17.4 Sound and Hearing

**Unit:** 5 - Waves

### Learning Objectives:

### Describe the properties of sound waves and explain how sound is produced and reproduced

### Describe how sound waves behave in application such as ultrasound and music.

### Explain how relative motion determines the frequency of sound an observer hears

### Analyze the function of the main regions of the human ear.

### Language Objectives:

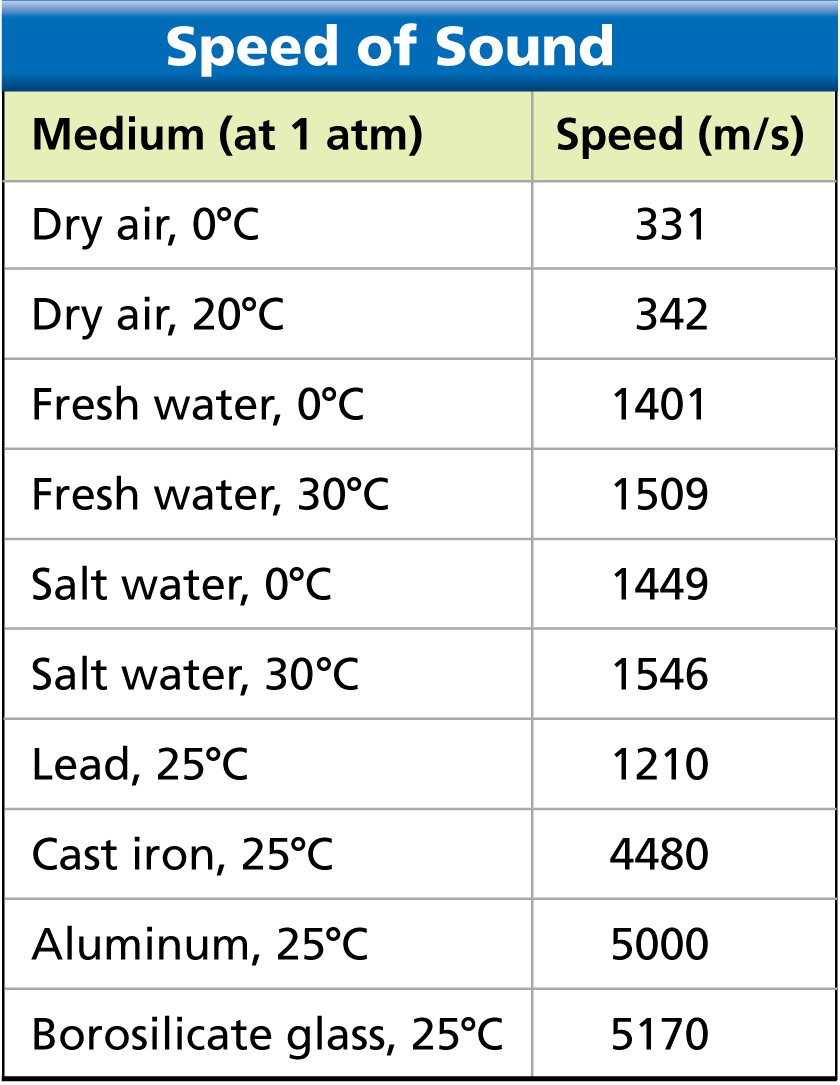
* Understand and correctly use the terms “Sound Wave, “Intensity”, “Decibel”, “Loudess”, “Pitch”, “Sonar”, “Doppler Effect”, “Resonance”

### Notes: What are the main properties of sound?

Many behaviors of sound can be explained using a few properties—\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Speed in Sound Wave**

It takes time for sound to travel from place to place.

****The speed of sound varies in different media. In dry air at 20°C, the speed of sound is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Properties of Sound Waves**

In general, sound waves travel \_\_\_\_\_\_\_\_\_\_\_ in solids, slower in liquids, and slowest in gases.

Particles in a solid tend to be closer together than particles in a liquid or a gas.

