Sound

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Additional Assessment Resources available with Glencoe Science:
- ExamView® Pro TestMaker
- Assessment Transparencies
- Performance Assessment in the Science Classroom
- Standardized Test Practice Booklet
- MindJogger Videoquizzes
- Vocabulary PuzzleMaker Software at: gpscience.com
- Interactive Chalkboard
- The Glencoe Science Web site at: gpscience.com
- An interactive version of this textbook along with assessment resources are available online at: mhln.com
To the Teacher

This chapter-based booklet contains all of the resource materials to help you teach this chapter more effectively. Within you will find:

- Reproducible pages for
  - Student Assessment
  - Hands-on Activities
  - Meeting Individual Needs (Extension and Intervention)
  - Transparency Activity Masters

- A teacher support and planning section including
  - Content Outline of the chapter
  - Spanish Resources
  - Answers and teacher notes for the worksheets

Hands-On Activities

MiniLAB and Lab Worksheets: Each of these worksheets is an expanded version of each lab and MiniLAB found in the Student Edition. The materials lists, procedures, and questions are repeated so that students do not need their texts open during the lab. Write-on rules are included for any questions. Tables/charts/graphs are often included for students to record their observations. Additional lab preparation information is provided in the Teacher Guide and Answers section.

Laboratory Activities: These activities do not require elaborate supplies or extensive pre-lab preparations. These student-oriented labs are designed to explore science through a stimulating yet simple and relaxed approach to each topic. Helpful comments, suggestions, and answers to all questions are provided in the Teacher Guide and Answers section.

Foldables: At the beginning of each chapter there is a Foldables: Reading & Study Skills activity written by renowned educator, Dinah Zike, that provides students with a tool that they can make themselves to organize some of the information in the chapter. Students may make an organizational study fold, a cause and effect study fold, or a compare and contrast study fold, to name a few. The accompanying Foldables worksheet found in this resource booklet provides an additional resource to help students demonstrate their grasp of the concepts. The worksheet may contain titles, subtitles, text, or graphics students need to complete the study fold.

Meeting Individual Needs (Extension and Intervention)

Directed Reading for Content Mastery: These worksheets are designed to provide students with learning difficulties with an aid to learning and understanding the vocabulary and major concepts of each chapter. The Content Mastery worksheets contain a variety of formats to engage students as they master the basics of the chapter. Answers are provided in the Teacher Guide and Answers section.
Directed Reading for Content Mastery (in Spanish): A Spanish version of the Directed Reading for Content Mastery is provided for those Spanish-speaking students who are learning English.

**Reinforcement:** These worksheets provide an additional resource for reviewing the concepts of the chapter. There is one worksheet for each section, or lesson, of the chapter. The Reinforcement worksheets are designed to focus primarily on science content and less on vocabulary, although knowledge of the section vocabulary supports understanding of the content. The worksheets are designed for the full range of students; however, they will be more challenging for your lower-ability students. Answers are provided in the Teacher Guide and Answers section.

**Enrichment:** These worksheets are directed toward above-average students and allow them to explore further the information and concepts introduced in the section. A variety of formats are used for these worksheets: readings to analyze; problems to solve; diagrams to examine and analyze; or a simple activity or lab which students can complete in the classroom or at home. Answers are provided in the Teacher Guide and Answers section.

**Note-taking Worksheet:** The Note-taking Worksheet mirrors the content contained in the teacher version—Content Outline for Teaching. They can be used to allow students to take notes during class, as an additional review of the material in the chapter, or as study notes for students who have been absent.

**Assessment**

**Chapter Review:** These worksheets prepare students for the chapter test. The Chapter Review worksheets cover all major vocabulary, concepts, and objectives of the chapter. The first part is a vocabulary review and the second part is a concept review. Answers and objective correlations are provided in the Teacher Guide and Answers section.

**Chapter Test:** The Chapter Test requires students to use process skills and understand content. Although all questions involve memory to some degree, you will find that your students will need to discover relationships among facts and concepts in some questions, and to use higher levels of critical thinking to apply concepts in other questions. Each chapter test normally consists of four parts: Testing Concepts measures recall and recognition of vocabulary and facts in the chapter; Understanding Concepts requires interpreting information and more comprehension than recognition and recall—students will interpret basic information and demonstrate their ability to determine relationships among facts, generalizations, definitions, and skills; Applying Concepts calls for the highest level of comprehension and inference; Writing Skills requires students to define or describe concepts in multiple sentence answers. Answers and objective correlations are provided in the Teacher Guide and Answers section.

**Transparency Activity Masters**

**Section Focus Transparencies:** These transparencies are designed to generate interest and focus students’ attention on the topics presented in the sections and/or to assess prior knowledge. There is a transparency for each section, or lesson, in the Student Edition. The reproducible student masters are located in the Transparency Activities section. The teacher material, located in the Teacher Guide and Answers section, includes Transparency Teaching Tips, a Content Background section, and Answers for each transparency.
Teaching Transparencies: These transparencies relate to major concepts that will benefit from an extra visual learning aid. Most of these transparencies contain diagrams/photos from the Student Edition. There is one Teaching Transparency for each chapter. The Teaching Transparency Activity includes a black-and-white reproducible master of the transparency accompanied by a student worksheet that reviews the concept shown in the transparency. These masters are found in the Transparency Activities section. The teacher material includes Transparency Teaching Tips, a Reteaching Suggestion, Extensions, and Answers to Student Worksheet. This teacher material is located in the Teacher Guide and Answers section.

Assessment Transparencies: An Assessment Transparency extends the chapter content and gives students the opportunity to practice interpreting and analyzing data presented in charts, graphs, and tables. Test-taking tips that help prepare students for success on standardized tests and answers to questions on the transparencies are provided in the Teacher Guide and Answers section.

Teacher Support and Planning
Content Outline for Teaching: These pages provide a synopsis of the chapter by section, including suggested discussion questions. Also included are the terms that fill in the blanks in the students’ Note-taking Worksheets.

Spanish Resources: A Spanish version of the following chapter features are included in this section: objectives, vocabulary words and definitions, a chapter purpose, the chapter Activities, and content overviews for each section of the chapter.
Reproducible Student Pages

- Hands-On Activities
  - MiniLab: Listening to Sound through Different Materials
  - MiniLab: Simulating Hearing Loss
  - Lab: Making Music
  - Lab: Design Your Own Blocking Noise Pollution
  - Laboratory Activity 1: Sound Waves and Pitch
  - Laboratory Activity 2: Musical Instruments
  - Foldables: Reading and Study Skills

- Meeting Individual Needs
  - Extension and Intervention
    - Directed Reading for Content Mastery
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    - Reinforcement
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    - Note-taking Worksheet

- Assessment
  - Chapter Review
  - Chapter Test

- Transparency Activities
  - Section Focus Transparency Activities
  - Teaching Transparency Activity
  - Assessment Transparency Activity
Hands-On Activities
Mini LAB

Listening to Sound Through Different Materials

Procedure
1. Tie the middle of a length of string onto a metal object, such as a wire hanger or a spoon, so that the string has two long ends.
2. Wrap each string end around a finger on each hand.
3. Gently placing your fingers in your ears, swing the object until it bumps against the edge of a chair or table. Listen to the sound.
4. Take your fingers out of your ears and listen to the sound made by the collisions.

Analysis
1. Compare and contrast the sounds you hear when your fingers are and are not in your ears.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

2. Do sounds travel better through air or the string?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Simulating Hearing Loss

Procedure
1. Tune a radio to a news station. Turn the volume down to the lowest level you can hear and understand.
2. Turn the bass to maximum and the treble to minimum. If the radio does not have these controls, hold thick wads of cloth over your ears.
3. Observe which sounds are hardest and easiest to hear.

Data and Observations

<table>
<thead>
<tr>
<th>Sounds or voices</th>
<th>Easy to hear</th>
<th>Hard to hear</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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Analysis
1. Are high or low pitches harder to hear? Are vowel or consonant sounds harder to hear?

2. How could you help a person with hearing loss understand what you say?
Lab Preview

Directions: Answer these questions before you begin the Lab.

1. Why do you need to wear an apron or other clothing protection?

2. Do you put the same amount of water in each of the test tubes?

There are many different types of musical instruments. Early instruments were made from materials that were easily obtained such as clay, shells, skins, wood, and reeds. These materials were fashioned into various instruments that produced pleasing sounds. In this lab, you are going to create a musical instrument using materials that are available to you—just as your ancestors did.

Real-World Question
How can you make different tones using only test tubes and water?

Materials
- test tubes
- test-tube rack

Goals
- Demonstrate how to make music using water and test tubes.
- Predict how the tones will change when there is more or less water in the test tubes.

Safety Precautions 🛑 🛑 🛑

Procedure
1. Put different amounts of water into each of the test tubes.
2. Predict any differences you expect in how the tones from the different test tubes will sound.
3. Blow across the top of each test tube.
4. Record any differences that you notice in the tones that you hear from each test tube.

Data and Observations

<table>
<thead>
<tr>
<th>Test Tube</th>
<th>Amount of Water</th>
<th>Tone Difference</th>
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<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
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<tr>
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<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
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</table>
Conclude and Apply

1. **Describe** how the tones change depending on the amount of water in the test tube.

2. **Explain** why the pitch depends on the height of the water.

3. **Summarize** why each test tube produces a different tone.

4. **Explain** how resonance amplifies the sound from a test tube.

5. **Explain** how the natural frequencies of the air columns in each of the tubes differ.

6. **Compare and contrast** the way the test tubes make music with the way a flute makes music.

**Communicating Your Data**

When you are listening to music with family or friends, describe to them what you have learned about how musical instruments produce sound.
Lab Preview

Directions: Answer these questions before you begin the Lab.

1. What is noise pollution?

2. Name three materials that can be used as barriers for testing.

What loud noises do you enjoy, and which ones do you find annoying? Most people enjoy a music concert performed by their favorite artist, booming displays of fireworks on the Fourth of July, and the roar of a crowd when their team scores a goal or touchdown. Although these are loud noises, most people enjoy them for short periods of time. Most people find certain loud noises, such as traffic, sirens, and loud talking, annoying. Constant, annoying noises are called noise pollution. What can be done to reduce noise pollution? What types of barriers best block out loud noises?

Real-World Question

What types of barriers will best block out noise pollution?

Form a Hypothesis

Based on your experiences with loud noises, form a hypothesis that predicts the effectiveness of different types of barriers at blocking out noise pollution.

