



Lesson Plan: The energy of waves

Grade Level: 8

Subject: Physical Science

Duration: 45–60 min

NGSS MS-PS4-1: Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.

Learning Objectives

By the end of this lesson, students will be able to:

- **Explain** how a wave transfers energy from one place to another without carrying the medium along with it.
- **Compare** transverse and longitudinal mechanical waves by how the particles of the medium



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along from particle to particle as the particles bump into each other and vibrate in place.

- **Transverse Wave:** A wave that moves the particles of the medium at 90 degree angles to the direction the wave is travelling, like the up-and-down ripples that run along a shaken rope.
- **Longitudinal Wave:** A wave that moves the particles of the medium back and forth along the same direction the wave is travelling. It produces compressions, where particles are pushed close together, and rarefactions, where particles are spread apart, as seen in the coils of a stretched spring toy.



- **Amplitude:** The greatest distance the particles of a medium move away from their resting position as a wave passes through. A wave with a larger amplitude carries more energy.
- **Wavelength:** The distance between two matching locations on a wave, for example from one crest to the next crest. It is a distance, so it is measured in units of length such as meters.
- **Frequency:** The number of complete waves that pass a given location in a certain amount of time. Frequency is measured in hertz (Hz), where 1 Hz means one whole wave passes each second.

Materials Needed: (all links are included in this PDF)

- Printed copies of the Energy of Waves Study Guide
(<https://newpathworksheets.com/api/guide/study-guide-science-grade-8-the-energy-of-waves-1.pdf>)



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Lesson Procedure

Step 1: Introduction (5 minutes)

- Open with the question: 'When you drop a stone into a pond, ripples spread all the way to the edge. Does the water itself travel across the pond, or does something else?'
- Tell students that a wave is a disturbance that transfers energy, and that today they will measure amplitude, wavelength, and frequency and use them to find how fast a wave moves.



- Ask students to name places they have seen or felt wave energy - a speaker cone buzzing, a rope snapping taut, news footage of a tsunami - and name the energy source in each case.

Step 2: Direct Instruction (15 minutes)

- Use the Study Guide's Wave Basics section to define a wave as a disturbance that transfers energy, and to explain that mechanical waves need a medium while the particles of that medium only vibrate in place. (<https://newpathworksheets.com/api/guide/study-guide-science-grade-8-the-energy-of-waves-1.pdf>)
- Stretch a coiled spring toy along a table: flick one end sideways to produce a transverse wave, then push and pull the end to produce a longitudinal wave, and have students point out where the coils bunch into compressions and spread into rarefactions.
- Project the labelled wave diagram on page 2 of the Study Guide and mark amplitude, wavelength, and frequency on it, noting that frequency is counted in hertz. (<https://newpathworksheets.com/api/guide/study-guide-science-grade-8-the-energy-of-waves-1.pdf>)



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- Assign Practice Worksheet 1, in which students read a tsunami speed graph, name the medium for waves on a jump rope, and read amplitude and wavelength off wave diagrams. (<https://newpathworksheets.com/api/worksheet/worksheet-science-grade-8-the-energy-of-waves-1-1.pdf>)
- Assign Practice Worksheet 2, which asks students to name the energy source and the medium for the sound of a violin string and a trumpet, and to solve for an unknown wavelength from a velocity of 20 m/s and a frequency of 2 Hz. (<https://newpathworksheets.com/api/worksheet/worksheet-science-grade-8-the-energy-of-waves-1-2.pdf>)



- Have each student sketch two waves that share the same wavelength but differ in amplitude, then label which of the two carries more energy and why.

Step 5: Assessment (10 minutes)

- Collect Practice Worksheet 2 and check that students solved correctly for the unknown wavelength and correctly named the medium carrying each sound wave.
(<https://newpathworksheets.com/api/worksheet/worksheet-science-grade-8-the-energy-of-waves-1-2.pdf>)
- Have students classify three everyday examples - a trumpet played in the classroom, a jump rope shaken by two students, and a tsunami crossing the open water - by naming the medium, the energy source, and whether the wave is transverse or longitudinal.
- Ask each student to answer the Study Guide's lesson checkpoint in one sentence: what is the relationship between a medium and a wave?
(<https://newpathworksheets.com/api/guide/study-guide-science-grade-8-the-energy-of-waves-1.pdf>)



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- Provide a worked example card showing $\text{speed} = \text{wavelength} \times \text{frequency}$ filled in for 20 m and 10 Hz, so students can substitute their own numbers into the same layout.

