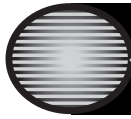


# Assessment



## Chapter Review

# Waves

### Part A. Vocabulary Review

**Directions:** Choose the correct term from the list below and write it in the space beside each definition.

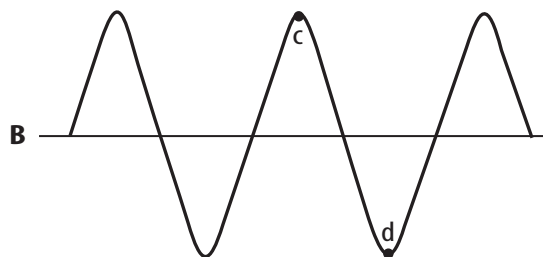
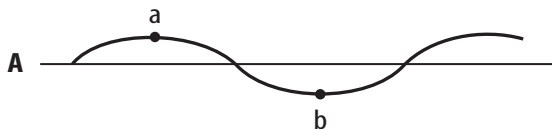
amplitude	compression	diffraction	compressional wave
crest	frequency	interference	
law of reflection	medium	rarefaction	reflection
refraction	resonance	standing wave	
transverse wave	trough	wavelength	waves

- \_\_\_\_\_ 1. when a wave strikes an object and bounces off
- \_\_\_\_\_ 2. repeating disturbances that transfer energy through matter or space
- \_\_\_\_\_ 3. highest point of a transverse wave
- \_\_\_\_\_ 4. region where the medium is crowded and dense in a compressional wave
- \_\_\_\_\_ 5. wave that makes matter in the medium move back and forth at right angles to the direction the wave travels
- \_\_\_\_\_ 6. ability of two or more waves to combine and form a new wave
- \_\_\_\_\_ 7. lowest point of a transverse wave
- \_\_\_\_\_ 8. material through which a wave transfers energy
- \_\_\_\_\_ 9. the bending of waves around a barrier
- \_\_\_\_\_ 10. less dense region of a compressional wave
- \_\_\_\_\_ 11. ability of an object to vibrate by absorbing energy at its natural frequency
- \_\_\_\_\_ 12. wave in which matter in the medium moves back and forth in the same direction the wave travels
- \_\_\_\_\_ 13. distance between one point in a wave and the nearest point just like it
- \_\_\_\_\_ 14. measure of how many wavelengths pass a fixed point each second
- \_\_\_\_\_ 15. the angle of incidence is equal to the angle of reflection
- \_\_\_\_\_ 16. measure of the energy in a wave
- \_\_\_\_\_ 17. a special type of wave pattern that forms when waves of equal wavelength and amplitude traveling in opposite directions continuously interfere with each other
- \_\_\_\_\_ 18. the bending of a wave caused by a change in its speed as it moves from one medium to another

## Chapter Review (continued)

### Part B. Concept Review

**Directions:** Use the diagram below to answer questions 1–5.



1. What type of wave is wave A? \_\_\_\_\_
2. Which wave carries more energy? \_\_\_\_\_
3. What do points **a** and **c** represent? \_\_\_\_\_
4. What do points **b** and **d** represent? \_\_\_\_\_
5. How does the frequency of wave B compare with that of wave A?  
\_\_\_\_\_

**Directions:** Using the equation  $v = \lambda \times f$ , find the missing values.

6. What is the velocity of a wave with a frequency of 760 Hz and a wavelength of 0.45 m?  
\_\_\_\_\_
7. A wave with a wavelength of 15 m travels at 330 m/s. Calculate its frequency.  
\_\_\_\_\_

**Directions:** Answer the following questions on the lines provided.

8. How do scientists know that seismic waves can be either compressional or transverse?  
\_\_\_\_\_  
\_\_\_\_\_
9. Why do surfers like water waves with high amplitudes?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
10. Will loud sounds from traffic near a school break glass objects inside the school? Explain.  
\_\_\_\_\_  
\_\_\_\_\_



## Chapter Test

# Waves

## I. Testing Concepts

**Directions:** Fill in the blanks using the terms listed below. Some terms may not be used.

wave	rarefaction	reflection	medium	compression
refraction	transverse wave	amplitude	diffraction	compressional wave
wavelength	interference	seismic wave	frequency	standing wave
crest	wave speed	node	trough	resonance

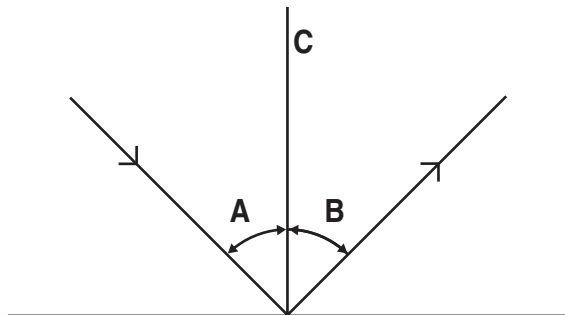
1. In a transverse wave, the \_\_\_\_\_ is the lowest point.
2. Adding energy at the natural frequency of an object is called \_\_\_\_\_.
3. The number of ocean waves that pass a buoy in one second is the \_\_\_\_\_ of the wave.
4. The \_\_\_\_\_ of a transverse wave is its highest point.
5. To find the \_\_\_\_\_ of a wave, measure the distance from one trough to the next trough.
6. When the string of a violin is played with a bow, the violin vibrates in \_\_\_\_\_.
7. Water waves bending around a dock is an example of \_\_\_\_\_.
8. The \_\_\_\_\_ of a wave is a measure of the energy it carries.
9. In a compressional wave in a coiled spring, a \_\_\_\_\_ is where the coils are spread out.
10. A \_\_\_\_\_ is a repeating disturbance that transfers energy through matter or space.
11. Waves bending because of a change in speed is called \_\_\_\_\_.
12. The medium vibrates perpendicular to the direction the wave travels in a \_\_\_\_\_.
13. When you squeeze the coils of a spring together, you cause a \_\_\_\_\_.
14. The \_\_\_\_\_ is the material through which a mechanical wave travels.
15. \_\_\_\_\_ occurs when two waves combine to form a new wave.
16. The type of wave made by squeezing the coils of a spring and letting them go is a \_\_\_\_\_.

## Chapter Test (continued)

### II. Understanding Concepts

#### Skill: Interpreting a Scientific Diagram

**Directions:** Use the diagram to answer questions 1 and 2.



1. In the diagram, identify each part by filling in the blanks below.

- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_

2. What is the relationship between A and B in the diagram?

\_\_\_\_\_

#### Skill: Measuring Data

**Directions:** Match the units in one column to the quantities they measure in the other column by writing the correct letter in the space provided.

- |                     |                  |
|---------------------|------------------|
| _____ 3. wavelength | a. meter         |
| _____ 4. frequency  | b. meters/second |
| _____ 5. wave speed | c. hertz         |

**Directions:** Circle the word in parentheses that makes each statement correct.

- If an obstacle is much larger than the wavelength of a wave, almost no (refraction, reflection, diffraction) occurs.
- When you shake a rope up and down, you create a (transverse, compressional, seismic) wave.
- When part of Earth's crust breaks, (seismic, tidal, uniform) waves pass through Earth.
- In a given medium, as the frequency of a wave increases, its speed (increases, decreases, remains the same).
- In a standing wave, the point at which the medium doesn't move is called the (antinode, node, compression).