Goals

- **Design** an experiment that tests the effectiveness of various types of barriers and materials for blocking out noise pollution.
- **Test** different types of materials and barriers to determine the best noise blockers.

Possible Materials

- radio, CD player, horn, drum, or other loud noise source
- shrubs, trees, concrete walls, brick walls, stone walls, wooden fences, parked cars, or hanging laundry
- sound meter
- meterstick or metric tape measure

Test Your Hypothesis

Make a Plan

1. Decide what type of barriers or materials you will test.
2. Describe exactly how you will use these materials.
3. Identify the controls and variables you will use in your experiment.
4. List the steps you will use and describe each step precisely.
5. Prepare a data table to record your measurements.
6. Organize the steps of your experiment in logical order.

Follow Your Plan

1. Ask your teacher to approve your plan and data table before you start.
2. Conduct your experiment as planned.
3. Test each barrier two or three times.
4. Record your test results in your data table.
Analyze Your Data
1. Identify the barriers that most effectively reduced noise pollution.

2. Identify the barriers that least effectively reduced noise pollution.

3. Compare the effective barriers and identify common characteristics that might help explain why they reduced noise pollution.

4. Compare the natural barriers you tested with the artificial barriers. Which type of barrier best reduced noise pollution?

5. Compare the different types of materials the barriers were made of. Which type of material best reduced noise pollution?

Conclude and Apply
1. Evaluate whether your results support your hypothesis.
2. Predict how your results would differ if you used a louder source of noise such as a siren.

3. Infer from your results how people living near a busy street could reduce noise pollution.

4. Identify major sources of noise pollution in or near your home. How could this be reduced?

5. Research how noise pollution can be unhealthy.

Communicating Your Data
Draw a poster illustrating how builders and landscapers could use certain materials to better insulate a home or office from excess noise pollution.
Sound Waves and Pitch

Sounds are produced and transmitted by vibrating matter. You hear the buzz of a fly because its wings vibrate, the air vibrates, and your eardrum vibrates. The sound of a drum is produced when the drumhead vibrates up and down, the air vibrates, and your eardrum vibrates. Sound is a compressional wave. In a compressional wave, matter vibrates in the same direction as the wave travels. For you to hear a sound, a sound source must produce a compressional wave in matter, such as air. The air transmits the compressional wave to your eardrum, which vibrates in response to the compressional wave.

Compressional waves can be described by amplitude, wavelength, and frequency—the same as transverse waves. The pitch of a sound is related to the frequency of a compressional wave. You are familiar with high pitches and low pitches in music, but people are also able to hear a range of pitches beyond that of musical sounds. People can hear sounds with frequencies between 20 and 20,000 Hz.

Strategy
You will demonstrate that sound is produced by vibrations of matter.
You will vary the pitch of vibrating objects.

Materials
4 rubber bands of different widths but equal lengths
cardboard box, such as a shoe box or cigar box

Safety Precautions
Safety goggles should be worn throughout the experiment.

Procedure
1. Stretch the four rubber bands around a box as shown in Figure 1.

2. Pluck the first rubber band, allowing it to vibrate. Listen to the pitch of the vibrating rubber band. Predict how the pitches of the other rubber bands will compare with this pitch. Record your prediction in the Data and Observations section. Pluck the remaining rubber bands. Record your observations about the variation in pitch.

3. Remove three rubber bands from the box. Hold the remaining rubber band tightly in the middle with one hand. Pluck it with the other. Move your hand up and down the rubber band to increase or decrease the length of the rubber band that can vibrate. Predict how the pitch will change as you change the length of the vibrating rubber band. Pluck the rubber band for each new length and record your observations of the length of the vibrating rubber band and pitch.
Laboratory Activity 1 (continued)

Data and Observations
1. Prediction of variation in pitch of sounds produced by rubber bands of different widths:
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

2. Observation of changes in pitch with varying thickness of rubber bands:
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

3. Observation of changes in pitch with varying length of the rubber band:
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

Questions and Conclusions
1. How does length affect the pitch of sound produced by a vibrating object?
   __________________________________________________________
   __________________________________________________________

2. How does the width of a rubber band affect its frequency of vibration?
   __________________________________________________________
   __________________________________________________________

3. Based on your results, how would you expect the pitch of sound produced by a vibrating string to be affected by the length of the string?
   __________________________________________________________
   __________________________________________________________

Strategy Check
   _____ Can you demonstrate that sound is produced by vibrations of matter?
   _____ Can you vary the pitch of vibrating objects?
Musical instruments have been made and used for thousands of years by different cultures around the world. String, brass, woodwind, and percussion instruments all produce their own distinctive musical sounds. In this activity, you can make and compare the sounds made by several simple instruments.

**Strategy**

You will construct simple musical instruments.
You will compare and contrast the sounds made by these instruments.
You will classify the instruments according to their type.

**Materials**

- block of wood, 15 cm × 10 cm × 5 cm
- wire coat hanger
- wire cutters
- wire staples
- hammer
- 6 beakers of the same size
- wooden spoon
- water
- shoe box or tissue box
- 2 pieces of wood, 1 cm × 1 cm × 15 cm
- 5 rubber bands of varying lengths and thicknesses
- 6 nails of varying lengths, 5 cm to 20 cm
- meterstick
- string, 90 cm
- scissors
- metal spoon
- 2 plastic soda bottles with lids
- dried peas, small pebbles, uncooked rice, or paper clips
- plastic trash bag
- string
- tape
- empty containers such as margarine tubs, plastic bowls, or cardboard tubes

**Procedure**

**Part A—Twanger**

1. Use wire cutters to cut a coat hanger into four or five pieces of different lengths. The lengths of the pieces should vary from 8 cm to 20 cm.
2. Use wire staples and a hammer to attach the lengths of wire to the wooden block, as shown in Figure 1.
3. Pluck the wires with your thumb or a pen. In the data table in the Data and Observations section, describe the sounds and pitches produced by the various pieces of wire.

**Part B—Xylophone**

4. Set up six beakers of the same size in a row.
5. Leave the first beaker empty. Add increasing amounts of water to each of the remaining five beakers. The third beaker should be about half full and the last beaker should be almost full.
6. Tap the side of each beaker gently with a wooden spoon. Describe the sounds and pitches produced by each of the beakers.
Part C—Guitar
7. Stretch the rubber bands around the box lengthwise.
8. With a partner’s help, slide one piece of wood under the rubber bands at one end of the box. Slide the other piece of wood under the rubber bands at the other end of the box. Your completed guitar should look like Figure 2.
9. Pluck the rubber bands with your fingers. Describe the sounds and pitches produced by each of the rubber bands.

Figure 2

Part D—Nail Chimes
10. Cut a piece of string into 15-cm pieces. Tie each piece of string around the meterstick, leaving a long end hanging down.
11. Tie the hanging end of each string around the head of a nail. Arrange the nails from shortest to longest.
12. Suspend the meterstick between two chairs or tables, as shown in Figure 3. Be sure the nails don’t touch each other.
13. Use a metal spoon to tap the nails. Describe the sounds and pitches produced by each of the nails.

Figure 3
Part E—Shakers
14. Place a small amount of dried peas, small pebbles, uncooked rice, or paper clips into one plastic bottle. Screw the cap on the bottle.
15. Place a small amount of another material in a second plastic bottle and screw on the cap.
16. Shake each bottle or tap it against your hand. Describe the sounds made by each shaker.

Part F—Drums
17. Cut down the sides of the plastic bag to make one large sheet.
18. Place one of your containers open side down on the plastic sheet. Cut around the container, leaving about an extra 10 cm all around the container.
19. With a partner, stretch the plastic tightly over the top of the container. Use string and tape to hold the plastic in place, as shown in Figure 4.
20. Repeat steps 18 and 19 with a container of a different size.
21. Hit the top of your drums lightly with your fingers or a pencil. Describe the sounds made by each drum.

Figure 4
### Questions and Conclusions

1. Which instruments were able to produce sounds of different pitches?

2. What caused the different pitches of sounds in each of those instruments?

3. Classify each of the instruments you made by type.

4. How does the length of a piece of wire or a nail affect its frequency of vibration?

### Strategy Check

[ ] Can you construct simple musical instruments?

[ ] Can you compare and contrast the sounds made by these instruments?

[ ] Can you classify the instruments according to their type?
Directions: Use this page to label your Foldable at the beginning of the chapter.

Can sound travel through solids?

Can sound travel through liquids?

Can sound travel through gases?

Sound travels slowly through this medium.

Sound travels faster through this medium.

Sound travels even faster through this medium.
Meeting Individual Needs
Directions: Complete the concept map using the terms in the list below.

amplified
frequency

pattern
gathered

wavelength
music

Sound waves

are detected by the ear

have the properties

can be used

deliberately

1.
by the outer ear,

2.
by the middle ear, and

converted

by the inner ear

3.

4.

5.

6.

Directions: Match the description in the first column with the item in the second column by writing the correct letter in the space provided.

7. often used to examine parts of the body, including the heart and liver
   a. brass and woodwinds
   b. ultrasound
   c. percussion
   d. sonar
   e. strings

8. often used to find sunken treasure

9. rely on vibration of air to make music

10. struck, shaken, rubbed, or brushed to produce sound

11. plucking, striking, or drawing a bow across tightly stretched strings to make music.
1. Sound is produced by (vibrations, waves).
2. Compressions and rarefactions are kinds of (sound waves, vibration waves).
3. Sound travels faster in (liquids, solids).
4. The speed of sound depends on the (temperature, empty space).
5. The inner ear contains the (cochlea, anvil) that sends nerve impulses to the brain.

6. The amount of energy that flows through a certain area in a specific amount of time is known as ______.
   a. intensity
   b. loudness

7. The intensity of a sound is measured in ______.
   a. units
   b. decibels

8. Sources such as wind, earthquakes, and heavy machinery produce sound waves that vibrate ______.
   a. slowly
   b. quickly

9. A change in pitch or wave frequency due to movement is known as ______.
   a. the Doppler effect
   b. ultrasonic waves

10. A sound wave consists of compressions and ______.
    a. vibrations
    b. rarefractions

11. Sound waves can NOT move through ______.
    a. wood
    b. a vacuum

12. Sound waves of ______ intensity travel farther.
    a. low
    b. high
Directions: Use the clues below to complete the crossword puzzle.

