services) within the Midwest Region. This collaborative of science educators came together to respond to the need for instructional resources based on the New York State pK-12 Science Learning Standards (NYSSLS). The research behind the Next Generation Science Standards (NGSS) and the National Research Council (NRC) publication, *A Framework for K-12 Science Education* is the basis for the NYSSLS and the BOCES 4 science units.

We believe that the future health and well-being of our world depends on scientifically literate people making informed decisions. The development of scientific literacy begins at the earliest grades. Elementary children must have concrete experiences upon which to hook their understanding and new vocabulary – this is especially true in the discipline of science. We embrace the notion that students should experience phenomena and solve real problems to learn about the world. We strive to present lessons and materials that will make high quality science instruction available for all students through cost-effective resources for teachers.



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Riding the Waves of Information

About this Unit

Overview

This unit “Waves: Riding the Waves of Information” addresses science concepts related to wave motion, properties, and communication.

In Part 1 Lessons 1-6, students describe patterns of waves in terms of amplitude and wavelength, in addition to showing that waves can cause objects to move up and down but have no net motion.

In Part 2, Lessons 7-10, students learn how waves are used to communicate information. Students will understand how waves can be coded with information that can be converted or digitized into pictures (video) or sound (audio). Students will develop and use models, construct explanations and design a solution to transfer information using waves.

The unit culminates with an activity where students use both their knowledge of wave properties and communication with waves to open a lock box.

This unit also includes Student Science Journal pages that are available online at the BOCES 4 Science website. (A web address and password are located on a colored page inserted in the Teacher’s Guide.) Additional resources for the teacher, such as the specific assessments, ELA and/or ELL supports, direct links to videos or websites mentioned in the teacher’s guide, etc. can also be found on the BOCES 4 Science website.

Scheduling

This unit is scheduled to be in the classroom for 11 weeks. There are approximately 15 science instructional sessions in this unit, based on 30-40 minutes each. Adjust your schedule accordingly. Please return the unit promptly or to request an extension, call 585-352-1140.

Materials to Obtain Locally

Some lessons require materials that are NOT supplied in the kit. These materials can be easily obtained by the teacher or the students. Materials that will need to be provided are indicated with an asterisk in the lesson materials list and are also listed below:

Paper towels – L2, L6

Water – L2, L6

Construction paper, 11x17, three sheets/group - optional - L3

Highlighters, lighter and darker colors – L9, L11

Computers or tablets – teacher demonstration can be used if not available – L4

Candy or prize other than small Slinkys (included) in lock box – L11

Riding the Waves of Information

Three Dimensions

Each of the BOCES 4 Science lessons includes at least one element from each of the three dimensions identified in the NYSSLS. The lesson page identifies the specific elements targeted; the NYSSLS topic page is included after the Features that Support 3-D Learning page.

Science and Engineering Practices (SEP)

– These are the major practices that scientists employ as they investigate and build models of their understanding of the world. They also include key practices used by engineers as they design and build systems.

Disciplinary Core Ideas (DCI)

– Selected to represent four major domains: the physical sciences; the life sciences; the earth and space sciences; and engineering technology, and the applications of sciences.

Crosscutting Concepts (CCC)

– These big ideas have application across all domains of science and provide one way of linking across the domains of the DCI's. In addition, they link to ideas that are parts of other elementary subjects.

NYSSLS Shifts in Instruction

It is the intention of BOCES 4 Science that this unit provides lessons that demonstrate the following shifts in instruction:

- **Explaining Phenomena or Designing Solutions to Problems:** The unit focuses on supporting students to make sense of a phenomenon or design solutions to a problem.
- **Three Dimensions:** The unit helps students develop and use multiple grade-appropriate elements of the SEPs, CCCs, and DCIs which are deliberately selected to make sense of phenomena or design a solution to a problem.
- **Integrating the Three Dimensions for Instruction and Assessment:** The unit will elicit student artifacts that show direct, observable evidence of three dimensional learning.
- **Relevance and Authenticity:** By taking advantage of student questions and experiences in the context of their homes, neighborhood and community, the lessons in this unit will motivate student sense-making or problem-solving.
- **Student Ideas:** This unit provides opportunities for students to express clarify, justify, interpret or represent their ideas and to respond to peer and teacher feedback.
- **Building on Students' Prior Knowledge:** Since student understanding grows over time, this unit identifies and builds on students' prior learning in three dimensions in such a way as it is explicit to both students and teachers.