**Chapter Test (continued)****III. Applying Concepts****Directions:** Answer the following questions on the lines provided.

1. How do particles move differently in transverse waves and in surface water waves?

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---

2. A student holds a metal bar and strikes it with a hammer (a) in a direction parallel to its length, and (b) in a direction at right angles to its length. What kinds of waves are produced in each case?

a. \_\_\_\_\_

b. \_\_\_\_\_

3. Why don't all loud sounds cause glass objects to break?

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4. A light wave passes at an angle through a chunk of glass into the air. What happens to it in respect to the normal? Why?

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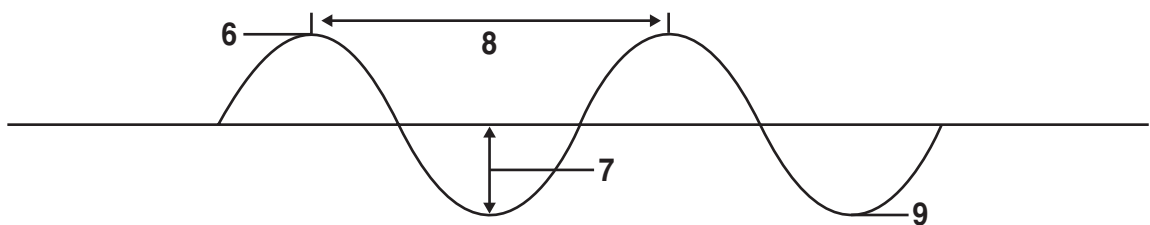
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5. In a standing wave, what kind of interference is producing the crests and the nodes?

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**Directions:** For questions 6 through 9 identify the parts of a transverse wave indicated.

6. \_\_\_\_\_ 7. \_\_\_\_\_ 8. \_\_\_\_\_ 9. \_\_\_\_\_

10. A sound wave with a frequency of 260 Hz has a wavelength of 130 m. What is the speed of the wave?

---

**Chapter Test (continued)****IV. Writing Skills**

**Directions:** Answer the following questions using complete sentences.

1. The Moon does not produce light by itself. How do we get moon light?

---

---

2. In a given medium, how are wavelength and frequency of a wave related? Using this relationship, state which would be more diffracted, waves with high frequency or waves with low frequency.

---

---

3. How do you know that light is a kind of wave that can travel without a medium?

---

---

4. You are creating a wave on a rope by shaking the rope back and forth. If you shake your hand the same distance but faster, what happens to the amplitude, frequency, wavelength, and speed?

---

---

5. When refraction takes place because a wave is passing from one medium to another medium with a different density, at what part of the media does the refraction take place?

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---

6. When two waves interfere, is there a loss of energy in the system? Explain.

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7. Explain why you can see your reflection in an unbroken mirror but cannot see your reflection in a broken mirror.

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8. How can sound waves with different frequencies be produced by the same guitar string?

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# Transparency Activities



**SECTION****1****Section Focus****Transparency Activity****Wave to the Camera**

How many waves can you pick out in this scene? Is light described as a wave? If you were there when this photograph was taken, you might also mention the sound waves.



1. Describe the different waves in this picture.
2. If you are swimming underwater, can you still hear the noises around you? What does this tell you about sound waves?
3. What does light travel through as it goes from the Sun to the eyes of an underwater swimmer?

**SECTION**  
**2****Section Focus**  
**Transparency Activity****Big Fiddle, Little Fiddle**

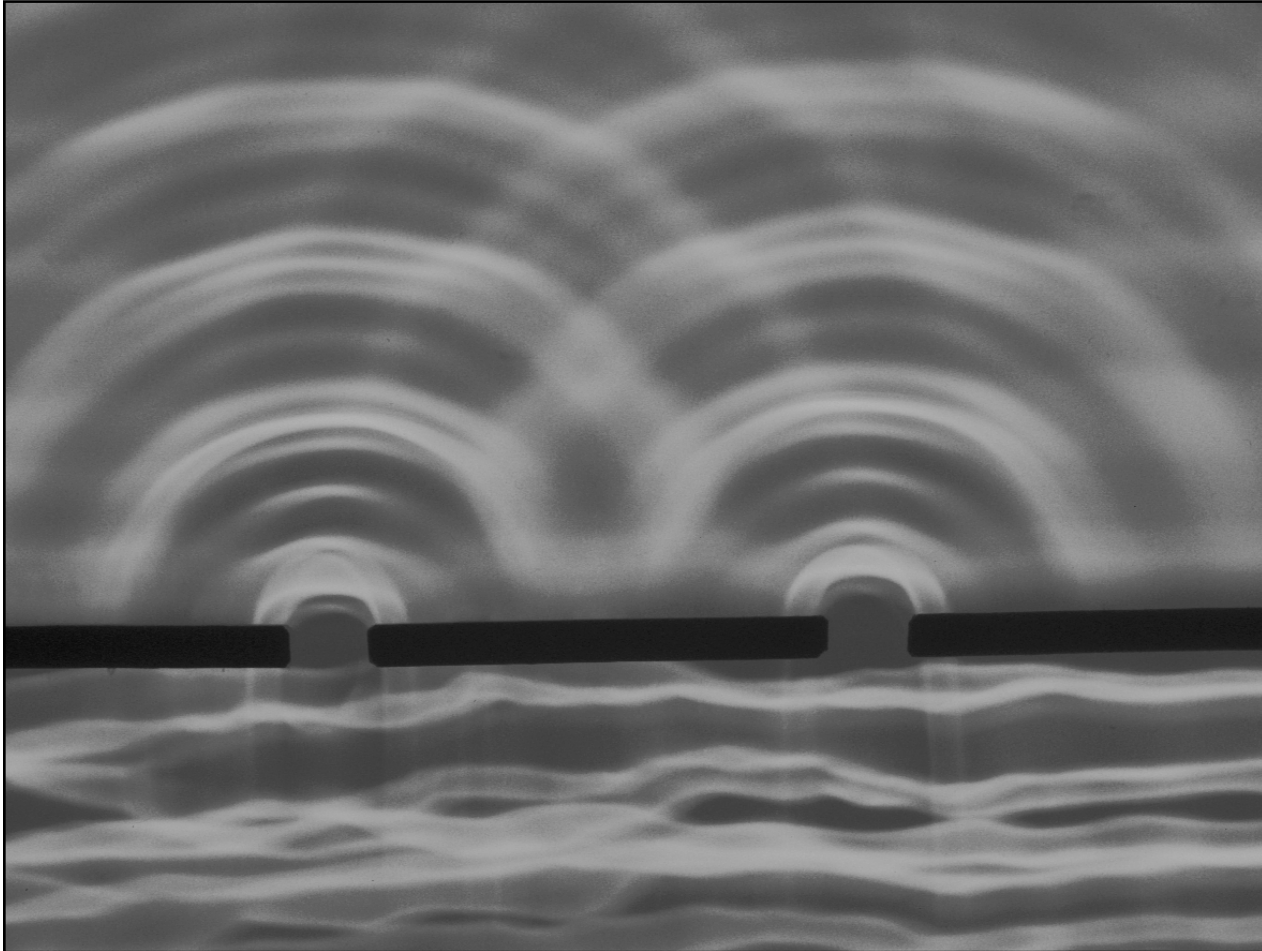
Have you ever heard the instruments below played? If you have, you probably noticed that the bass produces a much lower sound than the violin. The difference in the sounds is related to differences in the waves each instrument produces.