Across
2. Echoing effect produced by many reflections of sound
4. A kind of percussion instrument
6. Sometimes used to examine parts of the body
7. The study of sound
9. Describes the differences among sounds of the same pitch and loudness
10. A hollow chamber filled with air that amplifies sound when its air vibrates

Down
1. A vibration whose frequency is a multiple of the fundamental frequency
3. The process of locating objects by emitting sounds and interpreting the sound waves that are reflected back
5. Created when specific pitches and sound qualities are used deliberately in a set pattern
8. System that uses the reflection of underwater sound waves to detect objects.
Key Terms
Sounds

Directions: Unscramble the words in italics to complete the sentences below. Write the terms on the lines provided.

1. The study of sound is known as stauocsic.
2. Tiny hairs located in the hcleaco conduct sound to the brain.
3. The dmeraur passes sound vibrations to the hammer, anvil, and stirrup.
4. People’s perception of sound intensity is known as slunesdo.
5. When you hear a change in cptih, you are registering how high or low the sounds are.
6. The poDprel cetfesf lets you know that the source of a sound is moving toward or away from you.
7. When sounds and their reflections reach your ears at different times, you might hear an echoing effect called rberatveniroe.
8. A noserrato is a hollow chamber filled with air that amplifies sound when its air vibrates.
9. The use of underwater sound waves to detect objects is called rosan.
10. When sounds are deliberately used in a set pattern, simuc is created.
11. A vibration whose frequency is a multiple of the fundamental frequency is an onevoter.
12. A drum is an example of a resusponic instrument.
13. Sound intensity is measured in sceibled.
14. Every material has a natural queencyfr.
Instrucciones: Completa el mapa conceptual usando los siguientes términos.

amplificadas frecuencia  
patrón recogidas  
longitud de onda música

Las ondas sonoras

1. por el oído externo, son
2. por el oído medio y convertidas
3. tienen
4. y
5. deliberadamente en un
6. regular para producir

Instrucciones: Escribe la letra del término en la columna derecha con la descripción correspondiente en la columna izquierda.

7. se usa con frecuencia para examinar partes corporales como el corazón y el hígado
   a. instrumentos metálicos y de madera
8. se usa para buscar tesoros sumergidos
   b. ultrasonido
9. dependen de las vibraciones en el aire para producir música
   c. percusión
10. instrumento que produce sonidos al ser golpeado, frotado, cepillado o sacudido
    d. sonar
11. puntear, golpear o frotar con un arco las cuerdas templadas para producir música
    e. cuerdas
Sección 1 La naturaleza del sonido

Sección 2 Propiedades del sonido

Instrucciones: Encierra en un círculo el término que completa correctamente cada oración.

1. El sonido es producido por (vibraciones / ondas).

2. Las compresiones y las rarefacciones son tipos de (ondas de sonido / ondas de vibración).

3. El sonido viaja más rápido que los (líquidos / sólidos).

4. La velocidad del sonido depende de la(s) (temperatura / partículas).

5. El oído interno contiene el(la) (cóclea / yunque) que envía impulsos nerviosos al encéfalo.

Instrucciones: En cada uno de los siguientes, escribe la letra del término o frase que complete mejor cada oración.

   6. La cantidad de energía que fluye a través de un área en un tiempo determinado se conoce como ______.
      a. intensidad
      b. volumen

   7. La intensidad sonora se mide en ______.
      a. unidades
      b. decibeles

   8. Fuentes como el viento, los terremotos y la maquinaria pesada producen ondas sonoras que vibran ______.
      a. lentamente
      b. rápidamente

   9. Un cambio de tono o frecuencia de las ondas debido al movimiento se conoce como ______.
      a. el efecto Doppler
      b. ondas de ultrasonido

   10. Una onda de sonido consiste de compresiones y ______.
       a. vibraciones
       b. rarefacciones

   11. Las ondas sonoras NO se mueven a través de ______.
       a. la madera
       b. el vacío

   12. Las ondas sonoras de ______ intensidad pierden energía más rápidamente.
       a. alta
       b. baja
Instrucciones: Us a las pistas para completar el crucigrama.

Horizontales
1. Efecto de eco producido por muchas reflexiones sonoras
3. Sistema que usa la reflexión de ondas sonoras bajo el agua para detectar objetos
6. Estudio del sonido
7. A veces se usa para examinar partes del cuerpo
8. Vibración cuya frecuencia es un múltiplo de la frecuencia fundamental
9. Describe las diferencias entre sonidos del mismo tono y volumen

Verticales
2. Proceso por el cual se localizan objetos al emitir sonidos e interpretar las ondas sonoras reflejadas
4. Tipo de instrumento de percusión
5. Se crea cuando tonos y cualidades sonoras específicos se usan en forma deliberada en un patrón determinado
6. Cámara hueca llena de aire que amplifica el sonido cuando su aire vibra
**Instrucciones:** Ordena las letras de los términos en bastardilla para completar las oraciones. Escribe los términos en los espacios dados.

1. El estudio del sonido se llama **úsacita**.
2. Pequeños pelos localizados en la **ólecac** conducen el sonido hacia el encéfalo.
3. El **nompatí** pasa las vibraciones del sonido al martillo, el yunque y el estribo.
4. La percepción humana de la intensidad sonora se conoce como **monuvle**.
5. Cuando percibes un cambio en el **oton**, estás percibiendo si los sonidos son altos o bajos.
6. El **fceetp pelpDor** te permite saber si la fuente de sonido se acerca o se aleja de ti.
7. Cuando los sonidos y sus reflexiones llegan a tu oído en momentos diferentes, puedes oír un efecto de eco llamado **rbercaveniróe**.
8. Un(a) **noserrado** es una cámara hueca llena de aire que amplifica el sonido cuando el aire vibra.
9. El uso de ondas de sonido bajo el agua para detectar objetos se llama **rosan**.
10. Cuando los sonidos se usan deliberadamente en un patrón dado, se crea **icúmsa**.
11. Una vibración cuya frecuencia es el múltiplo de la frecuencia fundamental es **niarcamó**.
12. El tambor es un ejemplo de un instrumento de **sócirepun**.
13. La intensidad sonora se mide en **bildecee**.
14. Todo material tiene una **cafireuenc** natural.
Directions: Answer the following questions on the lines provided.

1. What causes sound?

2. How do air molecules enable sound to travel from a radio’s speaker to your ears?

3. Describe how the ringing sound of a telephone travels from the phone to your ear.

4. Describe a compression and a rarefaction of a sound wave traveling through air.

5. Through which medium would sound travel the fastest, water, a steel bar, or nitrogen gas? Explain.

6. In which medium would sound travel the fastest, water at 10°C or water at 25°C? Why?

Directions: In questions 7 through 11, identify the parts of the ear in the diagram below by putting the correct letters in the blanks.

7. cochlea
8. eardrum
9. inner ear
10. middle ear
11. outer ear
Properties of Sound

Directions: Answer the following questions on the lines provided.

1. What indicates the amplitude of a compressional wave?

2. Compare and contrast loudness and intensity.

3. How are loudness and intensity related to the amplitude and energy of a sound wave? What is the unit of intensity?

4. Describe how ultrasound and infrasound differ from normal sound, and give an example of each.

5. What happens to the sound of a train whistle as the train approaches and then passes you? Why?

6. What does a hertz measure?

7. What is the abbreviation for hertz?

8. What do decibels measure?

9. What is the abbreviation for decibels?

10. What is the frequency of a wave?


**Directions:** Combine the word parts below to form the answers to the clues below. Work carefully. A space has been left between each word part to help you. Place one letter on each blank, and be sure the number of letters in each word part matches the number of blanks. Cross out each word part as you use it. The first definition has been started for you to use as an example.

**and** | **cy** | **men** | **o** | **quen** | **strings** | **ty**
---|---|---|---|---|---|---
**beat** | **da** | **mu** | **-res-** | **tal** | **ver**
**bra** | **fre** | **na** | **res** | **tion** | **vi**
**brass** | **fun** | **nance** | **per** | **sic** | **tones** | **winds**
**cus** | **li** | **noise** | **qua** | **sion** | **tor** | **wood**

1. effect produced when a musical instrument vibrates: **r e s o**

2. rely on vibration of air to make music (3 words)

3. rise and fall in sound intensity

4. causes music and noise

5. sound that has random patterns and pitches

6. describes the difference between two sounds having the same pitch and loudness

7. violins, guitars, and harps

8. main tone produced when an entire string vibrates up and down (2 words)

9. sounds that deliberately follow a regular pattern

10. drums and xylophone

11. produced by vibrations that are multiples of the fundamental frequency

12. hollow chamber that amplifies sound when the air in it vibrates
Using Sound

Directions: Answer the following questions on the lines provided.

1. What is acoustics?

2. Why would reverberation be a problem when using a gym for a concert?

3. What would an acoustical engineer consider when designing a concert hall? How could reverberation be reduced?

4. Describe echolocation and tell how bats use it to locate food.

5. What is sonar?

6. Explain how ultrasound is used to produce images of internal structures in the body.

7. When is it better to use ultrasound and when is it better to use X rays for detecting medical problems?

8. Why might ultrasound be a treatment of choice over surgery for kidney stones?
Children in the 1940s knew that the cartoon character Superman could fly faster than “a speeding bullet.” This was a time when bullets could travel faster than sound waves, but planes could not. In fact, sound waves were preventing planes from reaching superfast speeds. Air can travel only as fast as the speed of sound. When a plane approaches that speed, it must push the air with it. The air cannot move any faster as it becomes compressed. That caused the planes of the 1940’s to shake furiously and often break apart or spin out of control. It seemed to a number of people that the air created an invisible “sound barrier” through which no planes could pass.

**Not Yet Faster than a Speeding Bullet**

Air Force test pilot Chuck Yeager and a group of other pilots and aeronautical engineers were determined to break through the sound barrier. Because bullets could go faster than the speed of sound, the engineers used them as a model. They copied the shape of a .50-caliber bullet to design the airplane’s nose. They hoped the plane would reach speeds greater than Mach 1. Mach numbers indicate the relative speed of an object compared to the speed of sound. Mach 1 equals the speed of sound, Mach 2 equals twice the speed of sound, and so on.

Yeager and other pilots made a number of test runs. After each test flight, the people working on the project learned a little more about how and why the planes behaved as they did. The engineers made changes to the planes based on what they learned.

**The Record Breaker**

On the morning of October 14, 1947, technicians prepared Chuck Yeager’s plane for its flight. At Yeager’s suggestion, they even rubbed the plane’s windshield with shampoo to keep it from frosting over at the high, cold altitudes it would reach. A B-29 took Yeager and his smaller X-1 rocket plane, named the *Glamorous Glennis* after his wife, up to an altitude of about 9,144 m. Then the B-29 released the *Glamorous Glennis*, and Yeager took off to make aeronautical history.