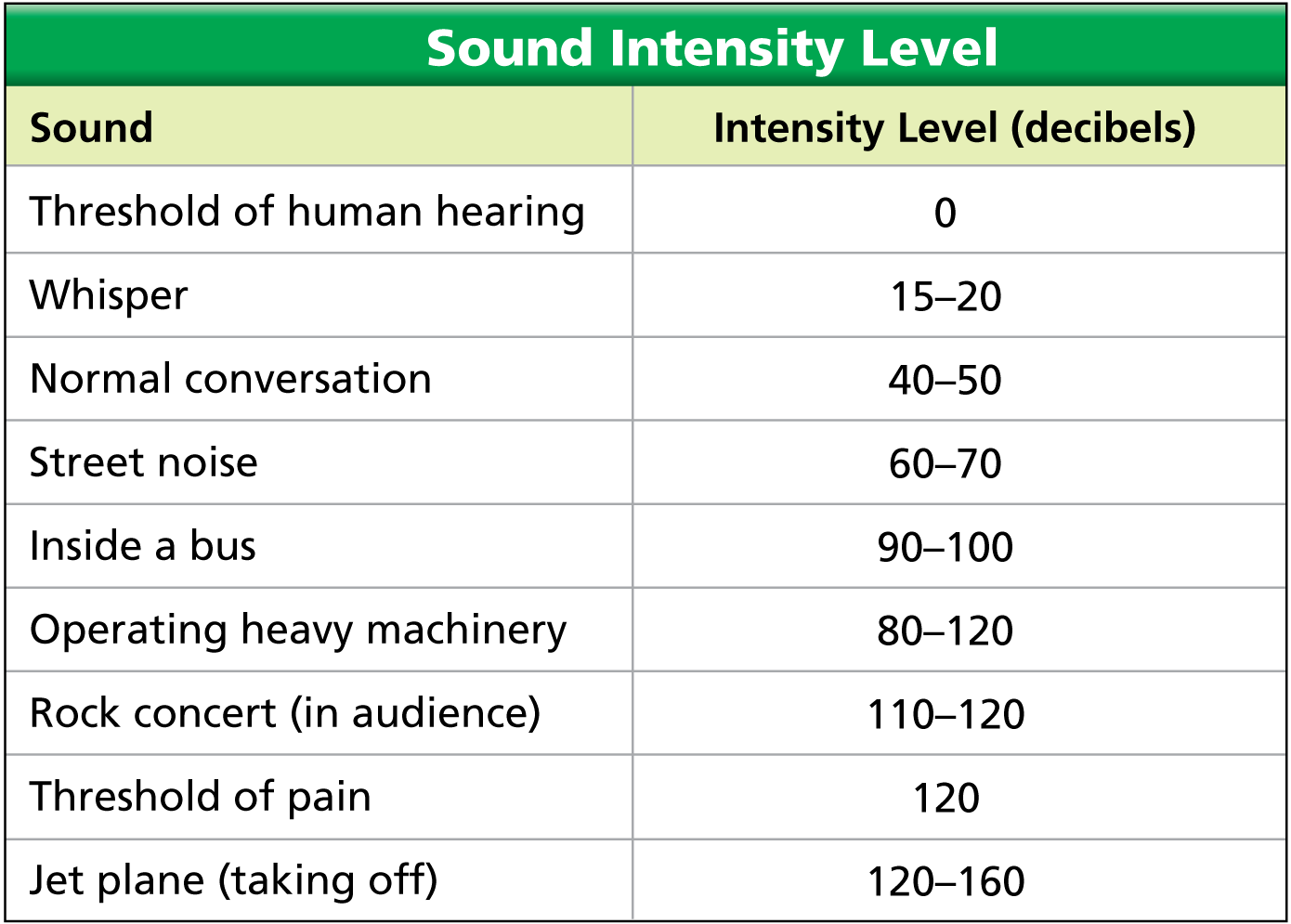
**Intensity and Loudness**

Intensity is the \_\_\_\_\_\_\_\_ at which a wave’s energy flows through a given area.

Sound intensity depends on both the wave’s \_\_\_\_\_\_\_\_\_\_\_\_\_ and the distance from the sound source.

The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a unit that compares the intensity of different sounds

For every 10-decibel increase, the sound intensity increases tenfold.

****A 0-decibel sound can just \_\_\_\_\_\_\_\_\_\_ be heard.

A 20-decibel sound has \_\_\_\_\_\_\_\_\_\_ more energy per second than a 0-decibel sound.

A 30-decibel sound delivers \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ more energy per second than a 0-decibel sound.

Lengthy exposure to sounds more intense than 90 decibels can cause hearing damage.

**Just Loudness**

Loudness is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ response to the intensity of sound, modified by physical factors.

The loudness depends on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Loudness also depends on factors such as the health of your ears and how your brain interprets sound waves.

**Frequency & Pitch**

The frequency of a sound wave depends on how \_\_\_\_\_\_\_\_\_\_ the source of the sound is vibrating.

The air in the tubing of brass instruments forms a standing wave. \_\_\_\_\_\_\_\_\_\_\_\_ tubing makes a standing wave with a \_\_\_\_\_\_\_\_\_\_ wavelength and a lower frequency.

**What is pitch?**

Pitch is the frequency of a sound as you \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

High-frequency sounds have a \_\_\_\_\_\_\_\_\_\_\_\_\_\_pitch, and low-frequency sounds have a low pitch.

Pitch also depends on other factors such as your age and the health of your ears.

