SECTION 4

Sound Quality

Have you ever been told that the music you really like is just a lot of noise? If you have, you know that people can disagree about the difference between noise and music.

You might think of noise as sounds you don't like and music as sounds that are pleasant to hear. But the difference between music and noise does not depend on whether you like the sound. The difference has to do with sound quality.

What You Will Learn

- Explain why different instruments have different sound qualities.
- Describe how each family of musical instruments produces sound.
- Explain how noise is different from music.

Vocabulary

sound quality
noise

READING STRATEGY

Reading Organizer As you read this section, make a table comparing the way different instruments produce sound.

What Is Sound Quality?

Imagine that the same note is played on a piano and on a violin. Could you tell the instruments apart without looking? The notes played have the same frequency. But you could probably tell them apart because the instruments make different sounds. The notes sound different because a single note on an instrument actually comes from several different pitches: the fundamental and several overtones. The result of the combination of these pitches is shown in **Figure 1.** The result of several pitches mixing together through interference is **sound quality.** Each instrument has a unique sound quality. **Figure 1** also shows how the sound quality differs when two instruments play the same note.

Figure 1 *Each instrument has a unique sound quality that results from the particular blend of overtones that it has.*

Sound Quality of Instruments

The difference in sound quality among different instruments comes from their structural differences. All instruments produce sound by vibrating. But instruments vary in the part that vibrates and in the way that the vibrations are made. There are three main families of instruments: string instruments, wind instruments, and percussion instruments.

sound quality the result of the blending of several pitches through interference

Reading Check **How do musical instruments differ in how they produce sound?** (*See the Appendix for answers to Reading Checks.*)

String Instruments

Violins, guitars, and banjos are examples of string instruments. They make sound when their strings vibrate after being plucked or bowed. **Figure 2** shows how two different string instruments produce sounds.