He had been given strict instructions not to go faster than Mach 0.96 unless he felt it was absolutely safe to do so. After Yeager determined the plane was in good shape, he accelerated to Mach 0.98 and continued to press forward. The indicated needle on the Machmeter lurched past the last number on the scale. Yeager had done it! He was flying faster than the speed of sound. He maintained his pace for about 20 seconds. Then he cut his speed and glided down to the dry lakebed he had left just 14 minutes earlier.

1. What happened to airplanes that approached the speed of sound before Yeager’s flight?

2. What do you think a Machmeter is? What is an equivalent piece of equipment on a car?

3. Once a plane exceeds the speed of sound, would you expect the flight to be rough or smooth? Explain your answer.
Humans cannot make sounds of very low frequency, because humans do not have the right body structure and strength to do so. In addition, human hearing can’t detect sounds below about 20 Hz.

**Low Frequency Communication**

However, the elephant is strong enough and has the right body structure to produce low frequency sound waves. Until recently, scientists did not know how elephants communicated over large distances. They thought perhaps the elephants produced a chemical that could be smelled in the air, but that proved false. As it turns out, elephants actually do communicate with each other, but they do it with sound rather than smell.

The front of an elephant’s skull is very large, broad, and flat. Elephants also have large lungs and muscles that enable them to produce loud sounds. If you have ever heard an elephant trumpet in a movie or on television, you know it can make quite a loud sound by blasting air through its trunk and mouth. This impressive noise is one form of communication used by elephants.

Elephants also use all that energy to make very low sounds—so low, in fact, that we cannot hear them. They send air up to the front of their face where the sinuses are broad and flat, and vibrate the bones of their skulls. This vibration produces a very low tone. These low tones require lots of energy to produce, and the elephant sounds carry over a long distance. Because adult males live away from the females, this particular kind of call is used when males are trying to communicate with females.

**Testing Communication**

A team of scientists tested this hypothesis of low-frequency communication by setting up speakers in elephant territories and playing very low sounds. After a short while, elephants gathered around the speakers. The elephants were not very happy though, because they thought they were coming to see other elephants, and instead they found a speaker.

The next time you see elephants in a zoo, look at the sides of their heads. If you see the skin flutter from the low-frequency sounds, you will know they are talking to each other.

1. Why can’t humans make very low sounds?

2. What are three things elephants have that help them make low sounds?

3. Why do elephants make low-frequency sounds?

4. How can you tell if an elephant is making subsonic sounds?
What is music?

You have learned how different musical instruments make sounds based on their shape and material. Musical instruments are designed to produce vibrations. These vibrations become the compression waves we hear as sound.
In this activity you will design a musical instrument and draw a diagram of it in the space below. Your instrument can be any shape you choose and can make as many different sounds as possible. However, your instrument must have at least three of the following components: strings must vibrate somewhere, air must blow through a tube, it must have finger holes, somewhere a percussion sound must be made, and an overtone must be produced. Be sure to label these components on your diagram. Your instrument can sit on the ground or be held.

1. How does your instrument produce a string vibration?

2. How does it produce a wind vibration?

3. Are there any percussion sounds? How are they produced?
Before today’s era of instantaneous electronic communications, military leaders depended on the sound of battle to give them their cue to “march toward the sound of the guns.” This was especially true in the Civil War, but sometimes generals were betrayed by something called acoustic shadows. An acoustic shadow is caused by winds, air temperature differences, or hills and forests. It can mask nearby sounds or carry them great distances.

Gettysburg

One battle affected by an acoustic shadow was that at Gettysburg, in Pennsylvania. Union General George Meade was just 19 km away in Taneytown, Maryland, but couldn’t hear the sounds of battle, although the sound could be heard in Pittsburgh, 240 km away. On the second day of the battle, Confederate General James Longstreet planned to attack a hill called Little Round Top, which would give his men high ground to fire on the Union forces. Confederate General Richard Ewell listened for the sound of Longstreet’s attack so he could launch an attack to distract Union forces. But the hills between Ewell and Longstreet absorbed the sound of Longstreet’s attack, and Ewell didn’t move. This allowed Union forces to reinforce Little Round Top and drive Longstreet back.

Seven Pines

At the battle of Seven Pines in Virginia, Confederate General Joseph Johnston planned a three-part attack on Union forces. Although the battle had started, Johnson couldn’t hear the fighting, just 3 km away, so he didn’t send in his troops. He couldn’t hear the battle because of a temperature inversion. Usually, air near the ground is warmer than air higher up, so sound waves bend upward toward the sky, making it difficult to hear distant sounds but not those nearby. But in a temperature inversion, air is warmer higher up than at ground-level, bending sound waves toward the ground, making it difficult to hear nearby sounds. That’s what happened to Johnston. By the time he received a note hours later telling him the battle was being fought, it was too late. If he had arrived earlier, the Confederates might have won. Instead, the battle ended with no clear winner, and Johnston was badly wounded.

Iuka

At Iuka, Mississippi, an acoustic shadow caused by strong winds kept Union forces from springing a trap after splitting into two groups to attack the Confederates. The Union hoped to catch the Confederates from two directions. One group of Union troops was to wait about 6.5 km away for the other group to attack, then start their own attack. But the strong winds carried the sounds of battle away from the second group of attackers. Next morning, the Union forces moved toward each other, but it was too late—the Confederates had escaped.

1. Could acoustic shadows influence battles today? Explain?

2. How might you use what you know about acoustic shadows to block sound from a busy street? Explain.
Section 1 The Nature of Sound

A. All sounds are caused by something that ______________.
   1. ______________—formed when a vibrating object collides with air molecules, transferring energy to them
   2. Compressional waves have two regions, called compressions and ______________, which push air molecules together and then spread them apart.

B. __________—the type of matter, whether liquid, solid, or gas; that sound waves travel through
   1. A sound wave’s ________ depends on the substance of the medium and whether the medium is solid, liquid, or gas.
   2. Sound travels more __________ through solids and liquids because the individual molecules are closer together than the molecules in gas.
   3. As a medium’s ______________ increases, its molecules move faster and it conducts sound waves faster.

C. Human hearing—________ stages
   1. The outer ear gathers sound waves, passing them through the ear canal to a tough membrane called the __________
   2. The vibrating eardrum passes the sound to three tiny bones in the middle ear—the __________, ________, and __________—which amplify the sound wave.
   3. The stirrup vibrates and transfers the sound to a membrane in the oval window, then on to the inner ear’s __________, a spiral-shaped structure that contains hair cells.
   4. As the hair cells in the cochlea vibrate, nerve impulses are sent through the __________ nerve to the brain.

Section 2 Properties of Sound

A. The amount of energy a wave carries corresponds to its ______________, which is related to the density of the particles in the compressions and rarefactions.
   1. ______________—the amount of energy that flows through a certain area in a specific amount of time
   2. ______________—human perception of sound intensity
   3. Each unit on a scale that measures sound intensity is a ______________.
B. __________—how low or high a sound seems to be
   1. ____________ is the number of compressions or rarefactions of a sound wave that pass per second; human ears can hear frequencies from about 20 to 20,000 Hz.
   2. ____________ waves are sound frequencies over 20,000 Hz that have medical and scientific uses.
   3. Infrasonic or ____________ waves with frequencies below 20 Hz usually can’t be heard but may feel like a rumble.

C. ________________—change in pitch or wave frequency due to a moving; either the source of the wave or the observer can be moving

Section 3  Music

A. __________—sounds that are deliberately used in a regular pattern
   1. ________________—frequency at which the a material vibrates
   2. ________________—the ability of a medium to vibrate by absorbing energy at its own natural frequency

B. Sound ______________—the differences among sounds of the same pitch and loudness
   1. ________________—the main tone played and heard
   2. ________________—vibration with a frequency that is a multiple of the fundamental frequency

C. Musical instruments—__________ used to make musical sounds
   1. ____________—instruments in which sound is produced by plucking, striking, or drawing a bow across tightly stretched strings
   2. Brass and woodwinds—air vibration in a ____________, or hollow chamber that amplifies sound, with the pitch determined by the length of the vibrating tube of air
   3. ____________ instruments produce sound by being struck, shaken, rubbed, or brushed.

D. ____________—a pulsing vibration in loudness

Section 4  Using Sound

A. Uses of sound—_________________, warning signals, information

B. ________________—study of sound, which can prevent excessive reverberation and create good listening environments

C. ________________—process of locating objects by sending out sounds and interpreting the waves reflected back
D. __________—a system that uses the reflection of underwater sound waves to locate objects

E. ____________ waves are used in medicine to diagnose, monitor, and treat many conditions.
   1. Can produce images of ____________ structures for detection of medical problems
   2. Can _________ certain medical problems such as kidney stones or gallstones
Assessment
Part A. Vocabulary Review

Directions: Unscramble the letters to find the terms described in the statements below. Write the terms on the lines provided.

1. underwater sound detecting system  
adnaors
2. perception of sound intensity  
sunsledo
3. sounds with frequencies above 20,000 Hz  
truunsdalo
4. multiple echoes in a concert hall  
eerrrtiavobn
5. determined by the amplitude of a sound wave  
ttiinnyse
6. multiples of the fundamental frequency  
eeortvns
7. regular pattern of pitch and rhythm  
 cuims
8. study of sound  
ssccuaoti
9. perception of the frequency of sound  
 thicp
10. used by dolphins to find prey  
ooociclatnhe
11. difference among sounds of the same pitch  
yqlatiu
12. change of pitch due to a moving wave source  
 proDlep cefet
13. passes sound vibrations to the middle ear  
 adeumrr
14. hollow chamber that amplifies sound when air is vibrated  
atnoorrse
15. coiled structure in the inner ear  
 occalhe

Part B. Concept Review

Directions: Answer the following questions on the lines provided.

1. Describe how a sound wave travels through the ear.

2. Explain how a trumpet produces a sound and how the pitch can be changed.
Chapter Review (continued)

Directions: Identify each statement as true or false. If false, change the term in italics to make the statement true.

3. Sound is caused by an echo.

4. Infrasound is used to clean glassware.

5. The bowl of a kettledrum that amplifies sound is called an echochamber.

6. Loudness is determined by the pitch of a sound.

7. As you move away from a warning siren, the pitch decreases.

8. Multiples of the fundamental frequency are called beats.

9. Music is sound without a set pattern.

10. Ultrasound is used to study body organs.

Directions: Use the diagrams to answer questions 11 and 12.