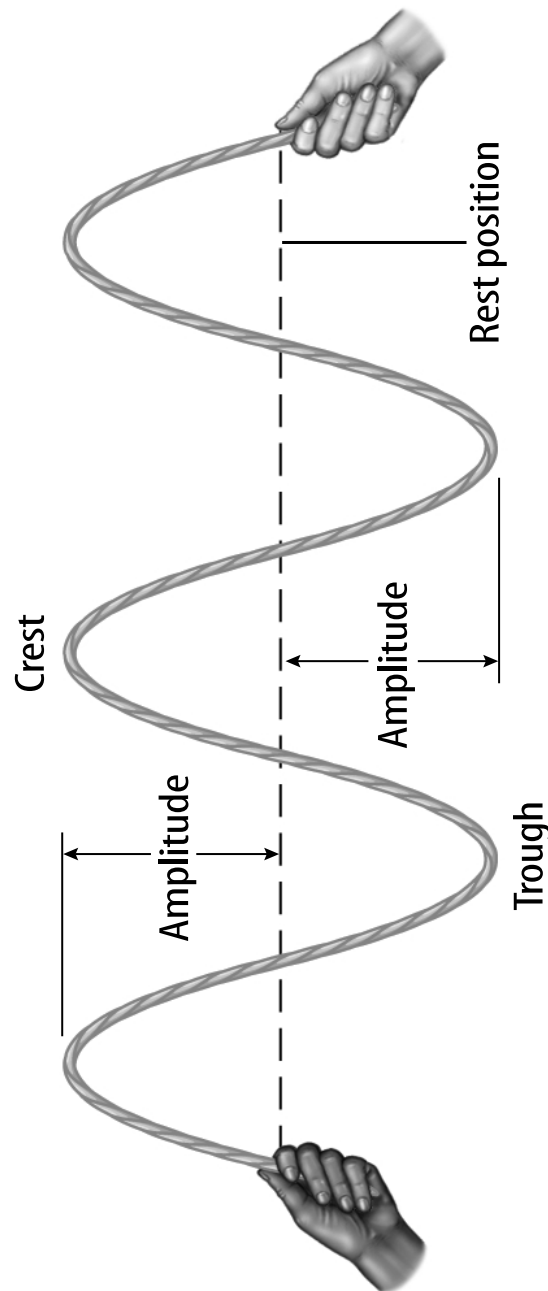
1. Name some musical instruments. How are the instruments you named played?
2. A cello is bigger than a violin but smaller than a bass. How do you think the sound made by a cello compares to the sounds made by violins and basses?

**SECTION**  
**3****Section Focus**  
**Transparency Activity****Wave Art**

This artistic picture shows how waves can make fascinating patterns in water. When waves travelling toward the wall reach the openings, they pass through them. After passing through the openings, the waves create new patterns as they overlap on the other side of the wall.



1. What do the waves look like before they reach the wall? What do they look like after passing through the opening?
2. Where do the waves in the photograph overlap?
3. What do you think this picture would look like if both holes were plugged?

**SECTION****2****Teaching Transparency  
Activity****Amplitude of Waves**



**Teaching Transparency Activity** (continued)

1. What is the highest point of a wave called?

---

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2. What is the lowest point of a wave called?

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3. How is the amplitude of a wave measured?

---

---

4. How is wavelength measured?

---

---

5. What is frequency?

---

---

6. What does the amplitude of a wave measure?

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# Waves

**Directions:** Carefully review the table and answer the following questions.

Electromagnetic Waves in Your Life		
Type of wave	Shortest wavelength (cm)	Longest wavelength (cm)
Radio waves	0.1	10,000,000
Microwaves	0.1	100
Red light	0.000063	0.000076
Green light	0.000049	0.000056
Blue light	0.000045	0.000049
X rays	0.000000001	0.000001

- Electromagnetic waves of different wavelengths have been given different names. According to the table, which type of electromagnetic wave can have a wavelength greater than 5 m?
 

**A** Radio waves

**B** Microwaves

**C** Red light

**D** Blue light
- According to the table, which type of electromagnetic wave can have a wavelength of 0.000046 cm?
 

**F** Radio waves

**G** Microwaves

**H** Red light

**J** Blue light
- If a device were emitting an electromagnetic wave of 0.00000001 cm, what kind of device would it be?
 

**A** Radio

**B** Microwave oven

**C** Flashlight

**D** X-ray machine



# Teacher Support and Planning

## Teacher Support and Planning

Content Outline for Teaching .....	T2
Spanish Resources .....	T5
Teacher Guide and Answers.....	T9





## Section 1 The Nature of Waves

Underlined words and phrases are to be filled in by students on the Note-taking Worksheet.

**A. Wave**—a repeating disturbance or movement that transfers energy through matter or space

1. Molecules pass energy on to neighboring molecules.
2. Waves carry energy without transporting matter.
3. All waves are produced by something that vibrates.

**4. Medium**—a material through which a wave travels.

- a. May be solid, liquid, or gas
- b. Not all waves need a medium to travel through. Example: Light waves

**B. Mechanical waves**—waves that can travel only through matter

1. **Transverse waves**—matter in the medium moves back and forth at right angles to the direction that the wave travels. Example: Water waves
2. **Compressional waves**—matter in the medium moves in the same direction that the wave travels. Example: Sound waves
3. **Combinations**—not purely transverse or compressional; examples: water waves, seismic waves

### DISCUSSION QUESTION:

How are sounds made? *When somebody vibrates their vocal chords or slams a door, air particles are pushed together. This starts a sequence of compressions in the air that make a wave. The air particles pass the energy on to neighboring air particles. When the wave reaches your ear, it causes your eardrum to vibrate. Your inner ear sends signals to your brain, which your brain interprets as sounds.*

## Section 2 Wave Properties

**A. Ways waves differ**

1. How much energy they carry
2. How fast they travel
3. How they look
  - a. Transverse waves have **crests**—the highest points, and **troughs**—the lowest points.
  - b. Compressional waves have dense regions called compressions and less dense regions called rarefactions.

## Content Outline for Teaching (continued)

**B. Wavelength**—the distance between one point in the wave and the nearest point just like it

**C. Frequency**—how many wavelengths pass a fixed point each second

1. Expressed in hertz (Hz)
2. As frequency increases, wavelength decreases.
3. The frequency of a wave equals the rate of vibration of the source that creates it.