Assessment:

Providing opportunities for assessment of learning and feedback to students is an important step in the educational process. This unit includes formative assessments and summative assessments. The teacher is encouraged to use a variety of informal or anecdotal assessment strategies.

Additional Features of this Unit

The Waves: Riding the Waves of Communication" unit also includes a Student Science Journal. A digital version of the Student Science Journal is available online at the BOCES 4 Science website. (A web address and password are located on a color insert in the Teacher's Guide.) Additional resources for the teacher, such as the specific assessments, ELA and/or ELL supports, direct links to videos or websites mentioned in the teacher's guide, etc. can also be found on the BOCES 4 Science website.

Riding the Waves of Information

Features that Support 3-D Learning

Look for these features in the Teacher's Guide:

NYS pK – 12 Science Learning Standards within each lesson provide the teacher with specific information about the Performance Expectation and the 3-Dimensions that are targeted by the instruction in this lesson.

Performance Expectations:

K-2-ETS1-2 – Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

Science and Engineering Practices

Developing and Using Models

Develop a simple model based on evidence to represent a proposed object or tool.

Disciplinary Core Ideas

ETS1.B: Developing Possible Solutions

- Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.

Crosscutting Concepts

Structure and Function

- The shape and stability of structures of natural and designed objects are related to their function(s).

ELA/Math/Social Studies Connections:

ELA: 2R1

Math: NY-2.MD

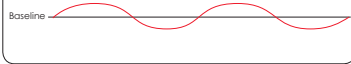
Throughout the Teacher's Guide, the 3-Dimensional Domains are color coded within the text so that teachers know to emphasize or explicitly point out to students this connection to either the **Science and Engineering Practices (SEPs)** and the **Crosscutting Concepts (CCCs)**. In addition, small boxes on the right hand side of the Procedure pages (see box in the green column to the right) serve as a visual reminder, as well.

In addition, a small picture of the page(s) of the Student Science Journal (with answers) that students are using for each lesson has been included on the appropriate pages in the Teacher's Guide (see box to the right). This keeps the teacher from needing to go back and forth between various documents pertaining to a particular lesson.

Lesson 3 - Waves and Spring Coils

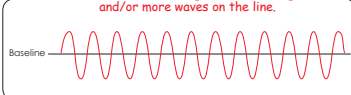
1. Draw a model of the wave you observed with the spring coil when you used **little energy** and the wave was small. The line in the box indicates the baseline.

Students drawing may or may not be equal above and below the baseline, but you should look for a longer, lower wave.



2. Draw a model of the wave you observed when you used **high energy** and the wave was fast. The line in the box indicates the baseline.

Students drawing should show higher and/or more waves on the line.



3. The amount of energy changes the movement of a wave. How did you make your waves higher or lower with energy?

Students should indicate that if they moved their arms or hands faster they added more energy then the wave went higher. If they moved their arms slower then the wave was lower.

4. What is the general motion of a wave?

The general motion is a pattern of up and down or back and forth movements. (Make sure students begin to use the word, pattern, in their answers about wave motion.)



CCC: Crosscutting Concept(s):

Cause and Effect:

Events have causes that generate observable patterns.

New York State P-12 Science Learning Standards

Waves and Information

Students who demonstrate understanding can:

4-PS4-1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. [Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.] [Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.]

