SECTION 1 (PP. 517-524): SOUND IS A WAVE.

Georgia Standards: S8P4a – *Identify the characteristics of electromagnetic and mechanical waves;* S8P4d – *Describe how the behavior waves is affected by a medium (such as air, water, and solids).*

1. **Sound is a type of mechanical wave.**
   Sound is a longitudinal wave. Vibrations in the wave move in the same direction as the wave. Because the sound is a mechanical wave, it must travel through a medium.

   Humans detect sound because of vibrations in the ear caused by sound waves.

2. **Sound waves vibrate particles.**
   As sound waves push against molecules in the medium, they compress the molecules creating bands of high and low pressure. These bands of pressure push and pull on the surrounding air, which then pushes and pulls on the around that, and so on. This creates a sound wave travelling through the air.

   Sound waves can travel through mediums that are made up of particles, but sound waves cannot travel through a vacuum.

3. **The speed of sound depends on its medium.**
   The speed of sound depends on the state and the temperature of the medium.
   - Sound usually travels most quickly through a solid and most slowly through a gas.
   - Sound travels more quickly through a specific medium at high temperatures.

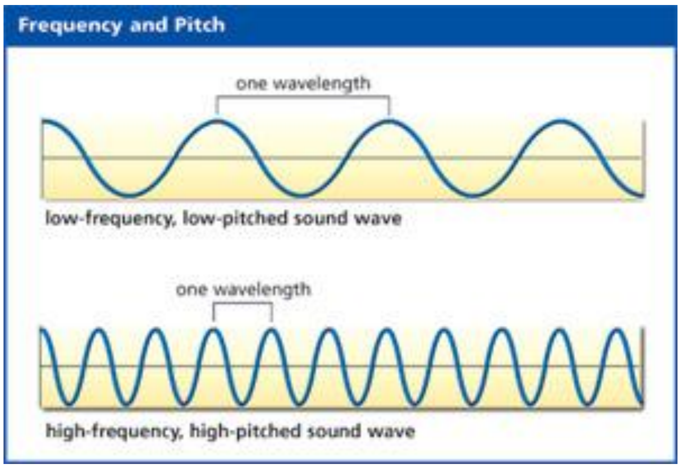
Materials and Sound Speeds		
Medium	State	Speed of Sound
Air (20^{o}C)	Gas	344 m/s (769 mi/h)
Water (20^{o}C)	Liquid	1,400 m/s (3,130 mi/h)
Steel (20^{o}C)	Solid	5,000 m/s (11,200 mi/h)

Temperature and Sound Speeds		
Medium	Temperature	Speed of Sound
Air	0^{o}C (32^{o}F)	331 m/s (741 mi/h)
Air	100^{o}C (212^{o}F)	386 m/s (864 mi/h)

SECTION 2 (PP. 525-531): FREQUENCY DETERMINES PITCH.

Georgia Standards: S8P4e – *Relate the properties of sound to everyday experiences;* S8P4f – *Diagram the parts of the wave and explain how the parts are affected by changes in amplitude and pitch.*

1. **Pitch depends on the frequency of a sound wave.**
   Pitch is an indication of how high or how low a sound is. A high-frequency wave has a short wavelength and produces a high pitch. A low-frequency wave has a long wavelength and produces a low pitch.



Human ears can hear a wide range of pitches. Most people with good hearing can hear sounds in the range of 20 hertz to 20,000 hertz. The note of middle C on a piano, for example, has a frequency of 262 hertz.

Sound waves with wavelengths below 20 hertz are called **infrasonic**. People cannot hear sounds in this range. Infrasound waves have a very long wavelength and can travel great distances without losing much energy. Elephants may use infrasound to communicate over long distances. Some of the waves that elephants use travel through the ground instead of the air, and they may be detected by another elephant up to 32 kilometers (about 20 miles) away. The highest frequency that humans can hear is 20,000 hertz. Sound waves in the range above 20,000 hertz are called **ultrasonic**. Though people cannot hear ultrasound, it is very useful.

Hertz is the unit used to measure frequency and therefore pitch. One hertz equals one wavelength per second.

All objects have a natural frequency of vibrations. When a sound wave is produced that matches an object's natural frequency, its waves combine to create sound with larger amplitude. This increase in amplitude is known as **resonance**.

Timbre, or sound quality, is affected by
- The combination of waves produced by an object and
- How the sound starts and stops

2. **The motion of the source of a sound affects its pitch.**
   The **Doppler Effect** is a change in pitch that occurs because the source or receiver of a sound is moving. Because the sound source is a little closer to the receiver each time it vibrates, it takes less time for the compression to reach the receiver. The decrease in distance makes the wavelength shorter, and the pitch rises.

SECTION 3 (PP. 532-537). INTENSITY DETERMINES LOUDNESS.

