

# Force & Motion

## Objective 6.P.1

Date:

**6.P.1 Understand the properties of waves and the wavelike property of energy in earthquakes, light and sound.**

6.P.1.1 Compare the properties of waves to the wavelike property of energy in earthquakes, light and sound.

6.P.1.2 Explain the relationship among visible light, the electromagnetic spectrum, and sight.

6.P.1.3 Explain the relationship among the rate of vibration, the medium through which vibrations travel, sound and hearing.

# Waves

## Riding the Wave

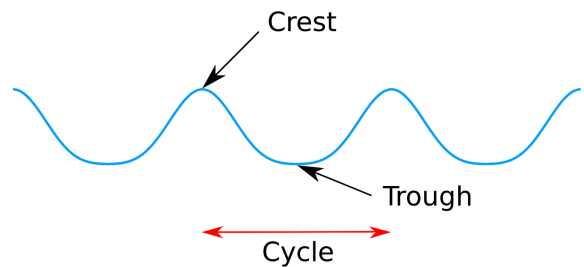
### What are waves?

• \_\_\_\_\_ are disturbances that transfer energy from one place to another.

• Waves are caused by vibrations of a medium. A \_\_\_\_\_ is the material through which a wave can travel.

• Water waves are just one of many kinds of waves. \_\_\_\_\_ and \_\_\_\_\_ are also waves.

• The points where a wave is highest are called \_\_\_\_\_. The points where a wave is lowest are called \_\_\_\_\_.



• A wave is a disturbance that transfers \_\_\_\_\_.

• Some waves, such as ocean waves, transfer energy through a medium.

• Some waves, such as \_\_\_\_\_ waves, can transfer energy \_\_\_\_\_ a medium.

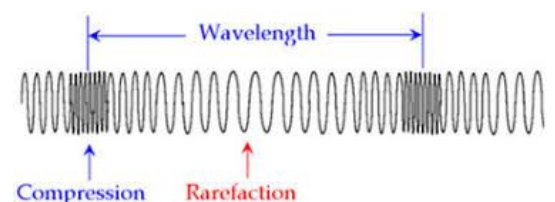
## Different Ways to Transfer Energy

### How does a wave transfer energy?

• Not \_\_\_\_\_ waves transfer energy the same way.

• Waves can be \_\_\_\_\_ by comparing the direction that they cause particles in the medium to move with the direction in which the wave moves.

• Energy can be transferred from one object to another using \_\_\_\_\_, when the coils are \_\_\_\_\_ together, and



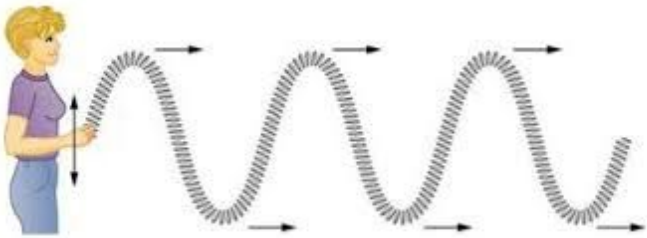
\_\_\_\_\_ , when the coils are \_\_\_\_\_ apart.

• This causes energy to travel in a \_\_\_\_\_ **wave**.

• \_\_\_\_\_ waves are longitudinal waves.

• Energy can be transferred from one object to another using \_\_\_ and \_\_\_\_\_ motions. This causes energy to travel as a \_\_\_\_\_ **wave**.

• In a transverse wave, particles move \_\_\_\_\_ to the direction the wave travels.

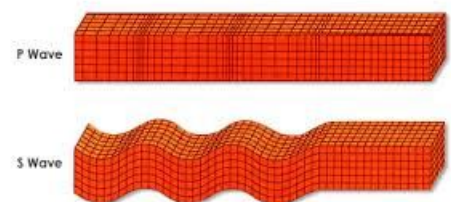
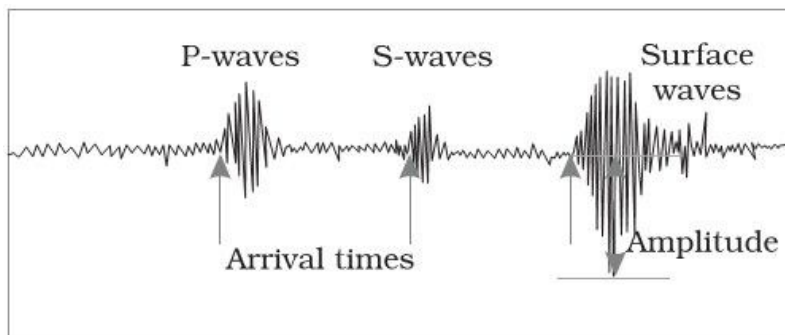


• \_\_\_\_\_ send out both types of waves.