4-PS4-3. Generate and compare multiple solutions that use patterns to transfer information.* [Clarification Statement: Examples of solutions could include drums sending coded information through sound waves, using a grid of 1s and 0s representing black and white to send information about a picture, and using Morse code to send text.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models

Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.

- Develop a model using an analogy, example, or abstract representation to describe a scientific principle. (4-PS4-1)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-PS4-3)

Connections to Nature of Science Scientific Knowledge is Based on Empirical Evidence

- Science findings are based on recognizing patterns. (4-PS4-1)

Disciplinary Core Ideas

PS4.A: Wave Properties

- Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. (Note: *This grade band endpoint was moved from K–2*). (4-PS4-1)
- Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (4-PS4-1)

PS4.C: Information Technologies and Instrumentation

- Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—and vice versa. (4-PS4-3)

ETS1.C: Optimizing The Design Solution

- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (secondary to 4-PS4-3)

Crosscutting Concepts

Patterns

- Similarities and differences in patterns can be used to sort and classify natural phenomena. (4-PS4-1)
- Similarities and differences in patterns can be used to sort and classify designed products. (4-PS4-3)

Connections to Engineering, Technology, and Applications of Science Interdependence of Science, Engineering, and Technology

- Knowledge of relevant scientific concepts and research findings is important in engineering. (4-PS4-3)

New York State P-12 Science Learning Standards

Connections to other DCIs in fourth grade: **4.PS3.A** (4-PS4-1); **4.PS3.B** (4-PS4-1); **4.ETS1.A** (4-PS4-3)

Articulation of DCIs across grade-levels: **K.ETS1.A** (4-PS4-3); **1.PS4.C** (4-PS4-3); **2.ETS1.B** (4-PS4-3); **2.ETS1.C** (4-PS4-3); **3.PS2.A** (4-PS4-3); **MS.PS4.A** (4-PS4-1); **MS.PS4.C**

Common Core State Standards Connections:

ELA/Literacy –

- RI.4.1** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (4-PS4-3)
- RI.4.9** Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. (4-PS4-3)
- SL.4.5** Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes. (4-PS4-1)

Mathematics –

- MP.4** Model with mathematics. (4-PS4-1)
- 4.G.A.1** Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures. (4-PS4-1)

Lesson 4

Wave Properties



Focus Question:

What are the properties of waves?

Lesson Synopsis

Learning Target:

I can identify the amplitude and wavelength of a wave and explain how these properties change when energy is added or taken away.

Lesson Description:

Students will observe a computer generated oscilloscope wave. This can be done on a white board as a teacher-led activity if you do not have enough electronic devices for students to use. The wave can be manipulated by adding more volume (amplitude) or by playing different keys, pitch (wavelength/frequency) on the piano that will generate a new wave. As students explore with the oscilloscope, they should begin to recognize how a wave's amplitude (height) and wavelength (length of a wave) can change. In this lesson students will formally be introduced to the concepts of **amplitude** and **wavelength**.

Management

Materials

For the class:

Computer – with or without microphone*
Digital projector*
Oscilloscope website – located on the BOCES 4 Science website, see information in the preparation section

Bill Nye YouTube Video
KWL chart*

For each student:

Student Science Journal
"Ticket Out the Door", Located on the BOCES 4 Science website

*Provided by teacher

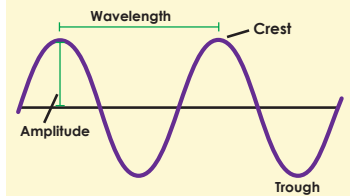
Preparation:

- Website: You will need to choose from two websites located on the BOCES 4 Science website. This lesson is based on the first "[Physics](#)" site. The second "academo" site is good if the first does not work, but you will need a computer with a microphone to use it.
 - o **No microphone needed:** this is a physics-chemistry interactive site. This lesson is based on this site.
 - o **Microphone needed:** - Academo site, make sure you practice if using.
- Bill Nye Video on waves - you could watch ~2:40 -5:40 min. of video about properties.

(All three videos can be accessed at the BOCES for Science Website.)