Figure 2 **String Instruments**

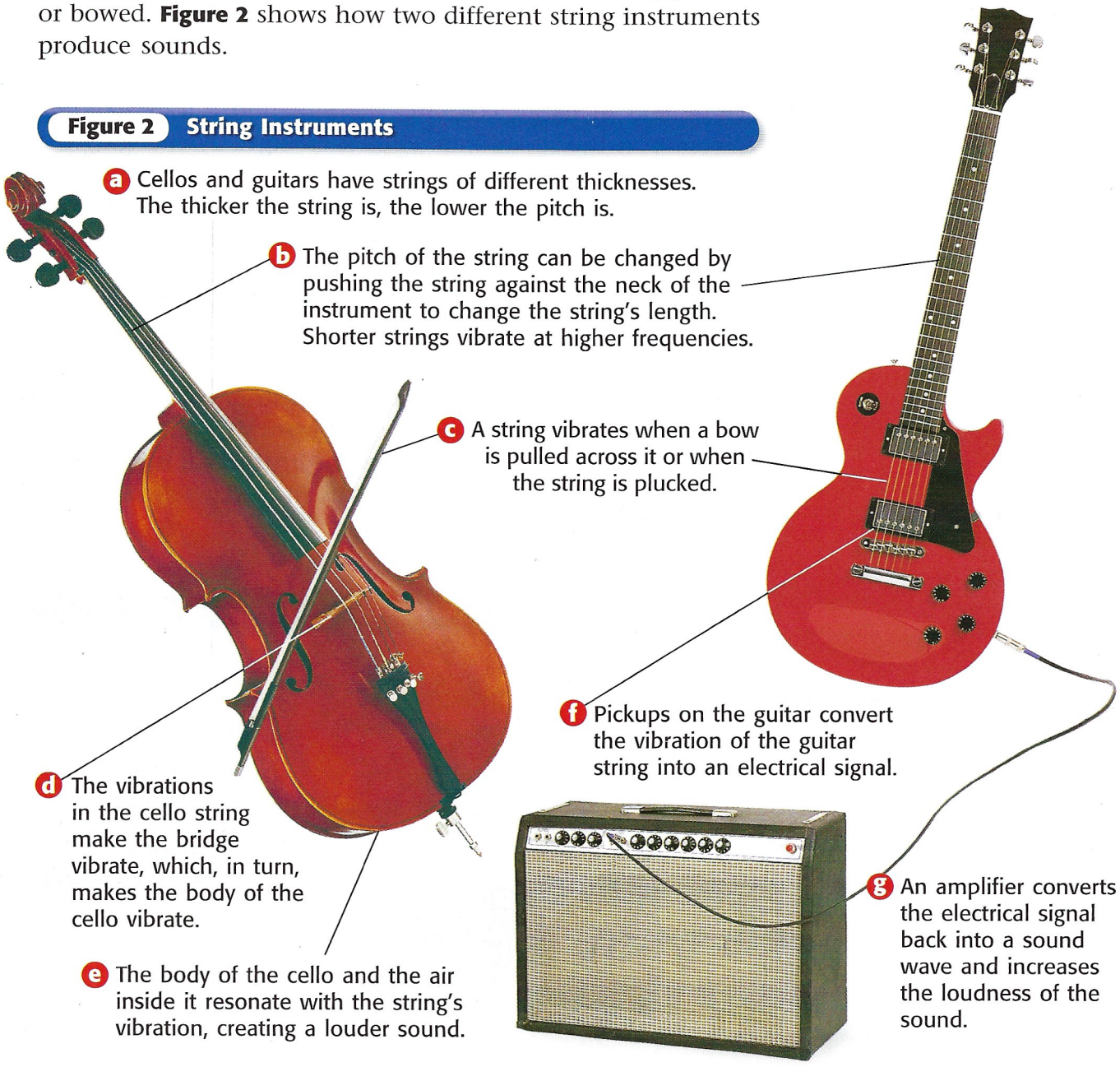
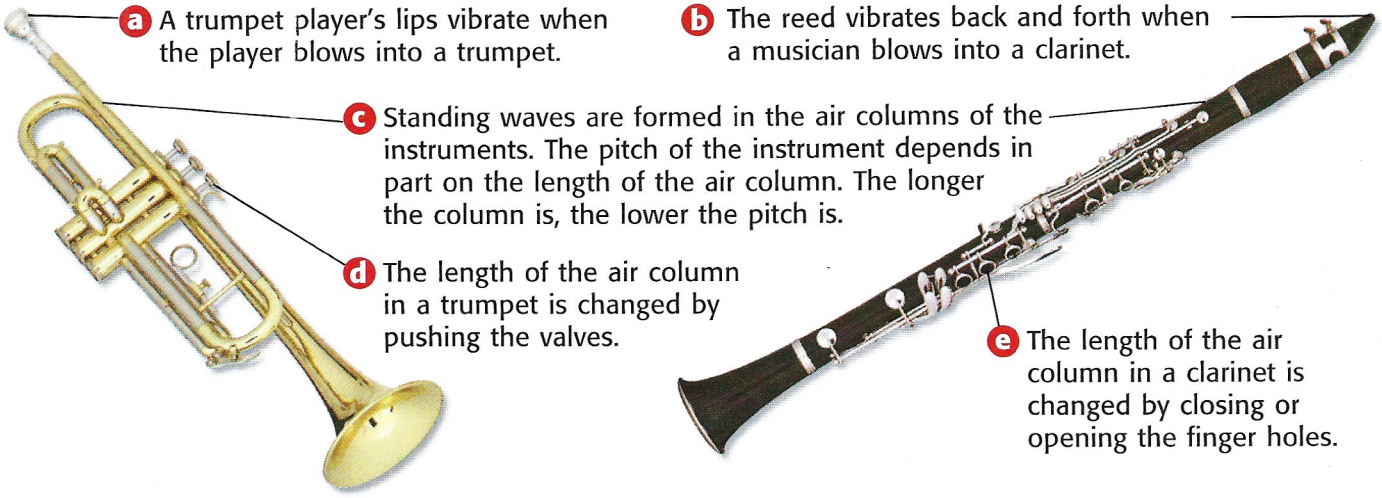