**D. Wave velocity**, or  $v$ , describes how fast the wave moves forward.

1. velocity = wavelength  $\times$  frequency, or  $v = \lambda \times f$ .
2. Light waves travel faster than sound waves.
3. Sound waves travel faster in liquids and solids than in gas.
4. Light waves travel faster in gases and empty space than in liquids and solids.

**E. Amplitude**—a measure of the energy in a wave

1. The more energy a wave carries, the greater its amplitude.
2. Amplitude of compressional waves is related to how tightly the medium is pushed together at the compression
  - a. The denser the compressions, the larger the amplitude is and the more energy the wave carries
  - b. The less dense the rarefactions, the larger the amplitude and the more energy the wave carries
3. Amplitude of transverse waves
  - a. The distance from the crest or trough of a wave to the normal position of the medium
  - b. Example: how high an ocean wave appears above the water level

### DISCUSSION QUESTION:

In a thunderstorm, why do you see the lightning before you hear the thunder? *Light waves travel much faster than sound waves.*

## Section 3 The Behavior of Waves

**A. Reflection** occurs when a wave strikes an object and bounces off of it.

1. All types of waves can be reflected.
2. The angle of incidence of a wave is always equal to the angle of reflection.
  - a. Normal—an imaginary line perpendicular to a reflective surface
  - b. Angle of incidence—the angle formed by the wave striking the surface and the normal

## Content Outline for Teaching (continued)

c. Angle of reflection—the angle formed by the reflected wave and the normal

**B. Refraction**—the bending of a wave caused by a change in its speed as it moves from one medium to another

1. The greater the change in speed is, the more the wave bends.
2. When a wave passes into a material that slows it down, the wave is bent toward the normal.
3. When a wave passes into a material that speeds it up, the wave is bent away from the normal.

**C. Diffraction**—an object causes a wave to change direction and bend around it

1. If the obstacle is smaller than the wavelength, the wave diffracts a lot.
2. If the obstacle is much larger than the wavelength, the wave does not diffract much.
3. The larger the obstacle is compared to the wavelength, the less the waves will diffract.

**D. Interference**—the ability of two or more waves to combine and form a new wave

1. Waves pass right through each other and continue in their original direction.
2. New wave exists only while the two original waves continue to overlap.
3. Constructive interference—waves add together
4. Destructive interference—waves subtract from each other

**E. Standing waves**—a wave pattern that stays in one place

1. Form when waves of equal wavelength and amplitude that are traveling in opposite directions continuously interfere with each other.
2. Nodes—the places where two waves always cancel each other

**F. Resonance**—the ability of an object to vibrate by absorbing energy at its natural frequency

### DISCUSSION QUESTION:

How do you think wave behaviors apply to music? *Constructive interference causes sound waves to become louder; destructive interference causes sound waves to become more quiet. Standing waves create rich, even, constant tones in music.*

## SECCIÓN 1 La naturaleza de las ondas

### Lo que aprenderás

- A reconocer que las ondas transportan energía, pero no transportan materia.
- A definir ondas mecánicas.
- A distinguir entre ondas transversales y ondas de compresión.

### Vocabulario

**wave / onda:** perturbación rítmica que transfiere energía a través de la materia o del espacio; existe solamente mientras posea energía para transportar.

**medium / medio:** cualquier material, ya sea sólido, líquido, gas o una combinación de estos tres, a través del cual una onda transfiere energía.

**transverse wave / onda transversal:** tipo de onda, como la ola, en que la materia del medio se mueve de un lado a otro formando ángulos rectos a la dirección en que viaja la onda; posee crestas y senos.

**compressional wave / onda de compresión:** tipo de onda donde la materia del medio poseen un movimiento de vaivén en la misma dirección en que viaja la onda; tiene compresiones y rarefacciones.

### Por qué es importante

Oyes y ves en el mundo a tu alrededor debido a la energía que transportan las ondas.

## SECCIÓN 2 Propiedades de onda

### Lo que aprenderás

- A comparar y a contrastar las ondas transversales y las de compresión.
- A describir la relación entre frecuencia y longitud de onda.
- A explicar cómo la amplitud de una onda está relacionada con la energía de la onda.
- A calcular la rapidez de una onda.

### Vocabulario

**crest / cresta:** el punto más alto de una onda transversal.

**trough / seno:** el punto más bajo de una onda transversal.

**rarefaction / rarefacción:** la región menos densa de una onda de compresión.

**wavelength / longitud de onda:** distancia entre un punto en una onda y el punto más cercano semejante en la onda siguiente; a medida que aumenta la frecuencia, la longitud de onda siempre disminuye.

**frequency / frecuencia:** mide el número de longitudes de onda que pasan por un punto fijo cada segundo y se expresa en hertz (Hz).

**amplitude / amplitud:** medida de la energía que transporta una onda.

### Por qué es importante

El cambiarle las propiedades a las ondas permite usarlas de muchas maneras.



## Construye ondas en diferentes medios

¿Alguna vez has nadado bajo el agua? Si es así, probablemente aún con la cabeza bajo el agua pudiste escuchar algunos sonidos. Las ondas sonoras pueden viajar a través de más de un medio, inclusive aire y agua. Los ruidos probablemente sonaron diferente dentro del agua, a como suenan en el aire. ¿Cómo difieren las ondas cuando pasan a través de diferentes medios?

### Lo que investigarás

¿Cómo afecta la velocidad de las ondas el tipo de material a través del cual éstas viajan?

## Spanish Resources (continued)

### Posibles materiales

juguete pequeño de resorte hecho de metal y plástico  
 cuerda, pesada y liviana  
 cordón  
 cadena  
 liga larga, como las que se usan para hacer ejercicio.  
 tira de tela pesada, como alfombra  
 tira de tela liviana como media pantalón de nilón  
 listón  
 cronómetro

### Metas

- Demostrar ondas transversales
- Comparar la velocidad de las ondas a través de diferentes medios.

Medidas de seguridad  

### Procedimiento

1. Usa trozos de cada material que sean más o menos de la misma longitud. Coloca un alumno por cada material, sosteniendo cada uno de los extremos de cada material. Uno de los alumnos debe sostener su extremo sin moverlo, mientras el otro alumno mueve el material de allá para acá, entre dos puntos determinados para hacer una onda. Los puntos pueden identificarse con marcas en el suelo o sillas instaladas en los puntos. El alumno que sacude los materiales debe tratar de sacudirlos en la misma dirección.
2. Haz que otro alumno tome el tiempo de cuánto demora el impulso en llegar al extremo opuesto del material. Si la onda viaja muy rápidamente, intenta reducir la tensión para ayudar a que se reduzca la velocidad de la onda. Debes hacer todo lo posible para mantener la misma tensión para cada material.
3. Ata dos de los materiales a dos tipos diferentes de cuerda o ata una pieza pesada de cuerda con una liviana. Observa cómo cambia la onda cuando se mueve de un material a otro. Puede ser más fácil tener dos alum-

nos midiendo esto, un cronometrador para cada material.