Vocabulary:

amplitude
crest
frequency
trough
wavelength

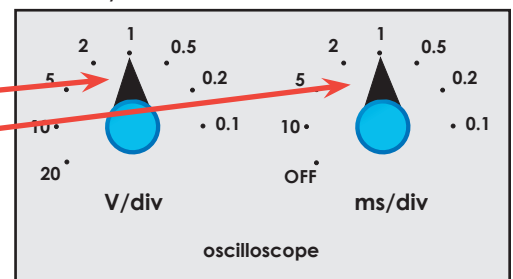


Suggestion:

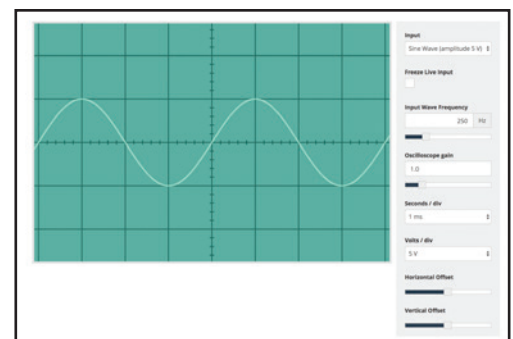
It is suggested that you practice with the website before doing this lesson in front of the students

Lesson 4 Wave Properties *cont.*

- Check that the website of choice works on all devices prior to starting.
- Make sure the websites have the correct settings on the oscilloscopes so that students do not need to prepare this on their own (see the activity below).
- Using the computer can be challenging to some students. Those students who struggle with manipulating computer sites should be paired with students better versed at using the computer. Once the computer settings are ready (see procedure) students can follow along with the teacher leading this activity from a Smart board. To help struggling learners, a stronger computer-based student can first play the given notes and then show their partners what notes to play. Alternatively, the teacher can do the entire activity on a Smart board.
- Bring the Student Journal pages up on the Smart/White board. Be prepared to help all students with these graphs. You may have to begin by counting squares together and drawing a point with a pencil on the graph where the wave starts, the highest point (crest), the lowest point (trough), and where it crosses the baseline. Once the points are placed on the graph students can draw the wave line connecting the points.
- The lesson will be based on the physics-chemistry interactive website: No microphone needed:
 - Adjust the V/div (amplitude setting) to 1 (~1.5 grid for amplitude)
 - ms/div to 1 (~4 grids for a wavelength)
 - Set the volume (located on the keyboard) in the middle of the scale.
 - Make sure your computer speaker volume is turned up. Students can play with these buttons after exploring the activity but should keep them constant to start so they are exploring 1 variable at a time. They will create the sound by clicking on a keyboard note.



For the “Academo” website you will need a microphone on the computer and updated software to use. The live input is at the top right drop down menu called “input”. It might start with “sine wave”. Just under that menu is a select button for “freeze live input”. As students create waves using their voices they can click that button and the wave will be saved on the screen for them to evaluate.



Teacher Background:

As students have learned, a wave is a pattern of motion either up and down or side to side. Waves are initiated from a source of energy although the students may only be identifying the location, such as their hand. Waves also have properties that can be identified. The **amplitude** is the height of the wave. Amplitude changes when more or less energy is added to the wave.

Lesson 4 Wave Properties *cont.*

With sound, the more volume, the higher the amplitude. The top part of the wave above the baseline is called the **crest**, the bottom part of the wave below the baseline is called the **trough**. Students do not need to know crest and trough although if the opportunity presents itself you can introduce the vocabulary. Waves also have a **wavelength**. The wavelength is the distance from the beginning of one part of a wave to the same spot on the next wave. The more energy added to the wave, the more wavelengths there are in a given distance. Again with sound, the higher the tone or pitch, the more wavelengths can be seen on the oscilloscope. This is related to **frequency** or the number of cycles (wavelengths) per second of time. Students do not need to know about frequency, pitch and volume but should understand that the change in energy can change the properties of the wave.