Georgia Standards: S8P4e – *Relate the properties of sound to everyday experiences;* S8P4f – *Diagram the parts of the wave and explain how the parts are affected by changes in amplitude and pitch.*

1. **Intensity depends on the amplitude of a sound wave.**
   Intensity is the amount of energy a sound wave has, measured in **decibels** (dB). Low-intensity wound waves are heard as quiet sounds. Louder sounds are produced by high-intensity sound waves.

2. **The intensity of a sound can be controlled.**
   Changing the amount of energy in a sound wave changes the sound's intensity without changing its pitch or quality.
   - A muffler decreases intensity.
   - An **amplifier** increases intensity.

3. **Intense sound can damage hearing.**
   The hair cells in the cochlea in the ear are easily damaged by loud sounds. Long-term exposure to sounds of 90 dB or more can damage human hearing. Even short bursts of very intense sound can deafen a person.

4. **The study of sound.**
   The scientific study of sound is called **acoustics**. Acoustics involves both how sound is produced and how it is received and heard by humans and animals.

   Acoustics also refers to the way sound waves behave inside a space. Experts called acoustical engineers help design buildings to reduce unwanted echoes. An **echo** is simply a reflected sound wave. To control sound intensity, engineers design walls and ceilings with acoustical tiles. The shapes and surfaces of acoustical tiles are designed to absorb or redirect some of the energy of sound waves.


The pointed tiles in this sound-testing room are designed to absorb sound waves and prevent any echoes.

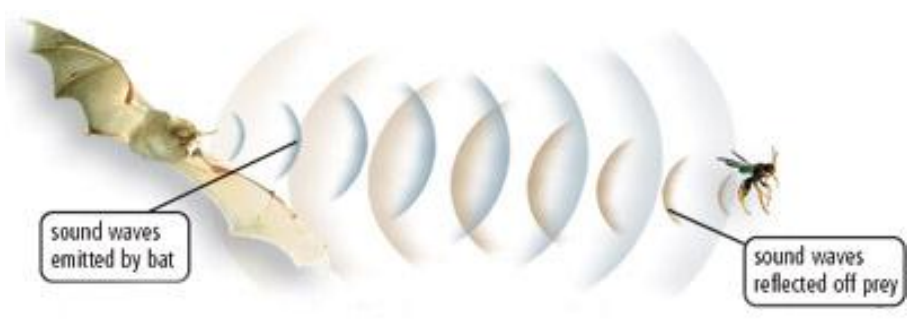

The shapes and surfaces in this concert hall direct sound waves to the audience.

READING VISUALS COMPARE AND CONTRAST Imagine sound waves reflecting off the surfaces in the two photographs above. How do the reflections differ?

SECTION 4 (PP. 538-545). SOUND HAS MANY USES.

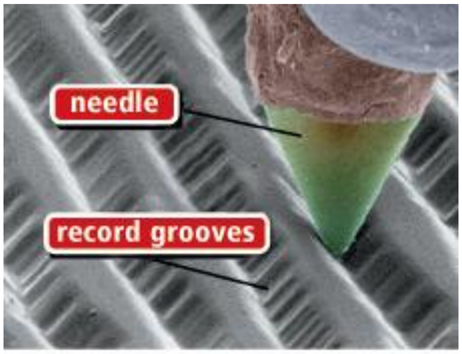
Georgia Standards: S8P4e – *Relate the properties of sound to everyday experiences.*

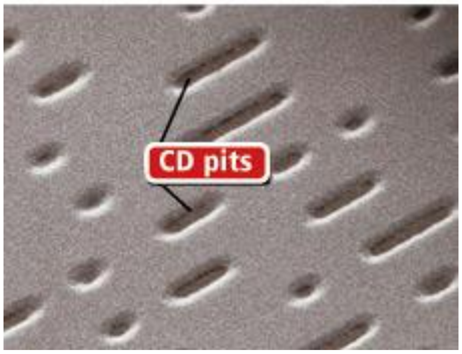
1. **Ultrasound waves are used to detect objects.**
   Reflected ultrasound waves are used to detect the presence and location of objects.
   - Some animals, such as bats, use **echolocation**, which involves sending out ultrasound signals and interpreting the returning sound echoes.
   - Humans use **sonar**, a form of echolocation, to locate objects underwater.
   - In medicine, ultrasound is used to treat kidney stones that form in the human body and to scan internal organs.



2. **Sound waves can produce music.**
Noise is sound with no pattern. **Music** is sound with clear patterns of pitch and rhythm. Stringed, wind, and percussion instruments all produce vibrations in different way, which accounts for their distinctive timbres.

3. **Sound can be recorded and reproduced.**
Vibrations can be changed to other types of signals or stored as reproducible information.
   - Some methods of communication, such as the telephone, change sound waves into electrical signals. These signals travel to a receiver that changes them back into sound.
   - Sound can be recorded as physical grooves (records) or pits (CD's) or as magnetic information (tapes) that can be changed back to sound waves.





The images above were taken by a scanning electron micrograph (SEM). Both the record grooves (top) and CD pits (bottom) store all of the information needed to reproduce sound.