4. Si tienes enrollados resortes de juguete, también puedes observar ondas de compresión. Puedes conectar dos tipos diferentes de resortes de juguete para ver cómo cambia la onda de compresión en diferentes medios.

### Concluye y aplica

1. ¿Tienen las ondas la misma amplitud a través de diferentes medios? Explica tu respuesta
2. ¿Viajan las ondas a la misma velocidad a través de diferentes medios? Explica.
3. Explica cómo cambian las ondas al pasar de un material a otro.
4. Las ondas cargan energía. ¿De dónde obtienen su energía, las ondas que se crearon en esta actividad?



## El comportamiento de las ondas

### Lo que aprenderás

- A identificar la ley de la reflexión.
- A reconocer qué causa el doblamiento de las ondas.
- A explicar cómo se combinan las ondas.

### Vocabulario

**refraction / refracción:** flexión de una onda a medida que cambia de rapidez, al moverse de un medio a otro.

**diffraction / difracción:** describe la flexión de las ondas alrededor de un obstáculo; también puede ocurrir cuando las ondas atraviesan una abertura estrecha.

**interference / interferencia:** ocurre cuando dos o más ondas se traslapan y se combinan para formar una nueva onda; puede formar una onda más grande (interferencia constructiva) o una onda más pequeña (interferencia destructiva).

**standing wave / onda estacionaria:** tipo de onda que se forma cuando las ondas con longitud de onda y amplitud idénticas, pero que viajan en direcciones opuestas, interfieren continuamente

## Spanish Resources (continued)

entre sí; posee puntos llamados nodos que no se mueven.

**resonance / resonancia:** capacidad que tiene un objeto de vibrar al absorber energía a su frecuencia natural.

### Por qué es importante

Puedes ver tu reflejo en un espejo, oír ecos y ver sombras debido al comportamiento de las ondas.

### Actividad Mide propiedades de onda

Algunas ondas viajan por el espacio, otras pasan a través un medio como el agua o la tierra. Todas las ondas, desde las grandes olas del mar hasta las pequeñas ondas luminosas, tienen algunas de las mismas características. Cada onda tiene longitud, velocidad, frecuencia y amplitud de onda. En esta actividad harás ondas en el salón de clases y observarás, medirás y cambiarás algunas de las propiedades de estas ondas?

### Lo que investigarás

¿Cómo se puede medir la rapidez de una onda?  
¿Cómo puede determinarse la frecuencia de una onda a partir de su longitud de onda?

### Materiales

resorte de demostración largo (o cuerda o manguera)  
vara de medir  
cronómetro

### Metas

- Medir la velocidad de una onda transversal.
- Crear ondas con diferentes amplitudes.
- Medir la longitud de onda de una onda transversal.

### Medidas de seguridad

Medidas del resorte y ondas			
	Longitud del resorte	Tiempo de onda	Conteo de ondas
onda 1			
onda 2			
onda 3			
	Conteo de longitud de onda	Frecuencia	Longitud de onda
onda 4			
onda 5			
onda 6			

### Procedimiento

1. Con un compañero(a), estira tu resorte en el piso despejado y mide la longitud del resorte. Anota esta medida en la tabla de datos. Asegúrate de que el resorte esté estirado la misma longitud para cada paso.
2. Haz que compañero(a) sostenga un extremo del resorte. Crea una sola pulsación de onda sacudiendo el otro extremo del resorte de adelante hacia atrás.
3. Haz que un tercer compañero(a) mida, con el cronómetro, el tiempo que demora una onda en moverse a lo largo del resorte. Anota esta medida en la columna “Tiempo de onda” de tu tabla de datos.
4. Repite los pasos 2 y 3, dos veces más.
5. Calcula la rapidez de las ondas 1, 2 y 3 en tu tabla de datos, usando la siguiente fórmula:  

$$\text{rapidez} = \text{distancia} / \text{tiempo}$$
 Calcula el promedio de la rapidez de las ondas 1, 2 y 3 para calcular la rapidez de las ondas en tu resorte.
6. Crea una onda con varias longitudes de onda. Haz que alguien se pare en el centro del resorte. Cuenten el número de longitudes de onda que pasan a este alumno. Anota esta medida en para la onda 4 en la columna Conteo de longitud de onda de tu tabla.

## Spanish Resources (continued)

7. Repite el paso 7 dos veces más. Trata cada vez de crear una onda con diferentes longitudes de ondas sacudiendo el resorte lenta o rápidamente.
8. Calcula la frecuencia de las ondas 4, 5 y 6 dividiendo el número de ondas entre 10 s.
9. Calcula la longitud de onda de las ondas 4, 5 y 6 usando la siguiente fórmula:  
$$\text{longitud de onda} = \text{rapidez de onda} / \text{frecuencia}$$
Usa la rapidez promedio, que calculaste en el paso 5, para la rapidez de la onda.

### Concluye y aplica

1. ¿Cambió la velocidad de onda para los tres pulsaciones de onda que creaste? Explica.
2. ¿Por qué sacas el promedio de las tres pulsaciones de onda para calcular la rapidez de las ondas en tu resorte?
3. ¿Cómo dependen las longitudes de onda que creaste de la frecuencia de las ondas?

## Guía de estudio

### Repasa las ideas principales

### Sección 1 La naturaleza de las ondas

Refiérete a las figuras en tu libro de texto.

1. Las ondas son perturbaciones rítmicas que transportan energía a través de la materia o del espacio.
2. Las ondas transfieren sólo energía, no materia. *¿Sigue esta regla una “onda” humana en un estadio?*
3. Las ondas mecánicas necesitan un medio por el cual viajar. Las ondas mecánicas pueden ser de compresión o transversales.
4. Cuando una onda transversal pasa a través de un medio, la materia en el medio se mueve en ángulos rectos a la dirección en que viaja la onda. Para una onda de compresión, la materia se mueve de delante hacia atrás, en la misma dirección en que viaja la onda.

### Sección 2 Propiedades de las onda

1. Las ondas transversales tienen puntos altos (crestas) y puntos bajos (valles). Las ondas de compresión tienen más áreas densas (compresión) y menos áreas densas (rarefacción)
2. Las ondas transversales y de compresión se pueden describir según sus longitudes, frecuencias y amplitudes de onda: Conforme la frecuencia aumenta, la longitud de onda siempre disminuye.
3. A mayor amplitud de onda, mayor es la energía que transporta. *¿Cómo medirías la amplitud de estas olas de mar?*
4. La velocidad de una onda puede calcularse multiplicando su frecuencia por su longitud de onda.

### Sección 3 El comportamiento de las ondas

1. Para todas las ondas, el ángulo de incidencia es igual al ángulo de reflexión.
2. Una onda se dobla o refracta, cuando cambia la velocidad al entrar a un nuevo medio. *¿Cómo afecta la refracción la manera en que este pescador apunta con su lanza?*
3. Cuando dos o más ondas se traslapan, se combinan para formar una nueva onda. Este proceso se llama interferencia.