A.  

11. Which diagram shows the lowest pitch?

B.  

12. Which diagram shows the loudest sound?
## I. Testing Concepts

**Directions:** Match the description in the first column with the item in the second column by writing the correct letter in the space provided. Some items in the second column will not be used.

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1. the part of the violin that amplifies the sound of the strings  
   a. eardrum  
2. the way the brain perceives the intensity of a sound.  
   b. cochlea  
3. the study of sound  
   c. intensity  
4. finding objects by emitting sound waves and interpreting the reflected sound  
   d. loudness  
5. the change in pitch of a sound caused by motion of either the sound source or receiver  
   e. frequency  
6. used to locate objects under water by the reflection of sound waves.  
   f. pitch  
7. the highness or lowness of a sound  
   g. ultrasonic waves  
8. membrane that vibrates the bones of the middle ear  
   h. Doppler effect  
9. difference between sounds of the same frequency caused by overtones  
   i. noise  
10. amount of sound energy that flows through a given area in a given time  
    j. quality  
11. unpleasant echo effect caused by many sound reflections  
    k. music  
12. sounds with frequencies above 20,000 Hz  
    l. overtones  
13. multiples of the fundamental frequency  
    m. resonator  
14. a combination of sounds and distinct pitches following a specified pattern  
    n. echo  
15. fluid-filled structure of the inner ear that contains hair cells  
    o. reverberation  
    p. acoustics  
    q. echolocation  
    r. sonar

## II. Understanding Concepts

### Skill: Recognizing Cause and Effect

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

1. An increase in temperature will (increase, decrease, not affect) the speed of a sound wave.
2. Increasing the frequency of a sound wave will change the (loudness, intensity, pitch) of a sound.
3. The pitch of the siren on a rapidly approaching fire truck will (increase, decrease, remain the same).
4. We cannot hear the sounds made by some heavy machinery because the frequencies are in the (infrasonic, ultrasonic, Doppler) range.

**Skill: Comparing and Contrasting**

5. Compare and contrast noise and music.

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**Skill: Sequencing**

6. Using the numbers 1–4, put these stages of hearing in the correct order.

   ____  a. The amplified waves are converted to nerve impulses that travel to the brain.
   ____  b. The ear amplifies the waves.
   ____  c. The ear gathers compressional waves.
   ____  d. The brain decodes and interprets the nerve impulses.

**Skill: Using Diagrams**

**Directions:** Identify the parts of the ear indicated in the diagram.

1. ______  7. ______  8. ______
2. ______  9. ______  10. ______
3. ______  11. ______
III. Applying Concepts

Directions: Match the materials in the first column with the speeds of sound within those materials at 0°C in the second column by writing the correct letter in the space provided.

| ______ | 1. wood       | a. 347 m/s |
| ______ | 2. air        | b. 1,498 m/s |
| ______ | 3. water      | c. 3,828 m/s |

Directions: Answer the following questions on the lines provided.

4. If the amplitude of a sound wave decreases, what happens to its loudness, intensity, pitch, and speed?

5. A train is blowing its whistle as it is approaching you at a crossing. What happens to the whistle's intensity, speed, frequency, and wavelength?

6. In a science fiction movie, a nearby spaceship explodes and you hear the explosion on your ship. Is this realistic? Why or why not?

Directions: Use the following diagrams to answer questions 8 through 10.

7. Which diagram represents a loud sound?

8. Which diagram represents a soft sound?

9. Explain your answers to questions 7 and 8.

---

A

Compression Refraction

B

Compression Refraction
IV. Writing Skills

Directions: Answer the following questions using complete sentences.

1. Suppose your class invites a person to give a speech in the gym of your school. When you test the sound system, you find that there are too many echoes. What might you do?

2. A piano and a violin playing a note at the same frequency and loudness sound very different. Explain.

3. How can a bat use echolocation and the Doppler effect to tell whether an insect it detects is approaching or moving away?

4. If someone you knew had gallstones, what treatment might you recommend?
Transparency Activities
This F/A-18C Hornet is pictured just as it breaks the sound barrier. When an object reaches the speed of sound, around 331 m/s, it creates a pressure disturbance shaped like a cone. Standing on Earth, we can hear this cone-shaped disturbance—it’s called a sonic boom.

2. Can you hear sounds when you are underwater? What does this tell you about sound?
Two hundred years ago the world was pretty quiet. In the years since, however, more and more machines have been making more and more noise. Exposure to loud noises can cause fatigue, nausea, headaches, and hearing loss.

1. How do sounds differ?
2. Why do you think this worker is wearing earguards?
Ancient Flutes of Bone

In 1987, a Chinese archaeological team unearthed six ancient flutes made of bone. Tests showed that five of the six might crack if played, but the sixth was intact and playable. Radiocarbon dating indicated the flute was almost 9,000 years old, making it the oldest known functionally intact musical instrument.

1. How is music different than noise?
2. Name some other musical instruments. Do the instruments you named produce sound the same way a flute does?
3. How do the holes affect the sound of a flute?
Oilbirds are the world’s only nocturnal, fruit-eating birds. Living in South American caves, oilbirds emit high-speed clicks and use the echoes to navigate and feed.

1. How do oilbirds use sound to their advantage?
2. What other creatures use sound in a similar way?
3. What are some technical uses of sound?
The Ear

- **Outer Ear**: Gather sound waves
- **Middle Ear**: Amplify waves
- **Inner Ear**: Convert waves to nerve impulses

### Activity

1. The Ear
1. What is the most common reason someone’s hearing is damaged?

2. What is a decibel?

3. What are the three regions of the ear and the function of each?

4. In which region of the ear do you find the hammer, anvil, and stirrup?

5. By what nerve in the inner ear do sound impulses get to the brain?

6. What causes the eardrum to vibrate?
Directions: Carefully review the diagram and answer the following questions.

1. Sound waves are collected and concentrated by the ___.
   A inner ear   C anvil
   B outer ear   D stirrup and hammer

2. Some people work in noisy areas. Which of the following would be the best way to help protect a person’s hearing from damage when exposed to a loud work environment?
   F Use ultrasound waves to weaken the anvil.
   G Surgically remove the cochlea.
   H Use a Doppler effect to interfere with the sound waves.
   J Use earplugs to block the eardrum.

3. Waves transfer energy through a variety of different media. A sound wave’s energy is transferred from the air and into a solid at the ___.
   A outer ear
   B eardrum
   C anvil, hammer, and stirrup
   D cochlea
Teacher Support and Planning

Content Outline for Teaching.......................... T2
Spanish Resources ...................................... T5
Teacher Guide and Answers ......................... T9
Section 1  The Nature of Sound

A. All sounds are caused by something that vibrates.

1. Sound waves—formed when a vibrating object collides with air molecules, transferring energy to them.
2. Compressional waves have two regions, called compressions and rarefactions, which push air molecules together and then spread them apart.

B. Medium—the type of matter, whether liquid, solid, or gas; that sound waves travel through.

1. A sound wave’s speed depends on the substance of the medium and whether the medium is solid, liquid, or gas.
2. Sound travels more quickly through solids and liquids because the individual molecules are closer together than the molecules in gas.
3. As a medium’s temperature increases, its molecules move faster and it conducts sound waves faster.

C. Human hearing—four stages

1. The outer ear gathers sound waves, passing them through the ear canal to a tough membrane called the eardrum.
2. The vibrating eardrum passes the sound to three tiny bones in the middle ear—the hammer, anvil, and stirrup—which amplify the sound wave.
3. The stirrup vibrates and transfers the sound to a membrane in the oval window, then on to the inner ear’s cochlea, a spiral-shaped structure that contains hair cells.
4. As the hair cells in the cochlea vibrate, nerve impulses are sent through the auditory nerve to the brain.

DISCUSSION QUESTION:
Why must there be a medium for sound to exist?  Sound is caused by molecules colliding. If there is no medium with molecules of matter to collide, sound cannot exist.
Section 2  Properties of Sound

A. The amount of energy a wave carries corresponds to its amplitude, which is related to the density of the particles in the compressions and rarefactions.

1. Intensity—the amount of energy that flows through a certain area in a specific amount of time
2. Loudness—human perception of sound intensity
3. Each unit on a scale that measures sound intensity is a decibel.

B. Pitch—how low or high a sound seems to be

1. Frequency is the number of compressions or rarefactions of a sound wave that pass per second; human ears can hear frequencies from about 20 to 20,000 Hz.
2. Ultrasonic waves are sound frequencies over 20,000 Hz that have medical and scientific uses.
3. Infrasonic or subsonic waves with frequencies below 20 Hz usually can’t be heard but may feel like a rumble.

C. Doppler effect—change in pitch or wave frequency due to a moving wave source—either the source of the wave or the observer can be moving

DISCUSSION QUESTION:
What is the difference between intensity and pitch? Intensity is amount of energy and is perceived as loudness; pitch involves frequency of compressions and rarefactions per second and is perceived as high or low sounds.

Section 3  Music

A. Music—sounds that are deliberately used in a regular pattern

1. Natural frequency—frequency at which the a material vibrates
2. Resonance—the ability of a medium to vibrate by absorbing energy at its own natural frequency

B. Sound quality—the differences among sounds of the same pitch and loudness

1. Fundamental frequency—the main tone played and heard
2. Overtone—vibration with a frequency that is a multiple of the fundamental frequency
C. Musical instruments—devices used to make musical sounds
   1. **Strings**—instruments in which sound is produced by plucking, striking, or drawing a bow across tightly stretched strings
   2. Brass and woodwinds—air vibration in a **resonator**, or hollow chamber that amplifies sound, with the pitch determined by the length of the vibrating tube of air
   3. **Percussion** instruments produce sound by being struck, shaken, rubbed, or brushed.

D. **Beats**—a pulsing vibration in loudness

**DISCUSSION QUESTION:**
Why do different musical instruments sound differently even when playing the same pitch at the same intensity? *Factors such as resonance and overtones make the sounds different.*

**Section 4  Using Sound**

A. Uses of sound—**entertainment**, warning signals, information

B. **Acoustics**—study of sound, which can prevent excessive reverberation and create good listening environments

C. **Echolocation**—process of locating objects by sending out sounds and interpreting the waves reflected back

D. **Sonar**—a system that uses the reflection of underwater sound waves to locate objects

E. **Ultrasound** waves are used in medicine to diagnose, monitor, and treat many conditions.
   1. Can produce images of **internal** structures for detection of medical problems
   2. Can **treat** certain medical problems such as kidney stones or gallstones

**DISCUSSION QUESTION:**
How are echolocation and sonar both similar and different? *They are similar because they both use reflected sound waves to locate objects, but different because echolocation uses air as a medium while sonar uses water as a medium.*
La naturaleza del sonido

Lo que aprenderás

■ A explicar cómo viaja el sonido a través de distintos medios.
■ A identificar qué influye en la velocidad del sonido.
■ A describir cómo te posibilita la audición la oreja.

