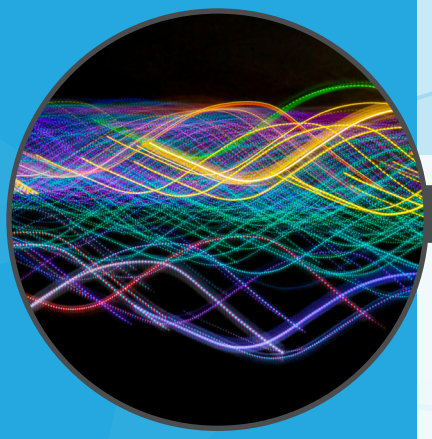


Introduction to Properties of Waves

Scope Planning and Overview

Student Wondering of Phenomenon

How are the properties of waves, such as wavelength and frequency, seen and heard?

Student Expectations

The student will–

- develop and use models to represent the basic properties of waves in a system including frequency, amplitude, wavelength, and speed.

Scope Overview

In this instructional unit, students engage deeply with the fundamental properties of waves—frequency, amplitude, wavelength, and speed—through hands-on activities and computer simulations. They generate physical waves using strings and spring toys, then use computational tools to model wave behaviors and predict their interactions. Applying mathematical concepts, students analyze data, create graphs, and validate their findings, enriching their understanding of how waves transfer energy and sound. This comprehensive exploration fosters critical thinking and a practical understanding of wave dynamics in various systems.

Scope Vocabulary

The terms below and their definitions can be found in Picture Vocabulary and are embedded in context throughout the scope.

Amplitude
The height of a wave from the origin to the crest

Crest
The highest part of a wave

Frequency
The number of wave cycles that pass a given point per unit of time

Speed
The rate of change of position (or distance traveled) with respect to time

Trough
The lowest part of a wave

Wave
A rhythmic disturbance that moves through a medium or vacuum

Wavelength
The distance between any two corresponding points on a wave, such as from crest to crest

Notes

Engage Activity Summaries

APK

Accessing Prior Knowledge:

In this activity, students assess their understanding of science vocabulary through a terminology inventory, where they indicate their familiarity with specific terms and describe them if known. This process helps identify student misconceptions about concepts like wave characteristics. The activity involves individual responses and is intended for diagnostic purposes, not grading. Teachers need to prepare by providing each student with the required handout.

SP

Scope Phenomenon

In this activity, students watch a video illustrating a spring toy's movements to explore wave properties like wavelength and frequency. They use the provided "Springy Waves" handout to guide their learning, responding to questions through doodles rather than written sentences. The activity, aimed at enhancing students' understanding of wave behavior, culminates in a class discussion that connects their observations to broader wave phenomena. Teachers need to print handouts and prepare for video projection and discussion.

Explore Activity Summaries

Explore 1

Activity - Observing Waves, Their Properties, and Relationships

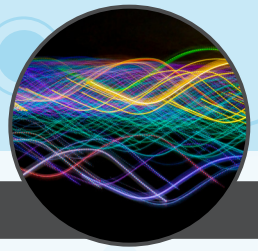
In this hands-on activity, students first generate physical waves using strings and markers, then transition to a computer simulation to delve into wave properties and their interrelationships. They apply mathematical and computational thinking to model these properties, make predictions, and test them through the simulation. The activity encourages students to explore patterns and predict wave behavior in various contexts. Materials needed include a heavy string, meterstick, marker, tape, and an internet-enabled device for each group.

Explore 2

Activity - Waves, Energy, and Sound

Students explore wave properties using spring toys and computer simulations to understand how waves transfer energy and sound. They engage in data analysis, presenting their findings through graphs and tables, and assessing the validity of their results. The activity prompts students to consider the conservation of energy and matter in practical and theoretical contexts. Required materials include coiled spring toys, stopwatches, metersticks, and internet-enabled devices. The activity is student-driven, promoting hands-on learning and critical thinking.