Extension Activities

- Fill a shallow tray with a thin layer of water and tap the surface at a steady rate, then faster, and record how the spacing between ripples changes as the tapping frequency rises.



- Send a pulse down the coiled spring toy from both ends at the same time to model interference, and observe when the combined pulse grows taller and when it shrinks.
- Stretch a rubber band over an open container and pluck it at different lengths, recording how the pitch changes and connecting the change to the frequency of the vibration.

Complete List of Available Resources:

- NewPathWorksheets: The energy of waves (<https://newpathworksheets.com/science/grade-8/the-energy-of-waves-1>)
- Study Guide PDF (<https://newpathworksheets.com/api/guide/study-guide-science-grade-8-the-energy-of-waves-1.pdf>)
- Worksheet PDF 0 (<https://newpathworksheets.com/api/worksheet/worksheet-science-grade-8-the-energy-of-waves-1-0.pdf>)
- Worksheet PDF 1 (<https://newpathworksheets.com/api/worksheet/worksheet-science->



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ENERGY OF WAVES

Wave Basics

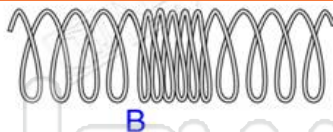
When a disturbance transfers energy from one place to another, this is referred to as a **wave**. Most waves, except for electromagnetic waves, require a substance or **medium** through which they can travel. This medium could be a solid, liquid or vapor like air. Waves requiring a medium are called **mechanical waves**. In these waves, energy is transferred from particle to particle, as the particles bump into each other and pass along the waves of energy. Basically, the source of energy is causing the particles in the medium to vibrate. Waves of energy travel through the particles of the medium, but they don't carry the medium with them.

LESSON CHECKPOINT: What is the relationship



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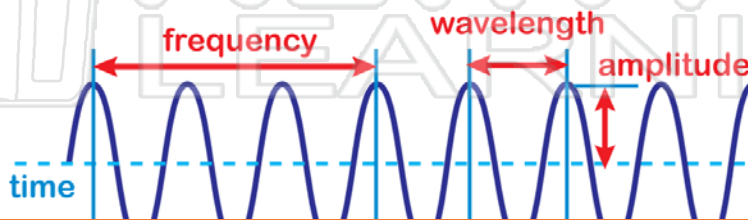
In the diagram above, energy creates areas of **compression** where particles of the medium are brought close together. Areas of the wave where the medium's particles are spread out are called **rarefactions**.

LESSON CHECKPOINT:

What are the two different types of mechanical waves?

The term **amplitude** is used to describe the maximum distance that the medium particles move away from their resting position when a wave is passing through. In a transverse wave, amplitude would describe how much up and down movement the particles exhibit and, in a longitudinal wave, it describes the amount of compression and rarefaction that occurs.

A **wavelength** is the distance between two corresponding locations on a wave.



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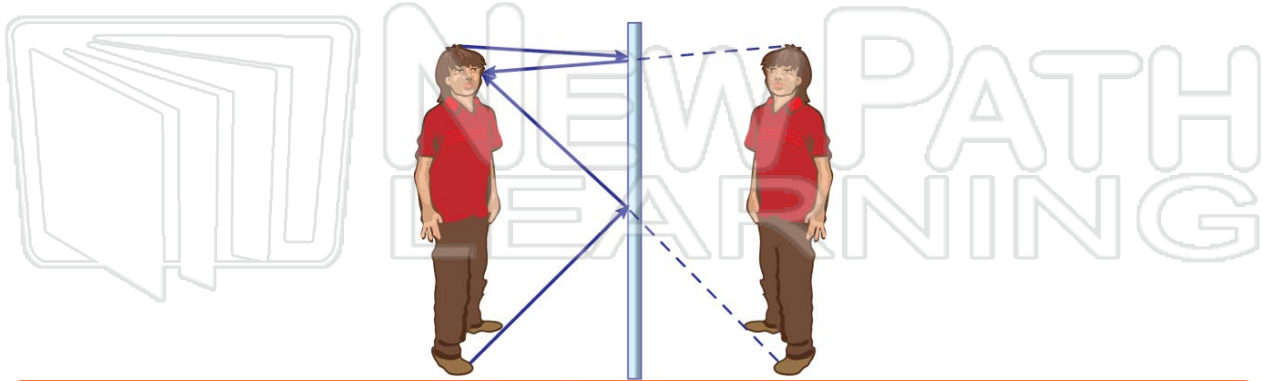
use the formula below:

$$\text{Speed} = \text{wavelength} \times \text{frequency}$$

Interactions of Waves

Waves interact in several different ways.