Vocabulario

eardrum / timpano: membrana resistente del oído externo de aproximadamente 0.1 mm de grosor y que transmite las vibraciones sonoras al oído medio.
cochlea / cóclea: estructura en forma de espiral y llena de líquido ubicada en el oído interno, la cual convierte las ondas sonoras en impulsos nerviosos.

Por qué es importante

La naturaleza del sonido afecta la manera en que oyes e interpretas los sonidos.

Propiedades del sonido

Lo que aprenderás

■ A reconocer la relación entre amplitud, intensidad y volumen.
■ A describir cómo se mide la intensidad sonora y los niveles que pueden causar daños a la audición.
■ A explicar la relación entre frecuencia y tono.
■ A comentar sobre el efecto Doppler.

Vocabulario

intensity / intensidad: cantidad de energía que transporta una onda sonora, la cual se puede medir en decibeles (dB).
loudness / volumen: describe cómo los seres humanos perciben la intensidad sonora.
decibel / decibel: unidad de la escala de intensidad sonora, abreviada dB.
pitch / tono: agudeza o gravedad de un sonido, el cual se relaciona con la frecuencia de las ondas sonoras.
ultrasonic / ultrasónico: ondas sonoras con frecuencias por encima de 20,000 Hz.
Doppler effect / efecto Doppler: cambio de tono o frecuencia que ocurre cuando la fuente de una onda sonora se mueve en relación con el observador.

Por qué es importante

Las propiedades de las ondas sonoras determinan la manera en que oyes los sonidos—desde un reproductor de cedés a todo volumen, hasta un susurro.

Música

Lo que aprenderás

■ A distinguir entre ruido y música.
■ A describir por qué los distintos instrumentos tienen diferentes cualidades sonoras.
■ A explicar cómo los instrumentos de cuerda, de viento y de percusión producen música.
■ A describir la formación de ritmo.

Vocabulario

music / música: sonido creado al usar tonos específicos y cualidades sonoras que se utilizan en un patrón fijo.
quality / calidad: describe las diferencias entre sonidos que poseen el mismo tono y volumen sonoro.
overtone / armónico: vibración cuya frecuencia es un múltiplo de la frecuencia fundamental o tono principal.
resonator / resonador: cámara hueca y llena de aire de un instrumento de cuerda que amplifica el sonido cuando su aire vibra.

Por qué es importante

La música realza el gozo de vivir, pero la contaminación debido al ruido puede interferir con tal gozo.
Produce música

Existen muchos tipos distintos de instrumentos musicales. Hay muchos tipos de instrumentos musicales, los primeros instrumentos se hicieron de materiales que se obtenían fácilmente tales como la arcilla, conchas, pieles, madera y cañas. Estos materiales eran moldeados en varios instrumentos que producían sonidos placenteros. En este laboratorio, vas a crear un instrumento musical usando los materiales que estén disponibles, así como lo hicieron tus antepasados.

Pregunta realista
¿Cómo puedes crear diferentes tonos usando sólo tubos de ensayo y agua?

Materiales
tubos de ensayo
gradilla para tubos de ensayo

Metas
■ Demostrar cómo producir música usando agua y tubos de ensayo.
■ Predecir cómo cambiarán los tonos al llenar los tubos de ensayo con más o con menos agua.

Procedimiento
1. Echa distintas cantidades de agua en cada uno de los tubos de ensayo.
2. Pronostica cualquier diferencia que crees que oirás en los tonos sonoros de los diferentes tubos de ensayo.
3. Sopla a través de la boca de cada tubo de ensayo.
4. Anota cualquier diferencia que observes en los tonos que escuchaste de cada tubo de ensayo.

Concluye y aplica
1. Describe cómo cambiaron los tonos según la cantidad de agua que había en el tubo de ensayo.
2. Explica por qué el tono depende de la altura del agua.
3. Resume por qué cada tubo de ensayo produce un tono distinto.
4. Explica cómo la resonancia amplifica el sonido producido por un tubo de ensayo.
5. Explica cómo difieren las frecuencias naturales de las columnas de aire en cada tubo de ensayo.
6. Compara y contrasta la manera en que los tubos de ensayo producen música y la manera en que una flauta produce música.

Usa el sonido
Lo que aprenderás
■ A reconocer algunos de los factores que determinan el diseño de una sala de conciertos o un teatro.
■ A describir cómo algunos animales usan las ondas sonoras para cazar y navegar.
■ A hablar sobre los usos del sonar.
■ A explicar la utilidad del ultrasonido en medicina.

Vocabulario
acoustics / acústica: estudio del sonido.
echolocation / ecolocalización: proceso en el cual se localizan objetos emitiendo sonidos e interpretando las ondas sonoras que regresan y son reflejadas de nuevo.
sonar / sonar: sistema que utiliza el reflejo de las ondas sonoras para hallar objetos debajo del agua.

Por qué es importante
Las ondas sonoras tienen muchos usos, desde buscar fortunas sumergidas bajo el agua hasta el diagnóstico y tratamiento de enfermedades.

Bloquea la contaminación causada por el ruido
¿Qué sonidos fuertes disfrutas y cuáles encuentras molestos? Muchos disfrutan los conciertos de música interpretados por su artista favorito, el estallido de los juegos artificiales en un 4 de julio y el ruido de la multitud cuando su equipo mete un gol o marca un
punto. A pesar de que son ruidos fuertes, la gente los disfruta durante un corto tiempo. Muchos encuentran molestos ciertos ruidos, como el tráfico, las sirenas y las conversaciones fuertes. A los ruidos molestos constantes se les llama contaminación debido al ruido. ¿Qué se puede hacer para reducir la contaminación debido al ruido? ¿Qué tipo de barreras bloquean mejor los ruidos fuertes?

**Pregunta realista**

¿Qué tipos de barreras podrían bloquear mejor la contaminación debido al ruido?

**Formula una hipótesis**

Basándote en tu experiencia con ruidos fuertes, formula una hipótesis sobre la efectividad de los diferentes tipos de barreras para bloquear la contaminación debido al ruido. Explica por qué crees que tu predicción ocurrirá.

**Metas**

- Diseñar un experimento que pruebe la efectividad de varios tipos de barreras y materiales que reduzcan la contaminación debido al ruido.
- Probar diferentes tipos de materiales y barreras para determinar el mejor bloqueador de ruido.

**Posibles materiales**

radio, reproductor de CD, trompeta, tambor u otras fuentes que emitan ruidos fuertes arbustos, árboles, paredes de concreto, paredes de ladrillo, paredes de piedra, rejas de madera, automóviles estacionados o ropa de lavandería colgada.

medidor de sonido regla métrica o cinta de medir

**Prueba tu hipótesis**

**Hace un diseño**

1. Decide qué tipo de barreras o materiales probarás.
2. Describe exactamente cómo usarás estos materiales.
3. Identifica los controles y variables que usaráis en el experimento.
4. Enumera los pasos que usarás y describe cada paso con precisión.
5. Prepara una tabla de datos en tu Diario de ciencias para anotar tus medidas.
6. Organiza los pasos de tu experimento en orden lógico.

**Sigá su diseño**

1. Pide a tu maestro(a) que revise tu plan y tu tabla de datos antes de empezar.
2. Conduce tu experimento según lo planificado.
3. Prueba cada barrera dos o tres veces.
4. Anota los resultados de cada prueba en la tabla de datos que preparaste en tu Diario de ciencias.

**Analiza tus datos**

1. Identifica las barreras que reducen más efectivamente la contaminación debido al ruido.
2. Identifica las barreras que reducen menos efectivamente la contaminación debido al ruido.
3. Compara las barreras efectivas e identifica las características en común que puedan explicar por qué reducen la contaminación debido al ruido.
4. Compara las barreras naturales que probaste con las barreras artificiales. ¿Qué tipo de barrera reduce mejor la contaminación debido al ruido?
5. Compara los diferentes tipos de materiales con los que fueron hechas las barreras. ¿Qué tipo de material redujo mejor la contaminación debido al ruido?

**Concluye y aplica**

1. Evalúa si tus resultados apoyan tu hipótesis.
2. Predice tus resultados si hubieras usado un recurso más fuerte de ruido, como por ejemplo una sirena.
3. Infieres de tus resultados cómo la gente que vive cerca de una calle muy transitada puede reducir la contaminación debido al ruido.
Spanish Resources (continued)

4. Identifica las principales fuentes de contaminación debido al ruido en tu hogar o cerca de tu hogar. ¿Cómo se puede disminuir esta contaminación?
5. Investiga cómo puede ser perjudicial para la salud la contaminación debido al ruido.

Guía de estudio

Refiérete a las figuras de tu libro de texto.

Sección 1 La naturaleza del sonido
1. El sonido es una onda de compresión creada por algo que vibra.
2. El sonido viaja rápidamente a través de los sólidos y lentamente a través de los gases. La rapidez de las ondas sonoras también aumenta a medida que la temperatura del medio aumenta. ¿Viajaría más rápidamente el sonido de un trueno en una tormenta de invierno o de verano?
4. Oír involucra cuatro etapas: reunir las ondas sonoras, amplificarlas, convertirlas en impulsos nerviosos e interpretar estas señales en el encéfalo.

Sección 2 Propiedades del sonido
1. La intensidad es la medida de la cantidad de energía que transporta una onda. Los humanos interpretan la intensidad de las ondas como volumen.
2. El tono de un sonido aumenta a medida que la frecuencia aumenta.
3. El efecto Doppler es un cambio en frecuencia que ocurre cuando una fuente de sonido está moviéndose relativamente hacia un oyente.

Sección 3 Música
1. La música consta de sonidos que se usan deliberadamente en un patrón regular.

2. Los instrumentos usan una variedad de métodos para producir y amplificar las ondas sonoras. ¿Cómo se produce el sonido mediante la vibración amplificada de las cuerdas de un violonchelo?
3. Cuando se sobreponen, las ondas sonoras pueden aumentar o disminuir en intensidad o formar ritmos.