Figure 3 **Wind Instruments**



Wind Instruments

A wind instrument produces sound when a vibration is created at one end of its air column. The vibration causes standing waves inside the air column. Pitch is changed by changing the length of the air column. Wind instruments are sometimes divided into two groups—woodwinds and brass. Examples of woodwinds are saxophones, oboes, and recorders. French horns, trombones, and tubas are brass instruments. A brass instrument and a woodwind instrument are shown in **Figure 3.**

Percussion Instruments

Drums, bells, and cymbals are percussion instruments. They make sound when struck. Instruments of different sizes are used to get different pitches. Usually, the larger the instrument is, the lower the pitch is. The drums and cymbals in a trap set, shown in **Figure 4,** are percussion instruments.

Figure 4 **Percussion Instruments**

Music or Noise?

Most of the sounds we hear are noises. The sound of a truck roaring down the highway, the slam of a door, and the jingle of keys falling to the floor are all noises. **Noise** can be described as any sound, especially a nonmusical sound, that is a random mix of frequencies (or pitches). **Figure 5** shows on an oscilloscope the difference between a musical sound and noise.

noise a sound that consists of a random mix of frequencies

Reading Check **What is the difference between music and noise?**

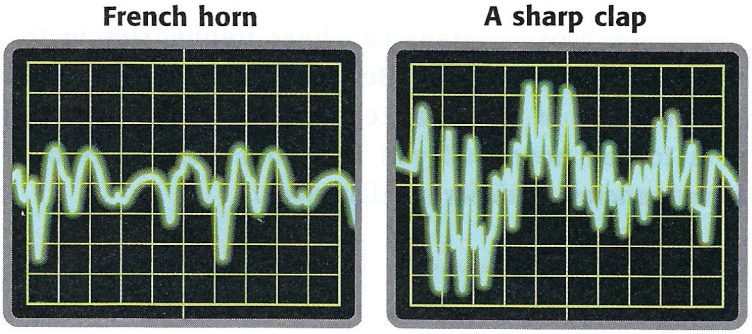


Figure 5 *A note from a French horn produces a sound wave with a repeating pattern, but noise from a clap produces complex sound waves with no regular pattern.*

SECTION Review

Summary

- Different instruments have different sound qualities.
- Sound quality results from the blending through interference of the fundamental and several overtones.
- The three families of instruments are string, wind, and percussion instruments.
- Noise is a sound consisting of a random mix of frequencies.

Using Key Terms

1. Use each of the following terms in a separate sentence: *sound quality* and *noise*.

Understanding Key Ideas

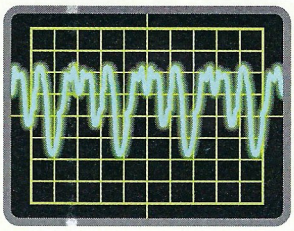
2. What interaction of sound waves determines sound quality?
   - **a.** reflection
   - **b.** diffraction
   - **c.** pitch
   - **d.** interference
3. Why do different instruments have different sound qualities?

Critical Thinking

4. **Making Comparisons** What do string instruments and wind instruments have in common in how they produce sound?
5. **Identifying Bias** Someone says that the music you are listening to is "just noise." Does the person mean that the music is a random mix of frequencies? Explain your answer.

Interpreting Graphics

6. Look at the oscilloscope screen below. Do you think the sound represented by the wave on the screen is noise or music? Explain your answer.



SCILINKS NSTA
Developed and maintained by the National Science Teachers Association

For a variety of links related to this chapter, go to www.scilinks.org

Topic: Sound Quality
SciLinks code: HSM1427

Chapter Review

USING KEY TERMS

Complete each of the following sentences by choosing the correct term from the word bank.

loudness	echoes
pitch	noise
sound quality	

1. The _____ of a sound wave depends on its amplitude.
2. Reflected sound waves are called _____.
3. Two different instruments playing the same note sound different because of _____.