- One type of interaction is **reflection**. In this case, when a wave makes contact with an object that it can not pass through, it bounces off. Light reflecting off a mirror is a good example of this.



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corners.

- The final type of interaction is called **interference**. Sometimes waves combine in a constructive manner to make a wave of greater amplitude. Other times, waves can combine in a destructive manner to decrease the overall amplitude of the new wave. See the diagram below for an illustration of this.

LESSON CHECKPOINT: *What are the ways that waves interact with each other?*

Seismic Waves

Waves that are caused by earthquakes are called **seismic** waves. The movement and breaking of rock in the Earth's crust causes earthquakes. When an earthquake occurs, energy gets released through rock as both transverse and longitudinal waves. The transverse waves are called **S** waves and the longitudinal waves are referred to as **P** waves. Earthquakes under the ocean cause the ocean crust to shift and break, and large amounts of water can be displaced, creating large waves of water called tsunamis. These waves of water typically have very long wavelengths, often several hundred kilometers long. Tsunamis are powerful and can be very destructive when they reach shorelines.

LESSON CHECKPOINT:



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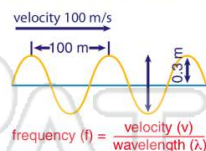
- 1 The **medium** through which a **tsunami** travels is _____.

A air
B light
C rock
D water



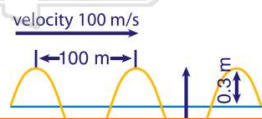
- 2 The diagram below represents a wave after a tsunami. Answer the question based on the information in the diagram. What is the **frequency**, in hertz (Hz), of this wave?

A 1 Hz
B 2 Hz
C 100 Hz
D 200 Hz



- 3 The **crest** of the wave is _____ above the resting position of the wave.

A 100 m
B 1 m
C 0.3 m
D 100.3 m



- 4 The **type of wave** that causes a tidal wave is a _____.

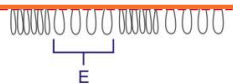
A fast wave
B magnetic wave
C seismic wave
D sound wave



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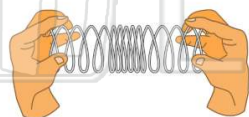
C rarefaction
D trough



D D B D

- 9 The diagram below shows a slinky being held and **stretched** by two students. What **type of wave** is shown by the slinky?

A compression
B longitudinal
C transverse
D seismic



- 10 The velocity of a wave is measured in meters per second. What is the **velocity** of a wave that has a frequency of **10 Hz** and a wavelength (λ) of **20 m**?

A 10 m/s
B 20 m/s
C 30 m/s
D 200 m/s

$$v = f\lambda$$



Name _____ Class _____ Date _____

- 1 The **medium** through which a **tsunami** travels is _____.

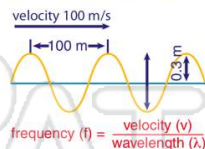
A air
B light
C rock
D water



(D)

- 2 The diagram below represents a wave after a tsunami. Answer the question based on the information in the diagram. What is the **frequency**, in hertz (Hz), of this wave?

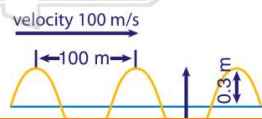
A 1 Hz
B 2 Hz
C 100 Hz
D 200 Hz



(A)

- 3 The **crest** of the wave is _____ above the resting position of the wave.

A 100 m
B 1 m
C 0.3 m
D 100.3 m



(C)

- 4 The **type of wave** that causes a tidal wave is a _____.

A fast wave
B magnetic wave
C seismic wave
D sound wave

(C)

5



(D)

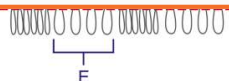
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(D)

C rarefaction
D trough

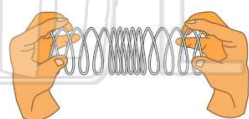


D D

B D

- 9 The diagram below shows a slinky being held and **stretched** by two students. What **type of wave** is shown by the slinky?