• Primary waves, called \_\_\_ waves, are \_\_\_\_\_ waves. They always arrive \_\_\_\_\_.

• Secondary waves, called \_\_\_ waves, are \_\_\_\_\_ waves. They always arrive \_\_\_\_\_.

• They can combine to form a \_\_\_\_\_ wave, like ripples on a pond.

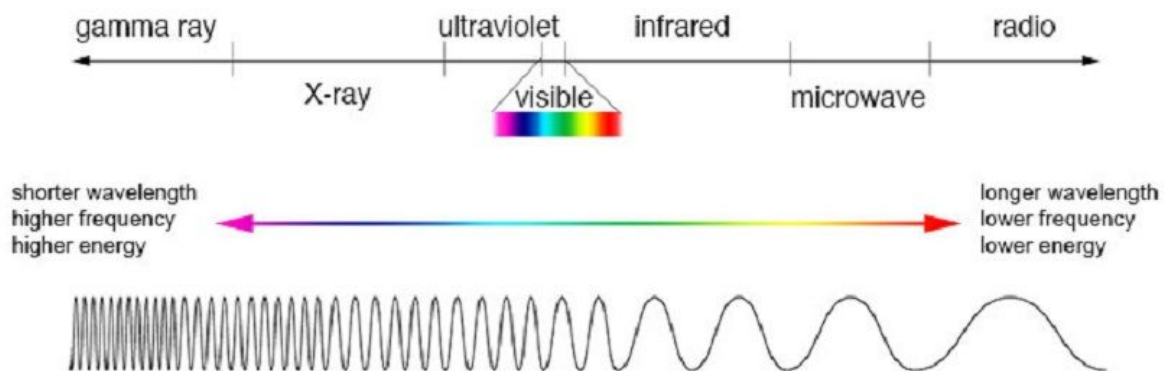


## Making Waves

### What are some types of waves?

• Waves can also be \_\_\_\_\_ by what they are \_\_\_\_\_ through.

- Waves that \_\_\_\_\_ a medium, such as water waves, are called \_\_\_\_\_ **waves**.
- Some mechanical waves can travel through \_\_\_\_\_ than one medium.
- For example, \_\_\_\_\_ waves can move through \_\_\_\_\_, \_\_\_\_\_, and a \_\_\_\_\_ wall.
- Mechanical waves \_\_\_\_\_ travel without a medium.
- \_\_\_\_\_ and similar waves are called electromagnetic (EM) waves. An \_\_\_\_\_ **wave** is a disturbance in \_\_\_\_\_ and \_\_\_\_\_ fields.
- \_\_\_\_\_ is an example of EM waves. Other examples include radio waves, \_\_\_\_\_, and X-rays.
- In \_\_\_\_\_ space, \_\_\_\_\_ EM waves travel at the same speed, called the \_\_\_\_\_.

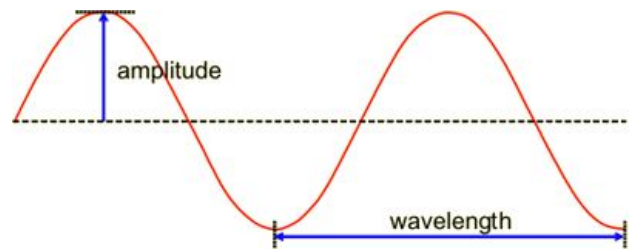
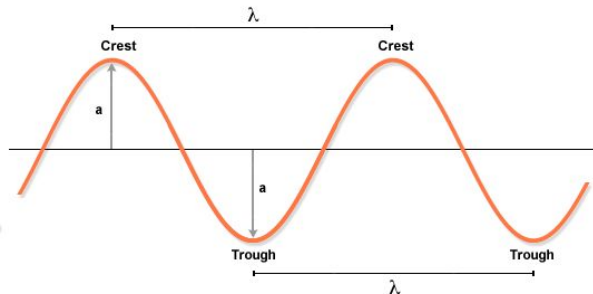


# Properties of Waves

Amp It Up!