## Hands-On Activities

### MiniLab: Try at Home (page 3)

1. The closer the waves, the shorter their wavelength.
2. As the rate of tapping increases, the spacing of the waves decreases.

### MiniLab (page 4)

The second tuning fork started vibrating, but the third one did not. The natural frequency of the second tuning fork is the same as the frequency of the waves that were hitting it from the first tuning fork, so it resonated. The natural frequency of the third tuning fork is different, so it did not resonate.

### Activity (page 5)

#### Lab Preview

1. by shaking each material
2. to represent compressional waves

#### Conclude and Apply

1. The waves will initially have the same amplitude determined by the movement of the student's hand. The amplitude will decrease in less dense material because of the effects of air or surface friction.
2. The waves travel faster in the less dense material.
3. The speed and amplitude decrease as the waves travel into denser material.
4. from the movement of the student's hand

### Activity (page 7)

#### Lab Preview

1. a spring, rope, or hose
2. by shaking the spring faster or slower

#### Conclude and Apply

1. Accept all reasonable responses. Wave speed probably varies because it would be difficult to shake the spring exactly the same way each time.
2. to compensate for errors in measurement
3. Wavelength decreased as frequency increased.  
 $\text{wavelength} = \text{wave speed} \div \text{frequency}$

### Laboratory Activity 1 (page 9)

**Lab Note:** Students may find it difficult to get satisfactory photos. You may wish to forego the photography and simply have the students sketch the waves.

**Lab Note:** In Part A, step 4 you may wish to increase the time to 60 seconds. Remind students that a yarn marker moves from a crest to a trough to a crest as one wave passes that point.

**Lab Note:** In Part B, step 2, It is important that students maintain the same frequency during each 30-second period.

#### Data and Observations

Data will depend on such factors as the type of rope used, its diameter, and its tautness.

### Questions and Conclusions

1. The frequency of the waves increased.
2. The wavelength decreased.
3. The velocity remained constant.
4. The data indicate that the velocity of a wave moving through a material is independent of its frequency. The velocity of the wave remained constant even though its frequency increased.

**Lab Note:** Because taking a good photo of wave patterns is difficult, you may wish to have students attach their sketches of the patterns instead of photos.

### Laboratory Activity 2 (page 13)

#### Data and Observations

1. circular
2. yes
3. straight line
4. The pulse reflects off of the barrier.
5. back towards the source
6. straight line
7. The wave bounces back.
8. a point on the other side of the paraffin block
9. The wave that hits the block is reflected.
10. The wave that does not hit the block continues on in the same direction.
11. The waves speed up as they pass from deep to shallow water.
12. The waves that pass over the glass are curved.
13. The waves that do not pass over the glass are straight.
14. The waves that pass over the glass are faster than the waves that do not pass over the glass.

### Questions and Conclusions

1. circular
2. reflects
3. Each part of the wave hits the barrier in succession, so they reflect in succession and maintain their circular shape
4. They move faster.

## Meeting Individual Needs

### Directed Reading for Content Mastery (page 19)

#### Overview

1. medium
2. reflection
3. mechanical
4. energy
5. incidence
6. space
7. c
8. a
9. b



## Teacher Guide & Answers (continued)

### Sections 1 and 2

1. energy
2. true
3. true
4. not all
5. transverse and compressional
6. transverse
7. compressional
8. true
9. frequency
10. true
11. larger
12. true

### Section 3

1. c
2. d
3. e
4. a
5. b
6. No, because light refracts or bends as it moves from the water to the air, the coin is not where it appears to be.
7. refraction—passing from one medium to another, waves bend because their speed changes diffraction—waves bend around the edge of an obstruction; diffraction varies depending on the difference between wavelength and obstruction size
8. a. constructive—waves add together, too or more crests overlap; new amplitude is the sum of the old amplitudes  
b. destructive—waves subtract from each other, crests and troughs overlap; new amplitudes is different between old amplitudes
9. A standing wave forms when waves of equal wavelength and amplitude, but traveling in opposite directions, continuously interfere with each other.

### Key Terms

1. o
2. j
3. b
4. f
5. m
6. i
7. d
8. h
9. c
10. n
11. l
12. g
13. e
14. a
15. k

### Lectura dirigida para Dominio del contenido (pág. 19)

#### Sinopsis

1. medio
2. reflexión
3. mecánica
4. energía
5. incidencia
6. espacio
7. c
8. a
9. b

#### Secciones 1 y 2

1. energía
2. verdadero
3. verdadero
4. no todos
5. transversal y de compresión
6. transversal
7. de compresión
8. verdadero
9. frecuencia
10. verdadero
11. más grande
12. verdadero

#### Sección 3

1. c
2. d
3. e
4. a
5. b
6. No, porque la luz se refracta o se dobla al moverse del agua al aire, la moneda no está donde pareciera que está.
7. refracción—paso de un medio a otro, las ondas se doblan porque su velocidad cambia la difracción—las ondas se doblan alrededor de los bordes de un obstáculo; la difracción varía dependiendo de la diferencia entre la longitud de onda y el tamaño del obstáculo
8. a. constructiva—las ondas se suman, dos o más crestas se sobreponen; la nueva amplitud es la suma de las amplitudes anteriores  
b. destructiva—las ondas se restan unas de las otras, las crestas y los valles se sobreponen; la nueva amplitud es diferente a las amplitudes anteriores
9. Se forma una onda vertical cuando las ondas con igual longitud de onda y amplitud, pero que viajan en direcciones opuestas, interfieren constantemente unas con otras.

#### Términos claves

1. o
2. j
3. b
4. f
5. m
6. i

7. d
8. h
9. c
10. n
11. l
12. g
13. e
14. a
15. k

## Reinforcement (page 27)

### Section 1

1. A wave is repeating disturbance that transfers energy through matter or space.
2. energy
3. any up and down or back and forth vibration
4. waves that can travel only through a medium
5. a. transverse waves: matter in the medium moves back and forth at right angles to the direction that the wave travels  
b. compressional waves: matter in the medium moves back and forth in the same direction that the wave travels
6. compressional
7. How does sound travel through a medium? Particles are pushed together and move apart as sound waves travel.
8. The object will follow a circle as it bobs up and down.
9. The change in wind speed is like a vibration as it blows across the surface.
10. They are a combination of compressional and transverse waves that are caused by Earth's crust breaking.

### Section 2

1. crest
2. trough
3. amplitude
4. wavelength
5. possibilities are frequency, wavelength, amplitude, and speed
6. The frequency is the number of waves that pass a given point in a second. The unit is hertz.
7. The wavelength decreases.
8. Measure the distance between two wave crests; Measure the distance between a crest and the rest position.
9. Measure the distance between two compressions; Measure the density of the medium at a compression.
10.  $v = \lambda = 6 \text{ Hz} \times 2 \text{ m} = 12 \text{ m/s}$

### Section 3

1. Reflection of sound waves produces an echo
2. The angle of incidence equals the angle of reflection.
3. both phenomena are caused by the bending of waves. Refraction is caused by waves bending because they change speed when passing from one medium to another. Diffraction is caused by waves bending around a barrier.