A compression
B longitudinal
C transverse
D seismic



(B)

- 10 The velocity of a wave is measured in meters per second. What is the **velocity** of a wave that has a frequency of **10 Hz** and a wavelength (λ) of **20 m**?

A 10 m/s
B 20 m/s
C 30 m/s
D 200 m/s

$$v = f\lambda$$

(D)



Name _____ Class _____ Date _____

1

The graph below plots the **speed** of a tsunami and the distance it traveled. **One hour** after the tsunami started, the wave had traveled about _____.

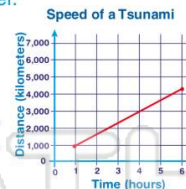
- A 1,000 km
- B 2,000 km
- C 3,000 km
- D 4,000 km



2

A seismologist knows the following information: hour 1 was at 5:00 a.m. in India, and India is 3,000 km from the epicenter. At approximately **what time** might India be struck by the oncoming tsunami?

- A 4:00 a.m. C 8:00 a.m.
- B 5:00 a.m. D 1:00 p.m.



3

Based on the graph below, the **speed** at which the tsunami traveled _____.

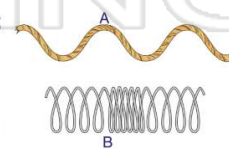
- A kept increasing
- B continued to decrease
- C stayed the same
- D speeded up and



4

In this diagram, **A** represents a _____.

- A longitudinal wave; B represents a transverse wave
- B transverse wave; B represents a longitudinal wave
- C refraction wave;



5



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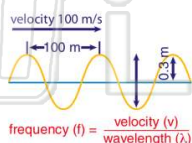
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9

The amplitude of this wave is 0.6 m. The **amplitude** of a wave is the distance _____.

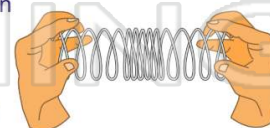
- A from the crest of one wave to the crest of the next wave
- B from the trough of one wave to the trough of the next wave
- C between wavelengths
- D from the crest to the trough within a wave



10

In the picture below, determine which **direction** the wave is moving.

- A up and down
- B to the left
- C to the right
- D cannot be determined





Name _____ Class _____ Date _____

1

The graph below plots the **speed** of a tsunami and the distance it traveled. **One hour** after the tsunami started, the wave had traveled about _____.

- A 1,000 km
- B 2,000 km
- C 3,000 km
- D 4,000 km

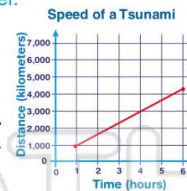


A

2

A seismologist knows the following information: hour 1 was at 5:00 a.m. in India, and India is 3,000 km from the epicenter. At approximately **what time** might India be struck by the oncoming tsunami?

- A 4:00 a.m. C 8:00 a.m.
- B 5:00 a.m. D 1:00 p.m.



C

3

Based on the graph below, the **speed** at which the tsunami traveled _____.

- A kept increasing
- B continued to decrease
- C stayed the same
- D speeded up and

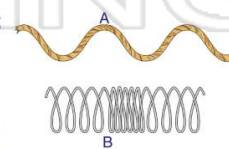


C

4

In this diagram, **A** represents a _____.

- A longitudinal wave;
- B represents a transverse wave
- B transverse wave;
- B represents a longitudinal wave
- C refraction wave;



B

5



B

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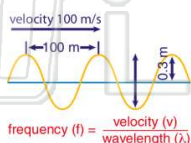
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C

9

The amplitude of this wave is 0.6 m. The **amplitude** of a wave is the distance _____.

- A from the crest of one wave to the crest of the next wave
- B from the trough of one wave to the trough of the next wave
- C between wavelengths
- D from the crest to the trough within a wave

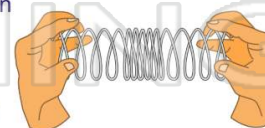


D

10

In the picture below, determine which **direction** the wave is moving.

- A up and down
- B to the left
- C to the right
- D cannot be determined



D



Name _____ Class _____ Date _____

1

In the picture below, the type of **energy** used to **make** the wave is _____.

- A seismic
- B chemical
- C physical
- D mechanical



2

What is the relationship of a **tsunami** to an **earthquake**?