Sección 4 Usa el sonido
1. La acústica es el estudio del sonido. ¿Por qué un gimnasio podría ser un lugar inadecuado para un concierto sinfónico?
2. Algunos animales emiten sonidos e interpretan ecos para navegar y capturar sus presas.
3. El sonar usa ondas sonoras reflejadas para detectar objetos.
4. Las ondas ultrasonicas se pueden usar en la producción de imágenes de los tejidos corporales o en el tratamiento de condiciones médicas.

Repasa las ideas principales
Hands-On Activities

MiniLab (page 3)
1. Possible answer: Objects sound deeper and more muffled when you place your fingers over your ears.
2. Through the string

MiniLab: Try at Home (page 4)
1. High pitches are harder to hear. Consonant sounds are harder to hear than vowel sounds.
2. People with hearing losses should be spoken to face-to-face, at a steady, unrushed pace with a slight emphasis on consonant sounds.

Lab (page 5)
Lab Preview
1. You could spill the water.
2. no

Conclude and Apply
1. The tone, or quality of sound, is better for test tubes having a larger column of air.
2. A higher column of water produces higher pitch.
3. Only low-frequency sound has room to vibrate in test tubes having long columns of air.
4. Because only frequencies having a node at the bottom of the air column and an antinode at the top will emerge from the tube, the sound is maximized.
5. Shorter air columns have higher frequencies than longer air columns.
6. Both produce sound when air is blown across an opening. The flute is an open-ended resonator. Its air column can be increased or decreased by opening or closing finger holes.

Lab: Design Your Own (page 7)
Lab Preview
1. constant, annoying noises
2. shrubs, trees, concrete walls, brick walls, stone walls, wooden fences, parked cars, hanging laundry

Analyze Your Data
1. Answers may vary but may include concrete and stone walls.
2. Answers will vary but may be similar to hanging laundry.
3. The effective barriers are thick and dense structures.
4. Answers will vary.
5. Answers will vary.

Conclude and Apply
1. Answer will vary
2. The ranking of sound barriers will be the same.
3. People could build some type of sound barrier between the house and the street.
4. Answers will vary.
5. Answers should include eardrum damage.

Laboratory Activity 1 (page 9)
Note: Before beginning the lab, you could use a guitar to demonstrate and then discuss differences in pitch.
Lab Note: You may demonstrate the variations in pitch in a similar way with a guitar or violin.
Data and Observations
1. Answers will vary.
2. Thicker rubber bands produce lower-pitched sounds.
3. As the length of the rubber band is shortened, the pitch becomes higher; as the length increases, the pitch becomes lower.

Questions and Conclusions
1. The pitch of the sound rises as the length increases.
2. The frequency rises as the thickness decreases.
3. The longer the string the deeper the sound.

Laboratory Activity 2 (page 11)
Note: Remind students to use caution when working with the wire cutters, staples, hammer and nails. For safety reasons, you could cut all the wire pieces beforehand. You could also use a staple gun to secure the wire coat hanger pieces to the wooden block. Freezer bags and plastic shopping bags could be used instead of plastic trash bags.
Lab Note: You might want to have each group perform for the class using the instruments they have made.
Data and Observations
Answers will vary

Questions and Conclusions
1. Twanger, xylophone, guitar, chimes
2. In a twanger, different lengths of wire produced different pitches. In the xylophone, different amounts of water in the beakers produced different pitches. In the guitar, different pitches were produced by rubber bands of different thicknesses and tightness. In the nail chimes, different sizes of nails produced different pitches.
3. The guitar is a stringed instrument. The twanger, xylophone, nail chimes, shakers, and drums all are percussion instruments.
4. Since longer length produces lower frequency the number of waves passing a point decreases. With shorter lengths producing higher frequency, the number of waves passing a point increases.
Meeting Individual Needs
Directed Reading for Content Mastery (page 17)

Overview
1. gathered
2. amplified
3. wavelength
4. frequency
5. pattern
6. music
7. b
8. d
9. a
10. c
11. e

Sections 1 and 2 (page 18)
1. vibrations
2. sound waves
3. solids
4. temperature
5. cochlea
6. a
7. b
8. a
9. a
10. b
11. b
12. b

Sections 3 and 4 (page 19)
1. vibrations
2. sound waves
3. solids
4. temperature
5. cochlea
6. a
7. b
8. a
9. a
10. b
11. b
12. b

Key Terms (page 20)
1. acoustics
2. cochlea
3. eardrum
4. loudness
5. pitch
6. Doppler effect
7. reverberation
8. resonator
9. sonar
10. music
11. overtone
12. percussion
13. decibels
14. frequency

Lectura dirigida para Dominio del contenido (pág. 21)

Sinopsis
1. recogidas
2. amplificadas
3. longitud de onda
4. frecuencia
5. patrón
6. música
7. b
8. d
9. a
10. c
11. e

Secciones 1 y 2 (pág. 22)
1. vibraciones
2. ondas sonoras
3. sólidos
4. temperatura
5. cóclea
6. a
7. b
8. a
9. a
10. b
11. b
12. b

Secciones 3 y 4 (pág. 23)

Términos claves (pág. 24)
1. acústica
2. cóclea
3. timpano
4. volumen
5. tono
6. efecto Doppler
7. reverberación
8. resonador
9. sonar
10. música
11. armónica
12. percusión
13. decibeles
14. frecuencia

Reinforcement (page 25)

Section 1
1. Sound is caused by vibrating matter. Sound travels in compressional waves.
2. Air molecules in contact with the radio speaker begin to vibrate. Energy is transferred to other air molecules, causing them to vibrate. Eventually, this energy transfer reaches the molecules near your ear.

3. The ringer in the phone starts the air molecules near it vibrating, transferring energy to them. These molecules hit other molecules and transfer energy. This collision and transfer of energy forms a sound wave that eventually reaches your ear.

4. In a compression, the air molecules are pushed together. In a rarefaction, the air molecules are more spread apart.

5. Sound would travel fastest through the steel bar, a solid. Sound passes through a solid faster than it does through a liquid or a gas because the particles are closer together and collide more often.

6. Sound would travel fastest in water at 25ºC. The higher the temperature of the medium, the faster the particles move and the more likely they are to collide with each other.

7. The amplitude is shown by the density of the particles in the compressions and rarefactions.

8. Both intensity and loudness are related to the amount of energy a wave carries. Intensity is the amount of energy that flows through a certain area in a given time. Loudness is the human perception of sound intensity.

9. The greater the amplitude, the more energy a wave carries. The greater the energy, the greater the intensity and the louder the sound. The unit of intensity is the decibel.

10. Both are out of the normal hearing range. Ultrasound has frequencies above 20,000 Hz. An example is the sounds emitted by bats in echolocation. Infrasound has frequencies below 20 Hz. Earthquakes and heavy machinery vibrate at these frequencies.

11. As the train approaches, the pitch rises because the sound waves are pushed closer together and the frequency increases. When the train passes the pitch drops because the sound waves are more spread out and the pitch is lower.

Section 3 (page 27)
1. resonance
2. brass and wood winds
3. beat
4. vibration
5. noise
6. quality
7. strings
8. fundamental frequency
9. music
10. percussion
11. overtones
12. resonator

Section 4 (page 28)
1. It is the study of sound.
2. Reverberation is an echoing effect caused by many reflections of sound. A gym has many hard surfaces, such as the floor and walls, that would cause many confusing and unpleasant echoes that would interfere with the music.

3. The engineer would consider the size and shape of the hall as well as the coverings of the surfaces. She would cut down reverberations by choosing soft, porous coverings for the walls and ceilings and thick carpets for the floor.

4. Echolocation is the process of emitting sound and interpreting the sound that is reflected back. A bat emits very high frequency sounds that hit anything in its path. By interpreting the echo, the bat can recognize insects, tell where they are, and how fast and in what direction they are moving.

5. Sonar is a form of echolocation that uses the reflection of underwater sound waves to detect objects.

6. High frequency sound waves are bounced off various internal organs in a patient’s body, and the reflections are interpreted by a computer to produce sonograms.

7. Ultrasound is better for producing images of soft tissue in the body. X rays are better for examining bones and lungs, because hard tissue and air absorb ultrasonic waves instead of reflecting them.

8. Ultrasound is less invasive, and recovery is quicker than from surgery.

Enrichment (page 29)
Section 1
1. The plane would shake, often spin out of control, or break apart.

2. It is a gauge of an aircraft’s speed and is based on the speed of sound. A car’s speedometer would be the equivalent of a Machmeter.

3. The flight would be smooth, since the aircraft would be past the limiting factor of air being unable to exceed the speed of sound.
Section 2 (page 30)
1. Humans don’t have the body structure and strength to make very low sounds. In addition, humans can’t detect sounds below a certain frequency.
2. Elephants have large, broad and flat skulls, as well as large lungs and muscles to provide strong air currents.
3. They make low frequency sounds to allow them to communicate.
4. If the skin on the sides of their heads is fluttering, they are making low frequency sounds.

Section 3 (page 31)
Answers will vary considerably. Look for logical constructions. Sample answers:
1. My first part of the instrument is like a cello, where I play the strings before the sound enters a tube.
2. The string vibration goes into a metal tube that is wound around in three circles before it opens like a trumpet.
3. In the middle of the metal tube is a small flap of metal. So the air goes through the metal, it makes the flap tape against the top of the tube.

Section 4 (page 32)
1. Answers will vary, but many students may say no. Electronic communications would provide the necessary intelligence. Commanders wouldn’t have to rely on battle sounds to coordinate strategies.
2. Answers should include a recognition that sound-absorbing materials should be used as a barrier.

Note-taking Worksheet (page 33)
Refer to Teacher Outline, student answers are underlined.