**What is an ultrasound?**

Ultrasound is used in a variety of applications, including sonar and ultrasound imaging.

Most people hear sounds between \_\_\_\_\_\_ hertz and \_\_\_\_\_\_\_\_\_\_\_\_\_ hertz.

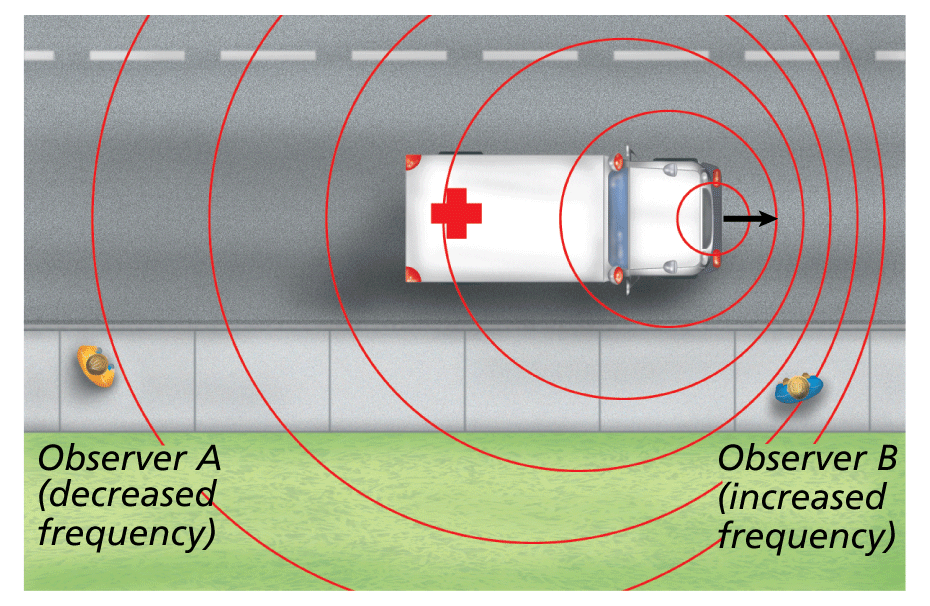
\_\_\_\_\_\_\_\_\_ is sound at frequencies lower than most people can hear.

\_\_\_\_\_\_\_\_\_\_is sound at frequencies higher than most people hear.

**What is the Doppler Effect?**

The Doppler Effect is when a source of sound approaches, an observer hears a \_\_\_\_\_\_\_\_\_\_\_\_frequency. When the sound source moves away, the observer hears a \_\_\_\_\_\_\_\_\_\_\_\_\_ frequency.

The Doppler effect is a change in sound frequency caused by motion of the sound source, motion of the listener, or both.



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**Outer Ear**

The part of the ear you can see funnels sound waves down the ear canal, a tunnel about \_\_\_\_\_\_\_\_\_\_\_\_\_ long.

Sound waves strike the eardrum, a tightly stretched membrane between the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ear.

The eardrum vibrates at the \_\_\_\_\_\_\_\_\_\_\_\_ frequency as the sound waves striking it.

**Middle Ear**

The middle ear contains three tiny bones—the \_\_\_\_\_\_\_\_\_\_\_\_\_, the \_\_\_\_\_\_\_, and the \_\_\_\_\_\_\_\_\_\_\_\_. The three bones act as a lever system to amplify the motion of the eardrum.

When the eardrum vibrates, the hammer vibrates at the same frequency.

The hammer strikes the anvil.

The anvil moves the stirrup back and forth

Ear Inner

Vibrations from the stirrup travel into the \_\_\_\_\_\_\_\_\_\_\_\_, a spiral-shaped canal filled with fluid.

The inside of the cochlea is lined with thousands of nerve cells with tiny hair-like projections.

As the fluid in the cochlea vibrates, the projections sway back and forth and send electrical impulses to the brain.

**How do musical instruments vary pitch?**

Most musical instruments vary pitch by changing the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of standing waves.

Musical instruments can produce a wide variety of sounds.

In a wind instrument, holes are closed using fingers or valves to change the length of the standing sound wave.

For some stringed instruments, musicians change the length of the strings by pressing down with their fingers.

Other instruments use a fixed set of strings of different lengths.

**More on Music**

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**Resonance**

Resonance is the response of a standing wave to another wave of the same frequency. Musical instruments often use \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to amplify sound.

One wave can “push” another wave to a \_\_\_\_\_\_\_\_\_ amplitude.

Resonance can produce a dramatic \_\_\_\_\_\_\_\_\_\_\_\_ in amplitude.

**Reverberations**

Sound-absorbing tiles in this auditorium \_\_\_\_\_\_\_\_\_\_\_unwanted reflections. Thecurved reflecting panels above the stage help gather and direct sound waves toward the audience.