- A they occur exactly at the same time
- B the earthquake occurs before the tsunami
- C the tsunami occurs before the earthquake
- D earthquakes and tsunamis are not related

3

The **sound** of a violin is caused by _____.

- A vibrations of the hand
- B vibrations of the violin handle
- C vibrations of the



4

When a student plays a trumpet, sound waves are made. The **medium** for these waves is _____.

- A air
- B the trumpet
- C the student playing it



5



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9

Long bridges have been known to collapse when there is too much **traffic** on them. What is one **possible cause** of these collapses?

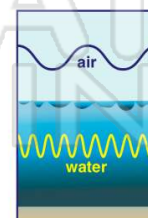
- A the traffic is giving off air pollutants
- B the traffic is causing air to move around
- C the traffic is causing vibrations in the bridge
- D the traffic was going too slow

10

All materials conduct vibrations at the **same rate**.

True or false?

- A true
- B false

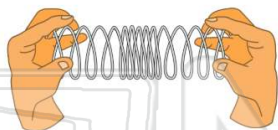




Name _____ Class _____ Date _____

- 1 In the picture below, the type of **energy** used to **make** the wave is _____.

A seismic
B chemical
C physical
D mechanical



D

- 2 What is the relationship of a **tsunami** to an **earthquake**?

A they occur exactly at the same time
B the earthquake occurs before the tsunami
C the tsunami occurs before the earthquake
D earthquakes and tsunamis are not related

B

- 3 The **sound** of a violin is caused by _____.

A vibrations of the hand
B vibrations of the violin handle
C vibrations of the



C

- 4 When a student plays a trumpet, sound waves are made. The **medium** for these waves is _____.

A air
B the trumpet
C the student playing it



A

5



C

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7

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A

9

Long bridges have been known to collapse when there is too much **traffic** on them. What is one **possible cause** of these collapses?

A the traffic is giving off air pollutants
B the traffic is causing air to move around
C the traffic is causing vibrations in the bridge
D the traffic was going too slow

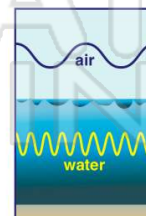
C

10

All materials conduct vibrations at the **same rate**. True or false?

A true
B false

B





Name _____ Class _____ Date _____

Match each of the following terms to its definition:

Reflection

Compression

Interference

Seismic wave

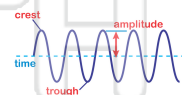
Refraction

Frequency

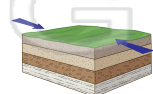
Amplitude

Medium

1. - the distance the particles of a medium move from their resting positions as a wave passes through



2. - stress created when two tectonic plates are pushing against each other causing rock to fold or break



3. time

4. either waves

5.

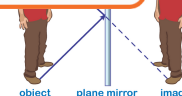
6.



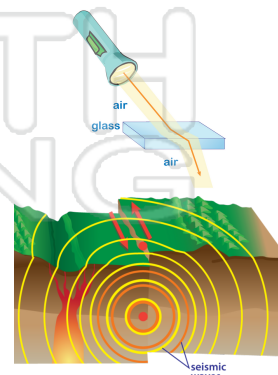
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7. - the bending of a wave as it moves at an angle through two different mediums; when light bends moving from one medium to another



8. - a wave that travels through the Earth, most often as the result of an earthquake; energy waves released by an earthquake that travel through the Earth





Name _____ Class _____ Date _____

Match each of the following terms to its definition:

Reflection

Compression

Interference

Seismic wave

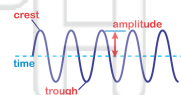
Refraction

Frequency

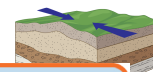
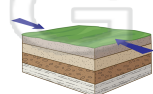
Amplitude

Medium

1. amplitude - the distance the particles of a medium move from their resting positions as a wave passes through



2. compression - stress created when two tectonic plates are pushing against each other causing rock to fold or break



3. frequency



4. into the core

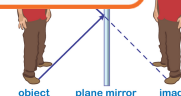
5. medium

6. reflection

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7. refraction - the bending of a wave as it moves at an angle through two different mediums; when light bends moving from one medium to another



8. seismic wave - a wave that travels through the Earth, most often as the result of an earthquake; energy waves released by an earthquake that travel through the Earth