Notes



Introduction to Properties of Waves

Accessing Prior Knowledge

Activity Preparation

Students will complete a science terminology inventory by selecting a response based on their level of familiarity with various vocabulary terms. If students claim to be familiar with the term, they will be asked to provide a description to reveal the extent to which they connect conceptual understanding to terminology. This element is designed to uncover student misconceptions. It should not be taken for a grade.

Materials

Activity Files

- 1 Student Handout: Wave Characteristics – Science Terminology Inventory (per student)

Reusable

- None

Consumable

- None

Preparation

- If not assigning the Accessing Prior Knowledge digitally, print one Student Handout for each student.

Procedure and Facilitation

Activity

Part I: Science Terminology Inventory

1. Pass out a Student Handout to each student.
2. Have students answer individually.
3. Read through the pages. If students checked either of the first two boxes for any term, they need more instruction on that concept.

ACTIVITY TIP

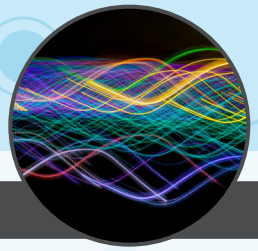
Have groups combine their inventories into one list using tally marks. Then combine all groups into one list. Use the information to inform instruction and address the needs of students.

Identifying Misconceptions

- Students may think that waves transport matter. Waves transport energy through matter.
- Students may think that waves must have a medium to travel through.

Notes

Notes



Introduction to Properties of Waves

Scope Phenomenon

Activity Preparation

Students will view a video showing a spring toy being pushed and pulled at different speeds to learn about how to model the basic properties of waves. Students should build on their knowledge and understanding of the phenomenon as they move through the different activities in this scope.

Materials

Printed Material

- 1 Student Handout: Springy Waves (per student)

Reusable

- None

Consumable

- None

Preparation

- If not assigning the activity digitally, print one Student Handout per student.
- Prepare to project the Student Handout.
- Brainstorm additional questions you may want to discuss beyond the Student Handout during the activity.

Procedure and Facilitation

Activity

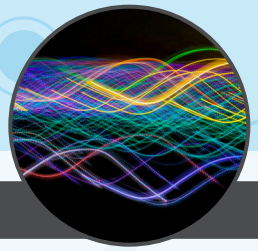
1. Pass out the Student Handouts.
2. Show students the video.
3. Ensure students have a blank piece of scrap paper and a writing utensil.
4. Ask the whole class the questions from the Student Handout.
5. Instruct students to doodle their answers. Encourage students to not write in sentences but instead to use images, pictographs, or funny phrases to answer.
6. When students finish their doodles, have them turn over their papers.
7. After everyone has had a chance to doodle, call on a student.
8. Introduce students to the Student Wondering of Phenomenon question below:
    a. How are the properties of waves, such as wavelength and frequency, seen and heard?
9. Let students know that, as they move through the scope, they will be doing a number of activities to help them answer the Student Wondering of Phenomenon question and to learn the information that is needed to describe the events in the Scope Phenomenon.
10. When the scope is completed, have students look back at the Scope Phenomenon. As you lead them in answering the question, encourage them to use the information that they learned throughout the scope.

ACTIVITY TIP

Extend the discussion by having partners create a list of sounds that loud and quiet on the back of their handout.

Notes

Notes



Introduction to Properties of Waves

Explore 1: Activity - Observing Waves, Their Properties, and Relationships

Activity Preparation

Timestamp: 1–2 hr.

Students will create waves during the first part of an activity and then use a computer simulation to observe wave properties and discover relationships between the properties.