UNDERSTANDING KEY IDEAS

Multiple Choice

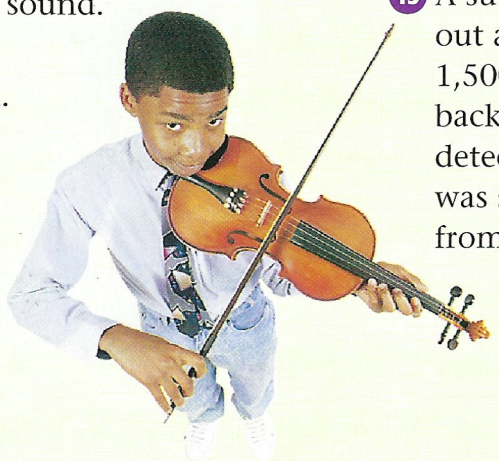
4. If a fire engine is traveling toward you, the Doppler effect will cause the siren to sound
   - **a.** higher.
   - **b.** lower.
   - **c.** louder.
   - **d.** softer.
5. Sound travels fastest through
   - **a.** a vacuum.
   - **b.** sea water.
   - **c.** air.
   - **d.** glass.
6. If two sound waves interfere constructively, you will hear
   - **a.** a high-pitched sound.
   - **b.** a softer sound.
   - **c.** a louder sound.
   - **d.** no change in sound.
7. You will hear a sonic boom when
   - **a.** an object breaks the sound barrier.
   - **b.** an object travels at supersonic speeds.
   - **c.** a shock wave reaches your ears.
   - **d.** the speed of sound is 290 m/s.
8. Resonance can happen when an object vibrates at another object's
   - **a.** resonant frequency.
   - **b.** fundamental frequency.
   - **c.** second overtone frequency.
   - **d.** All of the above
9. A technological device that can be used to see sound waves is a(n)
   - **a.** sonar.
   - **b.** oscilloscope.
   - **c.** ultrasound.
   - **d.** amplifier.

Short Answer

10. Describe how the Doppler effect helps a beluga whale determine whether a fish is moving away from it or toward it.
11. How do vibrations cause sound waves?
12. Briefly describe what happens in the different parts of the ear.

Math Skills

13. A submarine that is not moving sends out a sonar sound wave traveling 1,500 m/s, which reflects off a boat back to the submarine. The sonar crew detects the reflected wave 6 s after it was sent out. How far away is the boat from the submarine?



CRITICAL THINKING

14 Concept Mapping Use the following terms to create a concept map: *sound waves, pitch, loudness, decibels, frequency, amplitude, oscilloscope, hertz,* and *interference.*

15 Analyzing Processes An *anechoic chamber* is a room where there is almost no reflection of sound waves. Anechoic chambers are often used to test sound equipment, such as stereos. The walls of such chambers are usually covered with foam triangles. Explain why this design eliminates echoes in the room.

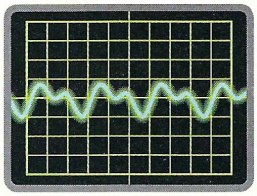
16 Applying Concepts Would the pilot of an airplane breaking the sound barrier hear a sonic boom? Explain why or why not.

17 Forming Hypotheses After working in a factory for a month, a man you know complains about a ringing in his ears. What might be wrong with him? What do you think may have caused his problem? What can you suggest to him to prevent further hearing loss?

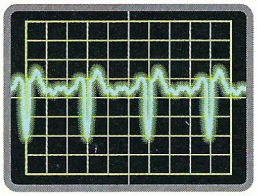
INTERPRETING GRAPHICS

Use the oscilloscope screens below to answer the questions that follow:

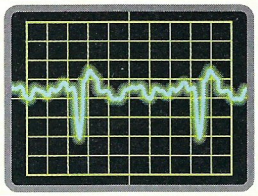
a



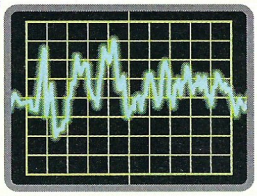
b



c



d



18 Which sound is noise?

19 Which represents the softest sound?

20 Which represents the sound with the lowest pitch?

21 Which two sounds were produced by the same instrument?