4. The light wave is bent toward the normal to the surface.
5. The tree is large compared to the wavelength of light, so the light rays are not diffracted.
6. When they meet, the waves interfere to form a new wave.
7. A standing wave is produced when two waves of equal wavelengths and amplitudes, traveling opposite directions, continuously interfere with each other.

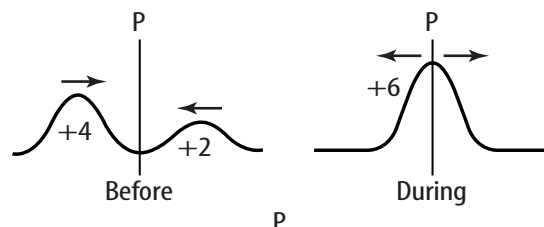
## Enrichment (page 30)

### Section 1

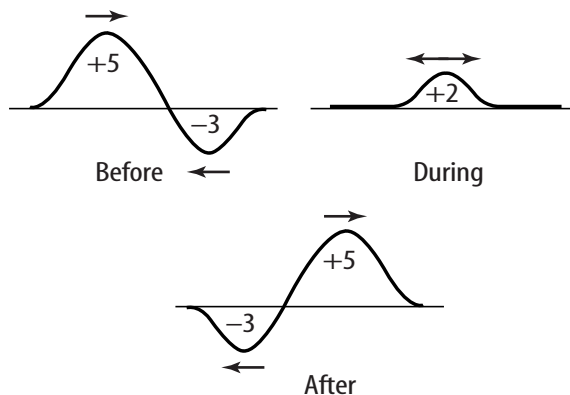
1. The sound barrier is the limit of the speed of sound for a particular sound wave in a certain medium
2. When a jet flies faster than the speed of sound it produces a sonic boom.
3. A sonic boom occurs when compression waves stack up until the molecules in the wave explode away from the source.
4. A Mach cone is a zone of exploding sound behind a supersonic jet.

### Section 2

1. sum of amplitudes =  $(+4 \text{ cm}) + (+2 \text{ cm}) = +6 \text{ cm}$



2. sum of amplitudes =  $(+5 \text{ cm}) + (-3 \text{ cm}) = +2 \text{ cm}$



3. The amplitude of the new wave is the sum of the waves at the instant they meet, which would be  $(+3 \text{ m}) + (-3 \text{ m}) = 0$  meters. They would cancel each other out, and at that instant, the lake would be flat.

### Section 3

1. The thickness and purity of glass can affect its resonant frequency

## Teacher Guide & Answers (continued)

2. Resonance is vibration caused by absorption of energy.
3. A singer can produce a high, pure note. This will make the glass vibrate to the note.
4. When the glass begins to vibrate, it is resonating with the pure sound. If the sound gets too loud, the glass molecules cannot move back and forth fast enough, so the glass breaks.

### Note-taking Worksheet (page 33)

Refer to Teacher Outline, student answers are underlined

## Assessment

### Chapter Review (page 37)

#### Part A. Vocabulary Review

1. reflection (8/3)
2. waves (1/1)
3. crest (4/2)
4. compression (2/1)
5. transverse wave (3/1)
6. interference (10/3)
7. trough (4/2)
8. medium (1/1)
9. diffraction (9/3)
10. rarefaction (5/2)
11. resonance (10/3)
12. compressional wave (3/1)
13. wavelength (5/2)
14. frequency (5/2)
15. law of reflection (8/3)
16. amplitude (6/2)
17. standing wave (10/3)
18. refraction (9/3)

#### Part B. Concept Review

1. transverse (3/1)
2. B (6/2)
3. crests (5/2)
4. troughs (5/2)
5. It is 2 times greater. (5/2)
6.  $v = \lambda \times f = 0.45 \text{ m} \times 760 \text{ Hz} = 320 \text{ m/s}$  (7/2)
7.  $f = v/\lambda = 330 \text{ m/s}/5 \text{ m} = 22 \text{ Hz}$  (7/2)
8. Rock piles are moved in the same direction as a seismic wave's motion, or they can be moved at right angles to it. (3/1)
9. The higher a water wave is above the normal, the more energy it carries. A surfer is likely to get a faster, longer ride from a high-amplitude wave (6/2)
10. Glass objects will resonate with sound at the natural frequency of the glass. If the sound has enough amplitude, the glass will shatter. Although traffic noise can be loud, it's not likely that it will be at the natural frequency of glass objects in the school. (6/2)

### Chapter Test (page 39)

#### I. Testing Concepts

1. trough (4/2)
2. resonance (10/3)
3. frequency (5/2)
4. crest (4/2)
5. wavelength (5/2)
6. standing waves (10/3)
7. diffraction (9/3)
8. amplitude (6/2)
9. rarefaction (3/1)
10. wave (1/1)
11. refraction (9/3)
12. transverse wave (3/1)
13. compression (3/1)
14. medium (1/1)
15. interference (10/3)
16. compressional wave (3/1)

#### II. Understanding Concepts

1. a. angle of incidence (8/3)  
b. angle of reflection (8/3)  
c. normal (8/3)
2. They are equal (8/3)
3. a (5/2)
4. c (5/2)
5. b (7/2)
6. diffraction (9/3)
7. transverse (3/1)
8. seismic (2/1)
9. remains the same (7/2)
10. node (10/3)

#### III. Applying Concepts

1. In a transverse wave, the particles move perpendicular to the direction of the wave's motion. In a surface water wave the particles move in a circle, both up and down and back and forth. (3/1)
2. a. compressional waves (3/1)  
b. transverse waves (3/1)
3. Only sound waves at the natural frequency of glass cause it to vibrate. Most sound waves have a different frequency than this. (10/3)
4. The wave is refracted (bent) away from the normal. The air is less dense than the glass. (9/3)
5. Constructive interference between two crests form the crests; destructive interference between a crest and a trough form the nodes. (10/3)
6. crest (4/2)
7. amplitude (6/2)
8. wavelength (5/2)
9. trough (4/2)
10.  $v = \lambda \times f = 260 \text{ Hz} \times 1.30 \text{ m} = 338 \text{ m/s}$  (7.2)

#### IV. Writing Skills

1. The moon reflects light from the Sun to Earth (8/3)
2. As frequency increases, wavelength decreases. Low frequency waves have a greater wavelength, so the low frequency waves would be diffracted more. (5/2)

3. Unlike other waves, light reaches Earth through empty space from the Sun. Like other waves, light can be reflected, refracted and diffracted. (1/1, 8/3, 9/3)
4. Frequency increases and wavelength decreases. Amplitude and wave speed stay the same. (5, 6, 7/2)
5. It takes place at the interface between the two media. (9/3)
6. No, there is no energy loss. The waves just add together as they pass through each other and then continue on their way in their original forms. (10/3)
7. With an unbroken mirror the light waves go straight from your face to the mirror, so they are reflected straight back. With a broken mirror, the angles of incidence are all different, so the angles of reflection are in all directions. (8/3)
8. The frequency of any wave is equal to the rate of vibration. A guitarist makes a string shorter as the guitarist's fingers move down the frets. The shorter string vibrates at a faster rate. (10/3)