Materials

Printed

- 1 Student Handout: Observing Waves, Their Properties, and Relationships (per student)

Reusable

- 1.5 m String, heavy (per group)
- 1 Meterstick (per group)
- 1 Marker (per group)
- 1 Internet-enabled device (per group)

Consumable

- 1 Piece of masking tape, 50 cm (per group)
- 1 Piece of masking tape, 15 cm (per group)

Preparation

- Print a Student Handout for each student.
- Place all of the materials in a central location for students to access as needed.
- Prior to the activity, test the weight of the string that students will use. It should be heavier than a kite string.
  - Nylon cording or a lightweight, beaded chain will work depending on availability. The string needs to move freely yet maintain its position when motion stops.
- The activity is designed to be student driven. Write the Materials list as follows on the board or chart paper for students to reference during the activity.
  - Part I
  - 1.5 m of string
  - One meterstick
  - One marker
  - A 50 cm piece of masking tape
  - A 15 cm piece of masking tape
  - Part II
  - One internet-enabled device
- Navigate to the "Wave on a String" PhET at phet.colorado.edu. Bookmark it to share with students.

Notes

Connections

SEP Connection

Using Mathematical and Computational Thinking

During this activity, students will use mathematics and computational thinking as tools to represent variables and their relationships in models, simulations, and data analysis in order to make and test predictions.

While students work through this activity, they should do the following:

- Use mathematics and computational thinking to represent variables and relationships
- Make predictions using models, simulations, and data analysis
- Test predictions using models, simulations, and data analysis

Once students have completed this activity, ask these questions:

- How were mathematics and computational thinking used in the activity?
- What variables or relationships were defined?
- What methods were used to make and test predictions?

CCC Connection

Patterns

During this activity, students will explore observations and explanations of patterns.

Ask students the following questions:

- Where do you see observations and explanations of patterns in this activity?
- Where have you seen observations and explanations of patterns before this activity?
- Where do you see observations and explanations of patterns outside the classroom?
- Where do you think you will see observations and explanations of patterns in other science lessons?

Procedure and Facilitation

1. This activity has been designed to be student driven.
2. Distribute a Student Handout to each student.
3. Have students work in pairs, in groups, or individually to complete this task.
4. Guide students in following the procedures and answering the questions on their Student Handouts.
5. After completing the activity, conduct a discussion about what was discovered. Important points include the following:
    a. There is no inherent relationship between a wave's amplitude and its wavelength or frequency. Adjusting the amplitude does not cause a change in a wave's wavelength or frequency.
    b. Assuming a constant speed, a wave's wavelength and frequency are inversely related.

CLASSROOM ENVIRONMENT TIP

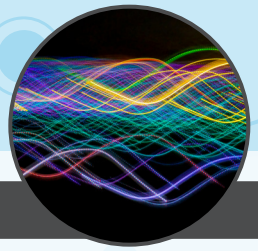
Consider setting up roles for each group that could be rotated for each trial such as recorder, technician, and manager.

Phenomenon Connection

Once students have completed this learning activity, revisit the Student Wondering of Phenomenon and use the following questions to guide a class discussion.

How are the properties of waves, such as wavelength and frequency, seen and heard?

- How does this activity connect to or answer the question above?
- How does this activity change your thinking about the phenomenon?
- Do you have any additional questions or observations about the connection between the phenomenon and the activity?



Introduction to Properties of Waves

Explore 2: Activity - Waves, Energy, and Sound

Activity Preparation

Timestamp: 1–2 hr.

Students will explore waves using spring toys and a computer simulation to discover relationships among various wave properties.

Materials

Printed

- 1 Student Handout: Waves, Energy, and Sound (per student)

Reusable

- 1 Coiled spring toy (per class)
- 1 Stopwatch (per group)
- 1 Meterstick (per group)
- 1 Internet-enabled device (per group)

Preparation

- Print a Student Handout for each student.
- The activity can be completed by student pairs or groups.
- Place all of the materials in a central location for students to access as needed.
- The activity is designed to be student driven. Write the Materials list as follows on the board or chart paper for students to reference during the activity:
  - Part I
  - One meterstick
  - One stopwatch
  - One coiled spring toy
  - Part II
  - One internet-enabled device

Connections

SEP Connection

Analyzing and Interpreting Data

During this activity, students will analyze and interpret data with appropriate data presentation (graph, table, statistics, etc.), identifying sources of error and the degree of certainty. Data analysis is used to derive meaning or evaluate solutions.