Standards

Performance Expectations:

4-PS4-1 – Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.

Science and Engineering Practices

Developing and Using Models

- Develop a model using an analogy, example, or abstract representation to describe a scientific principle.

Science Knowledge is Based on Empirical Evidence

- Science findings are based on recognizing patterns.

Disciplinary Core Ideas

Wave Properties

- PS4.A: Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach.
- Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).

Crosscutting Concepts

Patterns

- Similarities and differences in patterns can be used to sort and classify natural phenomena.

Cause and Effect

- Events have causes that generate observable patterns.

ELA/Math: 4R4, 4R7, 4W1b; 4.MD.1, 4.G.1, 4.G.3, 4.OA.5

Vocabulary:

- **amplitude** - the height to the “top” of a crest or “bottom” of a trough from the resting line
- **crest*** - the highest point of a wave above the baseline
- **energy** - the ability to do work
- **frequency*** - the number of cycles (wavelengths) per second of time
- **trough*** - the lowest point of the wave below the baseline
- **wavelength** - the distance from the beginning of one part of a wave to the same spot on the next wave

*These vocabulary terms are not required for students to know however they may be helpful.

Lesson 4 Wave Properties *cont.*

Procedure

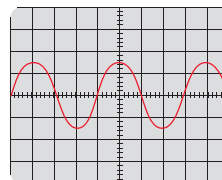
Phenomena: Using an oscilloscope to observe the properties of a wave.

1. The teacher should have the “piano” website (the “physics” one), open and ready on a Smart/white board. Play the middle “C” note so students can see where it is. The middle “C” note (see image above, it is the white key to left of the set of 2 black keys in the center of the piano) it should read 261.62 Hz or frequency (on the keyboard) if all the controls are set up as above. Have students play the middle “C” note on their computers. (If using the “Academo.org” site, have students hum into the microphone and “freeze live input” the wave.) Have students observe the wave created and draw it on page 11: “Wave Properties”, Graph #1 of their Science Journal. They should count the number of peaks (3), squares high (1.5) and long (4) each wave covers and be accurate in their drawing. Again, show students how to create the wave lines on the graph or partner struggling learners with those that are strong with graphing. To graph the wave, use a pencil to place a mark where the wave starts on the baseline, the height of it, where it crosses the baseline, the depth of the wave and where it crosses the baseline again. When all points are marked, draw the wave line.



Lesson 4 - Wave Properties

1. Graph 1: Draw the first wave you created on the Oscilloscope by playing middle “C.”



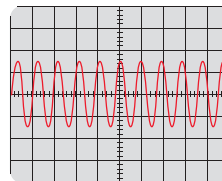
How many peaks are there?

3

How high are the peaks?

1 1/2

2. Graph 2: Draw the wave you created when you played the key all the way to the right.



How many peaks are there?

11

How high are the peaks?

1 1/2

3. How are these graphs the same?

Answers will vary. Both have waves, equal height of waves.

4. How are these graphs different?

Answers will vary. There are different amounts or peaks of waves on the graphs.

11

a. You can introduce the word “crest” to identify the peaks of the waves. “Trough” is the bottom part of the wave.

2. If groups of students have their own devices to use, allow 5 minutes of free play with the keyboard to change the look of the wavelength using different keys. Do not allow them to change the settings yet. Make sure students are observing what they are doing to create the different waves. If you are using a single class computer have students come up to the computer and play different keys on the keyboard and observe the resulting wave on the screen.
3. Have students play a key at the far right of the piano (or hum a high pitched note if using the “Academo” website). The farthest note will read 1046.5Hz. Have them draw it on page 11, Graph #2 in their Science Journal. This should give them many small waves. They should count the number of crests (11), squares high (1.5) and long (1) each wave covers and be accurate in their drawing (see the answer key page for Graph 1 and 2 above).