Assessment

Chapter Review (page 37)

Part A. Vocabulary Review
1. sonar (14/4)
2. loudness (4/2)
3. ultrasound (15/4)
4. reverberation (12/4)
5. intensity (5/2)
6. overtones (9/3)
7. music (8/3)
8. acoustics (12/4)
9. pitch (6/2)
10. echolocation (13/4)
11. quality (9/3)
12. Doppler effect (7/2)
13. eardrum (3/1)
14. resonator (10/3)
15. cochlea (3/1)

Part B. Concept Review
1. The sound is collected by the outer ear and makes the eardrum vibrate. The eardrum is connected to the bones of the middle ear, so they vibrate. This causes the inner ear to vibrate in turn, passing the vibrations to the cochlea, a structure filled with liquid containing hair cells. Vibration of the hair cells stimulate the auditory nerves. (3/1)
2. As you blow into the mouthpiece, your lips make the mouthpiece vibrate. The vibration is amplified when the mouthpiece makes the air in the tube of the trumpet vibrate. The pitch is changed by changing the length of the column of air. (10/3)
3. false; a vibration (1/1)
4. false; ultrasound (13/4)
5. false; a resonator (10/3)
6. false; intensity (5/2)
7. t (7/2)
8. false; overtones (9/3)
9. false; noise (8/3)
10. t (7/2)
11. B (6/2)
12. A (6/2)

Chapter Test (page 39)

I. Testing Concepts
1. m (9/3)
2. d (4/2)
3. p (12/4)
4. q (13/4)
5. h (7/2)
6. r (14/4)
7. f (6/2)
8. a (3/1)
9. j (10/3)
10. c (5/2)
11. o (12/4)
12. g (15/4)
13. l (9/3)
14. k (8/3)
15. b (3/1)

II. Understanding Concepts
1. increase (2/1)
2. pitch (6/2)
3. increase (7/2)
4. infrasonic (6/2)
5. Noise has random patterns and pitches; music has sounds that are deliberately used in a regular pattern. (8/3)
6. a. 3
   b. 2
   c. 1
   d. 4
7. outer ear
8. middle ear
9. inner ear
Teacher Guide & Answers (continued)

10. eardrum
11. cochlea (6–11, 3/1)

III. Applying Concepts
1. c
2. a
3. b (1–3, 1/1)
4. Loudness and intensity decrease, pitch and speed stay the same. (4/2)
5. Intensity and speed stay the same, frequency increases and wavelength decreases. (7/2)
6. It is not realistic. Sound waves need a medium to travel through, and there is very little matter in space.
7. B
8. A
9. In diagram B, the molecules are more compressed, denoting a louder sound than in diagram A, in which the molecules are less compressed. (8-10, 5/2)

IV. Writing Skills
1. You need to cut down on the sound reflections. You might cover the walls with fabric and put some kind of carpeting on the floor. The speech could also be relocated to a room with better acoustics. (12/4)
2. The qualities of the sounds are different. The two instruments are playing the same fundamental frequency, but each instrument has a different pattern of overtones. (15/4)
3. An insect flying toward the bat would return an echo of higher frequency than that the bat emitted. An insect flying away from the bat would return a lower frequency. (13/4)
4. You could suggest he investigate treatment with ultrasound because it would be less invasive and recovery would be faster. (15/4)

Transparency Activities

Section Focus Transparency 1 (page 44)

Booommmm!

Transparency Teaching Tips
- This transparency introduces sound. Explain that all sound is the result of vibrations. These vibrations occur in the transmitting medium (gas, liquid, or solid), transferring energy.
- Ask the students to explain how we hear these waves. The ear gathers vibrations, funneling them along the ear canal to the eardrum. The eardrum vibrates with the waves and transmits these vibrations to the tiny bones of the middle ear. The middle ear amplifies the vibrations as they are passed on to the inner ear, where they are converted to nerve impulses that the brain interprets.
- When an object travels slower than the speed of sound, it pushes through air molecules, which have time to separate and flow around the object. When an object reaches the speed of sound, air molecules are unable to move fast enough to out-distance the object. Instead, the object plows into this air mass, creating a disturbance as the air molecules are forced aside. This creates a vibrating, funnel-shaped cone of energy. When the edge of this cone comes into contact with Earth (and our eardrums), the vibrations are transferred to our ears.
- Aircraft traveling at the speed of sound don’t create a single sonic boom heard only in one location. Instead, such aircraft create moving cones that travel behind them. The booms are heard by everyone in the paths of the cones as they sweep along the ground.

Content Background
- At subsonic speeds, the sound waves created by a jet travel faster than the jet itself. But, as it reaches the speed of sound, the jet travels faster than the sound waves it creates. The pressure of the sound waves, closing in behind the jet as it speeds through them, causes condensation of the air, creating a cloud of water vapor.
- The shock wave of a sonic boom transfers enough energy to break windows. For this reason, commercial aircraft are forbidden to reach sonic speeds over land.
- A supersonic aircraft creates a series of shock waves, each coming off a different aircraft surface. Two larger waves are also created, one off the leading and one off the trailing edge of the wing. The initial bow wave compresses air molecules; and, this compression causes the air to become heated. The speed of sound increases with air temperature, so the following shock waves, generated by other aircraft surfaces, catch up to the bow wave. Thus, one intense wave is created, the energy reaching our ears as a vibrating boom.
- The speed of sound varies slightly, depending on air temperature and moisture content.
- In 1947, Chuck Yeager, flying the experimental X-1 aircraft, was the first person to reach the speed of sound.
- The crack of a bullwhip is created when the tip of the whip reaches the speed of sound. In fact, some people consider the whip the first human-made object to break the speed of sound.

Answers to Student Worksheet
1. Yes. Intense sound can cause hearing damage and break glass.
2. Yes. Sound waves can travel through any type of matter, solid, liquid, or gas.
Section Focus Transparency 2 (page 45)

Noisy Machines

Transparency Teaching Tips
- You may use this transparency to illustrate how the characteristics of sound waves affect human hearing. If possible, get a tuning fork and strike it in front of the students. Move about, allowing them to observe how it vibrates and how the sound slowly dissipates. Discuss the relationship between vibration, sound waves, and hearing.
- Ask the students to visualize a stone being tossed into a pond. The series of concentric waves created are similar to the waves created when a sound is made.
- Using a model or map of an ear, describe how sound waves are picked up by the eardrum, transmitted through the bones of the middle ear to the cochlea of the inner ear, and the resulting impulses sent to the brain.
- Looking at the worker on the transparency, ask the students to ascertain how the worker’s ears would be damaged if earguards were not worn.

Content Background
- People perceive a sound’s intensity as loudness. Intensity is a measure of how much energy the waves carry past a point in a given time.
- Sound intensity is measured in decibels. A whisper can be measured at 20 decibels, a telephone at 70 decibels, and a jet (up close) at 140 decibels. Above 140 decibels, pain is experienced but not sound.
- Prolonged exposure to loud noises or to sudden loud noises can cause sensorineural hearing loss (problems with the auditory nerve leading to the brain). This type of hearing loss cannot be surgically restored.
- Sound travels four times faster through water than it does through the air (the denser and more compressed a medium, the better it transmits sound).

Answers to Student Worksheet
1. People perceive differences in loudness and pitch. What we call loudness is our perception of a sound’s intensity. Pitch is related to frequency, or the number of waves that pass a point in one second.
2. The earguards reduce the intensity of the sound that reaches the ears by reflecting and absorbing some of the waves.

Section Focus Transparency 3 (page 46)

Ancient Flutes of Bone

Transparency Teaching Tips
- This transparency can be used to help the students reflect on the difference between music and noise. While in part subjective, the difference concerns pattern and pitch. Use a ruler or stick and tap out a random sequence and ask the students if they considered it music. Tap out a patterned sequence. Ask them again. If they answered in the affirmative, ask them to explain what made the difference.
- Play a recording of birds singing, people talking, a book being dropped, the blackboard being scratched, and a person whistling. Ask the students to classify each as to whether it’s music or noise. Ask them to develop criteria for each category.
- Ask the musicians in class to explain how their individual instruments make vibrations and how they turn the noise into music.

Content Background
- Noise is sound without pattern, definite pitch, or consistent frequency.
- The flute was one of the first instruments ever created. The flutes pictured were carved from the hollow wing bones of cranes. The playable flute was recently used to record a Chinese folk song.
- A flute fragment made of a bear femur has been dated between 43,000 and 82,000 years old. It’s the oldest instrument found to date.

Answers to Student Worksheet
1. Music’s pitch and frequency are patterned. Noise is just random sound without pattern.
2. Answers may vary.
3. In wind instruments such as the flute, the sound made is related to the length of the instrument. Covering or uncovering holes changes the sounding length.

Section Focus Transparency 4 (page 47)

A Late Night Snack

Transparency Teaching Tips
- This transparency introduces uses of sound. Explain that echolocation is a physiological process whereby an animal emits sound waves and uses the reflected waves for navigation or catching prey.
- Point out that while bats are the most well-known echolocators, the technique is also used by whales, porpoises, and even two species of birds. The oilbird of South America emits clicks, up to 250 per second at a frequency of 1,000 hertz. Unlike the bat, which emits its echo sounds at 12,000 hertz (beyond the range of human hearing), the oilbird can easily be heard.
- This echoing effect is called reverberation. The echolocation system used by bats and oilbirds is identical to sonar, except the latter is done underwater.
The high frequency clicking sounds of the oilbird spread out, three dimensionally, upon emission. The majority of the sound waves travel out in cone-shaped region to the front. If they strike an object, a portion of the waves are reflected back to the bird’s ears. The oilbird’s brain then interprets this data, providing orientation and navigational directions.

**Content Background**
- The oilbird, which is about 30 centimeters (12 inches) long, uses echolocation and its light-sensitive eyes to feed at night. It navigates through the pitch dark cave where it lives and out into the jungle in search of various fruit trees. It hovers, picks the fruit, and returns to its perch within the cave.
- In addition to its high-frequency clicks, the oilbird utters ear-piercing squawks. Its Spanish name, *quacheros*, means one who cries or wails.
- Before young leave the nest, they become very fat, weighing up to 100 percent more than the parents. They lose this fat as they mature. Their name is derived from the past practice of killing the young birds and boiling their fat to produce an odorless torch oil.

**Answers to Student Worksheet**
1. Oilbirds use echolocation to fly at night and find food. The ability allows them to live deep within the safety of caves.
2. Bats, whales, porpoises, and one other species of bird use echolocation.
3. Answers include sonar for navigation, ultrasound for imaging and surgery, etc.

**Teaching Transparency (page 49)**

**The Ear**

**Section 1**

**Transparency Teaching Tip**
- Point out on the transparency how a sound wave comes to the outer ear travels to the middle ear, inner ear, and up to the brain.

**Reteaching Suggestion**
- Review the vocabulary involved in the outer ear, middle ear, and the inner ear.

**Extensions**

**Activity:** Ask for student volunteers to bring in a guitar, violin, or other stringed instruments. Have the students demonstrate their instruments, then pass them around for others to examine the differences in the strings and the sounds they produce.

**Challenge:** Have students use library resources to find the decibel level for normal hearing. Then find the decibel levels for five sounds that they associate with their everyday life. Have students graph the decibel levels on a line graph.