While students work through this activity, they should do the following:

- Analyze and interpret data
- Identify sources of error
- Present data in an appropriate manner, such as graphs or tables

Once students have completed this activity, ask these questions:

- What is the best way to present the data you have collected?
- How would you identify sources of error in your data?
- How certain are you in your data's validity? How do you know this?

CCC Connection

Energy and Matter

During this activity, students will explore energy and matter conservation.

Ask students the following questions:

- Where do you see energy and matter conservation in this activity?
- Where have you seen energy and matter conservation before this activity?
- Where do you see energy and matter conservation outside the classroom?
- Where do you think you will see energy and matter conservation in other science lessons?

Procedure and Facilitation

1. This activity has been designed to be student driven.
2. Distribute a Student Handout to each student.
3. Guide students in following the procedures and answering the questions on their Student Handouts.
4. After completing the activity, conduct a discussion about what was discovered. Important points include the following:
    a. The amount of energy that is transferred by waves in a given time is proportional to the frequency.
    b. The energy of a wave is proportional to the square of the amplitude.
    c. In a sound wave, frequency determines pitch.
    d. In a sound wave, amplitude determines volume.

ACTIVITY TIP

Consider playing sounds that have different pitches, then have students predict how frequency of waves are related to pitch to engage students.

DIFFERENTIATION TIP

Depending on your students, you can allow groups to complete Part 2 on their own. Another option is to stop after each question activity, have a discussion to clarify ideas, and then model the next simulation activity.

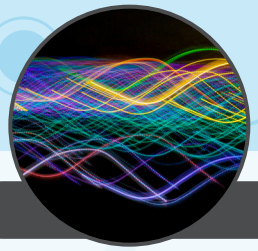
Phenomenon Connection

Once students have completed this learning activity, revisit the Student Wondering of Phenomenon and use the following questions to guide a class discussion.

How are the properties of waves, such as wavelength and frequency, seen and heard?

- How does this activity connect to or answer the question above?
- How does this activity change your thinking about the phenomenon?
- Do you have any additional questions or observations about the connection between the phenomenon and the activity?

Notes



Introduction to Properties of Waves

Scope Resources and Assessment Planner

Scope Resources

Explain

- ☐ **Picture Vocabulary**
  A slide presentation of important vocabulary terms along with a picture and definition.
- ☐ **STEMscopedia**
  Reference materials that includes parent connections, career connections, technology, and science news.
- ☐ **Linking Literacy**
  Strategies to help students comprehend difficult informational text.

Elaborate

- ☐ **Math Connections**
  A practice that uses grade-level appropriate math activities to address the concept.
- ☐ **Reading Science - Waves All Around**
  A reading passage about the concept, which includes five to eight comprehension questions.
- ☐ **Engineering Connections**
  A creative, kinesthetic extension into engineering and design that uses concepts addressed in the scope.

Evaluate

- ☐ **Claim-Evidence-Reasoning**
  An assessment in which students write a scientific explanation to show their understanding of the concept in a way that uses evidence.
- ☐ **Open-Ended Response Assessment**
  A short-answer and essay assessment to evaluate student mastery of the concept.
- ☐ **Multiple Choice Assessment**
  A standards-based assessment designed to gauge students' understanding of the science concept using their selections of the best possible answers from a list of choices

Intervention

- ☐ **Guided Practice**
  A guide that shows the teacher how to administer a small-group lesson to students who need intervention on the topic.

Acceleration

- ☐ **Extensions**
  A set of ideas and activities that can help further elaborate on the concept.

Notes

Assessment Planner

Use this template to decide how to assess your students for concept mastery. Depending on the format of the assessment, you can identify prompts and intended responses that would measure student mastery of the expectation. See the beginning of this scope to identify standards and grade-level expectations.

Student Learning Objectives	What Prompts Will Be Used?	What Does Student Mastery Look Like?
develop and use models to represent the basic properties of waves in a system including frequency, amplitude, wavelength, and speed.		