Lesson 4 Wave Properties *cont.*

4. Ask students to observe the two graphs and discuss the main differences between the graphs. (*students should see the height of the crests are the same, however the number of crests are more in graph #2*). Begin to introduce “wavelength” by wondering out loud to the students: “I wonder what that bunch of up and down “wavelike” patterns is called?” Students could begin to list a few names they think it could be called.
5. Introduce the idea that the waves they are creating have properties that have names.

6. Create a long wave by playing a low note on the piano (play a note towards the left end of the keyboard). For example if you play “G” (see image, it is the 12th note from the left end) there will be exactly 2 wavelengths if all the controls are set as in the beginning (196 hz). [There will be 1 wavelength if you play the lower “G” almost under the purple dot of the “Square” sign.] See if students can identify the 2 waves. If using the microphone website, hum a bass or low note) and have them draw the wave with precision (by counting the number of squares on the graph) on page 12; “Wave Properties”, Graph #3 in the Science Journal. Point out specifically that students can see 2 waves and count one **wavelength** starting from one part of the wave to the same point on the next wave. This is often done counting crest to crest, trough to trough, or from the beginning of the wave on the line to the same spot on the next wave.

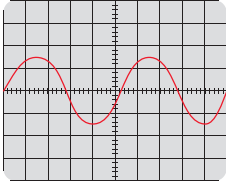


Then predict how to create a shorter wave (or many smaller waves). Students will have done that with Graph 2 but see if they can recreate it without help. Create the shorter wavelength by exploring (the highest note on the keyboard will give you 11 wavelengths, see the answer key with the Graph 1). Have students draw the wave they create with some precision on page 12, Graph 4 in their Science Journal. Have students count the wavelength of one wave that they see. These waves may have a different number of wavelengths depending on the note the student played.

7. Discuss the differences between the waves created with a high note and a low note. The main difference is the length of the wavelength (frequency). There were 2 wavelengths with the lower note, “G” and 11 wavelengths with the highest note. Again wonder out loud “I wonder what this property of the wave could be called?” Discuss the “length” of the waves and that one has a shorter length than the other. Introduce the word “wavelength” again if they have not determined it. At the bottom of Graph 4 is the question: The distance between one part of a wave to the same spot on the next wave is called: ___wavelength_____

Lesson 4 - Wave Properties (cont.)

5. Graph 3: Draw the wave you created with a low “G” note.

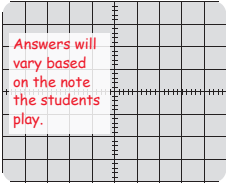


How many peaks are there?
2

How many squares long is one wave?
5

6. Graph 4: Draw the wave you created with a high note.

Answers will vary based on the note the students play.



How many peaks are there?
Answers will vary

How many squares long is one wave?
Answers will vary

7. The distance between one part of a wave to the same spot on the next wave is called the: **Wavelength**

12

Lesson 4 Wave Properties *cont.*



CCC: Crosscutting
Concept(s):

Cause and Effect:

Events have causes
that generate
observable patterns.

8. Allow students free exploration for about 2 minutes to create longer and shorter wavelengths.

Discussion questions:

- Do you remember the spring coil waves? How did you create many smaller wavelengths? (add more energy, move the hand faster)
- How did you create longer wavelengths with the coils? (slower hand movement)
- What **caused** the water waves to have many shorter wavelengths? (less energy)
- What **caused** the water waves to have fewer but longer wavelengths? (less energy)
- What is needed to create many shorter wavelengths? (More energy)

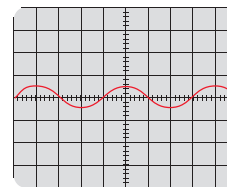
9. Have students or yourself create a low amplitude (height) wave by turning the volume almost all the way down on the oscilloscope and playing the "C" note (or humming softly into the microphone if using the other website). Have students draw this wave with precision by counting the number of squares high (0.5) on page 13 Graph 5 in their Science Journals. Students should also be able to count the length of the wavelength too (4)!