## Transparency Activities

### Section Focus Transparency 1 (page 44)

#### Wave to the Camera

##### Transparency Teaching Tips

- This is an introduction to waves. Ask the students if they have ever dropped a rock into a pond and watched a series of circular waves being formed. When the rock strikes the water's surface, energy from the rock is transferred to the water, causing waves to be formed. These waves transfer the energy away from the source.
- Ask the students to identify the energy source of the water waves on the transparency. (It's the wind.)
- Explain that a water wave is a transverse wave (the medium moves up and down, while the wave moves forward). This can be demonstrated by tying a piece of string to a doorhandle, with the other end of the string held in your hand. By snapping your wrist in a vertical fashion, a transverse wave will be generated.
- Explain that sound waves are the result of vibrations. As the vibrations move outward, again in a circular pattern away from the source, they compress air molecules. Called compressional waves, these waves cause the molecules in the medium to move in the same direction as the wave (not up and down like a transverse wave).

##### Content Background

- Waves carry energy, not matter.
- The boats on the transparency move because some of the wave's energy is transferred to the hulls of the ships.
- The transparency photo is of Titusville, Florida, during Hurricane Irene in 1999. Winds reaching

sustained speeds of 136 kph (85 mph) were registered up to 100 miles from the eye of the hurricane.

##### Answers to Student Worksheet

1. Answers will vary. Possible answers include the waves on the ocean, sound waves, and light waves.
2. Yes, you can still hear sounds. This tells you sound waves can travel through water.
3. Light travels through empty space, Earth's atmosphere, the water, and the lenses of the swimmer's goggles.

### Section Focus Transparency 2 (page 45)

#### Big Fiddle, Little Fiddle

##### Transparency Teaching Tips

- This is an introduction to wave properties. Using a real violin, bow one of the strings. Ask the students to explain how sound travels (in terms of waves). Bow a different note and ask the students to explain why a different sound is heard, again in terms of waves. Pitch is related to frequency, or number of wavelengths passing a fixed point each second.
- Ask the students to explain why the violin's shape and F-holes affect the sound it produces. (The shape and materials act to increase the energy of the waves.) Ask the students how this concept applies to the large bass on the transparency.

##### Content Background

- The vibration of the strings of any stringed instrument passes over the bridge and is transmitted to the belly (soundboard) and through the sound post to the instrument's back, all of which amplifies the sound.
- The most prized and expensive violins are those created by Antonio Stradivari in the late 17th and early 18th centuries. He altered the size of the violin, making it larger, and experimented with proportion, wood thickness and density, bridge position, and varnish, each of which affects how the instrument creates sound. His are the most acoustically perfect of all violins. Stradivari made more than 1,100 violins, cellos, violas, guitars, and harps, of which over 600 still survive. The price for an authentic Stradivarius violin can run over one million dollars.

##### Answers to Student Worksheet

1. Stringed instruments can be strummed like a guitar or played with a bow like a violin. Some instruments are tubes that people blow through, while others, like drums, are struck to produce sound.
2. The sound made by a cello is lower than the sound made by a violin and higher than the sound made by a bass.
3. If both holes were plugged, the waves could not pass through the wall. The pattern on the near side of the wall would be very similar—waves would hit the wall and reflect. There would be no pattern on the far side of the wall.

## Teacher Guide & Answers (continued)

### Section Focus Transparency 3 (page 46)

#### Wave Art

##### Transparency Teaching Tips

- This transparency is an introduction to the behavior of waves. Explain that the dark horizontal line on the transparency is a wall in which two openings have been cut. Ask the students to explain how the waves created the designs on both sides of the wall. Point out that the waves striking the wall and bouncing back are called reflected waves.
- Focusing on the waves created by the water passing through the apertures, note that the wave changes from a straight to a curved wave. This process is called diffraction.

##### Content Background

- Have the students look at the diffracting waves. Ask the students whether the waves appear to be adding to each other or canceling each other out. Some interference is destructive; this happens when the trough of one wave aligns with the crest of another. Interference can also be constructive. This occurs when the crests of two waves meet. In this case, the two waves combine to form a larger wave.
- The largest ocean waves are generated by earthquakes. Called tsunamis, these waves have enormous energy. Their wave heights are small (one to two feet), but the wavelengths (distance between waves) are very large, between 100 and 200 km. As a tsunami approaches the coast, friction with the bottom slows the wave's speed and shortens the wavelength. The energy of the wave is amplified, with wave heights increasing from two to almost one hundred feet.

##### Answers to Student Worksheet

1. The waves approach the wall in a straight line. The waves passing through the openings change from straight to curved (called diffraction). Since there are two openings, interference occurs where the waves overlap.
2. They overlap on the far side of the wall, starting in the region between the two holes. Use a pointer to indicate the overlap.
3. The pattern on the near side of the wall would be very similar—waves would hit the wall and reflect. There would be no pattern on the far side of the wall.

### Teaching Transparency (page 47)

#### Amplitude of Waves

#### Section 2

##### Transparency Teaching Tips

- Demonstrate the differences in the motion of transverse and compressional waves using a piece of rope and a coiled spring.

- Draw three transverse waves on the chalkboard and remind the students that frequency is the number of crests or troughs produced in a unit of time. Have students identify the waves with the highest and lowest frequency.

##### Reteaching Suggestion

- Have students make two lists in their notebooks with the headings *Transverse Waves* and *Compressional Waves*. Review the characteristics of each type of wave beginning with a discussion of the direction of wave motion. Then, discuss each part of each wave. Have students write, below the proper heading, complete definitions for each wave part discussed.

##### Extensions

*Activity:* Working in small groups, have students observe the motion of each type of wave using pieces of rope and coiled springs. Have students find out how to change the amplitude and frequency of waves.

*Challenge:* Using the formula for the speed of a wave, speed equals frequency times wavelength, have students calculate the speed of a wave when frequency and wavelength are given. Have them determine formulas for calculating frequency or wavelength when given the other two variables

##### Answers to Student Worksheet

1. It is called the crest.
2. It is called the trough.
3. Amplitude is measured by calculating the distance from the wave's resting position to either a crest or a trough.
4. Wavelength is the distance from one crest to the next, or from one trough to the next.
5. Frequency is the number of wave crests that pass a point in a given time.
6. Amplitude measures the energy in the wave.

### Assessment Transparency (page 49)

#### Waves

#### Section 3

##### Answers

1. **A.** Remember that 5 m is 500 cm. Of the listed waves, only radio waves are that long.
2. **J.** The question asks which category contains 0.000046. Forty-six falls between 45 and 49, so 0.000046 is in the blue light range (0.000045 to 0.000049).
3. **D.** Again, students are asked to categorize a wave. This question, however, connects the information to a machine by asking *what kind of device* would emit such a wave.

##### Test-Taking Tip

Remind the students to read the directions carefully and make sure they understand them before beginning.