10. Have students predict how they could create a high amplitude wave (a louder sound). Allow them time to create a high amplitude wave by turning up the volume on the oscilloscope and playing the "C" note (or humming louder with the other web site). Repeat a lower wave and a higher wave using the same note so that students can see the difference. Have them draw the high amplitude wave with some precision by counting the height of the wave in squares (3) and length of the wave in squares (4) on page 13; "Wave Properties" Graph 6 in their Science Journal (see answer key with Graph 5).

11. Again, wonder out loud "I wonder what the property of the wave may be that shows the differences in height?" Ask students if they know other words that relate to how high or low something is. Maybe the suggestion of an "amp" that turns the loudness up or down on a guitar.

Lesson 4 - Wave Properties (cont.)

8. Graph 5: Drag the volume button to the left on the second long line, for low volume. Play the middle "C" note. Draw the wave you created.



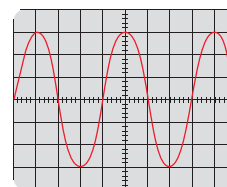
What is the wavelength?

4

How many squares high is this wave?

1/2

9. Graph 6: Drag the volume key to the right for high volume. Play the middle "C" note. Draw the wave you created.



What is the wavelength?

4

How many squares high is this wave?

3

10. How does the volume affect the properties of a wave?

The louder the volume the higher the amplitude. The lower the volume the lower the amplitude.

Students may indicate that the wavelength stays the same this is due to the same note being played.

13

Lesson 4 Wave Properties *cont.*

12. Introduce the word “amplitude” to the students. (You can introduce or remind students of the names crest and trough at this point also. The crest is the top of the wave and the trough is the bottom of the wave). See if students can explain amplitude. Confirm that it is how high or low a wave is above or below the baseline.

Discussion questions:

- Do you remember **observing** the **pattern** of how high and low the waves were created with the springs?
- What **caused** the springs to have a higher or lower wave? (amount of energy)
- Can you **predict** what is needed to create a higher wave? (More energy)
- Do you remember **observing** the **pattern** of how high and low your waves were created with the water?
- What **caused** the waves to be higher or lower? (more or less energy used to make the wave)

13. Allow students free play for about 2 minutes to create high and low amplitude waves.

14. Allow students time to use the oscilloscope to make waves with the following:

- a. High/low amplitude
- b. More/less wavelengths
- c. High amplitude with few wavelengths (high volume with a low note)
- d. High amplitude with many wavelengths (high volume with a high note)
- e. Low amplitude with few wavelengths (low volume with a low note)
- f. Low amplitude with many wavelengths (low volume with a high note)

Closing the Lesson

1. There are 4 remaining challenge graphs on page 14 in the Science Journal. On each graph, have students create waves based on the following criteria:

- a. Draw a wavelength with high amplitude.
- b. Draw a wave with many wavelengths (high frequency).
- c. Draw a wave with many wavelengths and high amplitude.
- d. Draw a wave with few wavelengths and low amplitude.

Lesson 4 - Wave Challenge

1. Draw a wave with high amplitude. **Taller equal crests/troughs**. The number of wavelengths does not matter.
2. Draw a wave with many wavelengths. **There should be several peaks/troughs but the height does not matter.**
3. Draw a wave with many wavelengths and high amplitude. **The wave should show several wavelengths with higher peaks.**
4. Draw a wave with few wavelengths and low amplitude. **Only 1 or 2 waves and low crests/troughs**

5. What do all waves have in common?
All waves have a pattern of up and down or side to side motion.
Students may add that they all have wavelengths and amplitudes that can be measured.

14



SEP: Science and Engineering Practice(s):

Analyzing and Interpreting Data:

Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions.



CCC: Crosscutting Concept(s):

Patterns:

Similarities and differences in patterns can be used to sort and classify natural phenomena.



CCC: Crosscutting Concept(s):

Cause and Effect:

Events have causes that generate observable patterns.

Lesson 4 Wave Properties *cont.*



CCC: Crosscutting Concept(s):

Cause and Effect:

Events have causes that generate observable patterns.



CCC: Crosscutting Concept(s):

Patterns:

Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.

Discussion questions:

- What is the **effect** on the amplitude when you add more/less energy? (It will increase the amplitude with more energy or decrease the amplitude if there is less energy)
- What is the **effect** on the wavelength when you add/take away energy? (Longer or shorter, slower or faster)
- What **pattern** do you see with the amplitude (crests/troughs) when you add/take away energy? (Amplitude will increase or decrease but the crests and troughs will be equal either way)

2. Students should be able to describe **patterns** of waves in terms of amplitude and wavelength. Have students go back to page 6 (Lesson 1: "My Wave Model") and add new information that they have learned. This may be a good time to make a final sketch of their wave in the bottom box of the student page. You could wait until the end of Lesson 10 to see if they can add anything for sound and light.
3. There is a reading passage on page 15 in the Science Journal page on that summarizes wave properties. This is a good time for students to read and review properties. Add any new information to the KWL chart.

Assessment

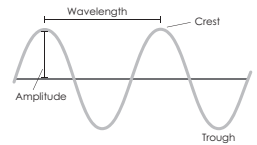
Have students complete the ticket out the door. The ticket out the door allows students to label a wave including the crest and trough. Students may have difficulty with those vocabulary words depending of if you have introduced the words during Lesson 4. If you have not, you can give students those answers. Students are also asked to draw a wave with a small amplitude and long wavelength and a wave with a large amplitude and short wavelength. Both drawings should be somewhat accurate with high versus low waves and short versus long waves depending on the wave they are drawing. It may be necessary to provide additional time with the spring coil and oscilloscope in order for students to see the connections.

Lesson 4 - Wave Properties

Waves have properties that help us identify information about the wave. If you are on the beach watching water waves you might notice if the waves are big or small. You can see how often they come in to shore or if there are many or few waves. You can see if they are moving fast or slow. Each of these observations is a basic property that can help describe a wave. The two properties of amplitude and wavelength help describe a wave.

The amplitude is the height of the wave. It is measured by how high the peaks (crests) are above the baseline of the wave. The amplitude is the same above the line (crest) as below the line (trough). For example the amplitude of a wave can tell us how high an ocean wave is or how loud a sound is. The higher the amplitude the higher the wave and the louder the sound.

The wavelength is how long the wave is. The wavelength is the distance from any point on a wave to an identical point on the next wave. For example from one crest to the next, or from where one wave starts on the baseline to where the next wave starts on the baseline. A wavelength can tell us how fast a water wave is coming in or how high a music note is (pitch). The higher (not louder) a sound is the more wavelengths there are.



15

Lesson 4 Wave Properties *cont.*

Connections

Differentiation:

The lesson can be controlled more by the teacher, by having students come up to the main computer to play different piano keys.

Cross-Discipline:

Earth Science: Students can measure the height of the waves, the wavelengths and if you like the frequency or number of wavelengths/sec. This can be done with the virtual oscilloscopes too.

Students can also research how waves are measured in other places; such as on a seismograph and what that means, a heartbeat, electromagnetic waves, etc.

Biology: Students can research how animals use wavelengths to help them survive. Bats, dolphins, and whales (amongst other animals) use echolocation to locate and determine the distance and type of their food. Currently there are many dangers to underwater animals and the use of sonar and boat motor vibrations that are disrupting the echolocation abilities of these animals to navigate. This is causing these animals to lose their ability to correctly migrate to their given locations.

Next Lesson Preparation

Lesson 5 deals with the motion of an object using the Slinkys. Make sure students have a large enough area to work with the Slinkys without getting them tangled. You can use the tape as the baseline if it is easier for students, but they are not required. You will need the Styrofoam balls but allow the students to explore where the ball needs to be located inside the slinky to remain still (~1/4 of the way).