## How can we describe a wave?

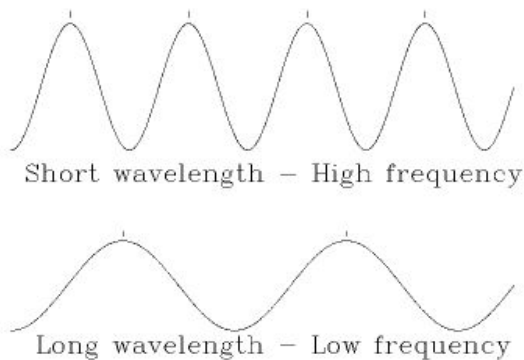
- A \_\_\_\_\_ is disturbance that transfers energy from one place to another.
- A wave's \_\_\_\_\_ is a measure of how far the particles in the medium move away from their normal rest position.



The \_\_\_\_\_ is the distance from any point on a wave to an identical point on the next wave. This measures the length of one cycle, or repetition.

## How can we describe a wave?

- Another property is \_\_\_\_\_, the time required for one wavelength to pass a given point.



- Another way to express the time of a wave's cycle is frequency. The \_\_\_\_\_ of a wave tells how many cycles occur in an amount of time, usually 1 s.
- Frequency is measured in \_\_\_\_\_ (Hz). One hertz \_\_\_\_\_ one wavelength per second.

- Frequency is the inverse of period.

## Amp It Down

### What affects the energy of a wave?

- Some waves carry more energy than others.
- For a mechanical wave, amplitude is related to the amount of energy the wave carries. For two similar waves, the wave with greater amplitude carries

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more energy.

- \_\_\_\_\_ frequency can also mean greater energy in a given amount of time. For most electromagnetic (EM) waves, energy is most strongly related to frequency.
- As a wave moves through a medium, \_\_\_\_\_ may move in \_\_\_\_\_ directions or come to rest in different places.
- As the wave travels through more of the medium, \_\_\_\_\_ energy is \_\_\_\_\_ to the medium.
- Often, higher-frequency waves lose energy more readily than lower-frequency waves lose energy. For example, when you stand far from a concert, you might hear only the low-frequency (bass) sounds.

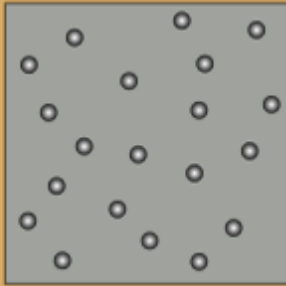
## A Happy Medium

### What determines the speed of a wave?

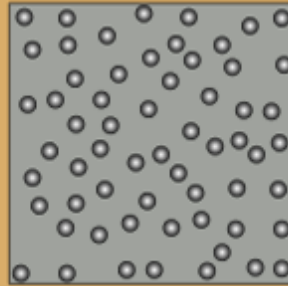
- \_\_\_\_\_, or the speed at which waves travel, depends on the properties of the medium.
- Waves tend to travel more \_\_\_\_\_ in a \_\_\_\_\_ medium.

## How Sound Travels

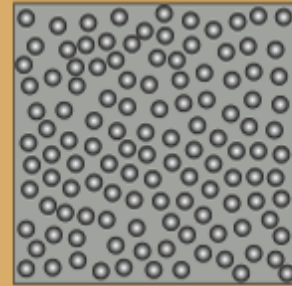
The speed at which **sound** travels from one place to another depends upon the **medium** and how closely packed the molecules are in the *matter*. A medium is a substance that allows sound waves to travel through it. Where there is no medium, no sound can be transmitted. Of the three mediums (solid, liquid, and gas), sound waves travel the slowest through gases, faster through liquids, and fastest through solids.



**GAS**  
**FAST**



**LIQUID**  
**FASTER**



**SOLID**  
**FASTEST!**

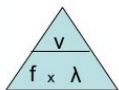
## What determines the speed of a wave?

### The Wave Equation

$v$  = speed of wave (m/s)

$f$  = frequency of wave (Hz)

$\lambda$  = wavelength (m)



$$v = f\lambda$$

• In \_\_\_\_\_, wave speed is \_\_\_\_\_ at higher temperatures.

• \_\_\_\_\_ electromagnetic waves travel at the \_\_\_\_\_ speed in \_\_\_\_\_ space, but they travel more slowly through a denser medium.

• Wave speed can be \_\_\_\_\_ from frequency and wavelength.

• Speed is distance \_\_\_\_\_ by

time.

• The speed of a wave \_\_\_\_\_ its wavelength divided by its period.

• This relationship can be combined with the relationship between wavelength

and frequency.

- Wavelength is \_\_\_\_\_ to wave speed divided by frequency.

# Light Waves

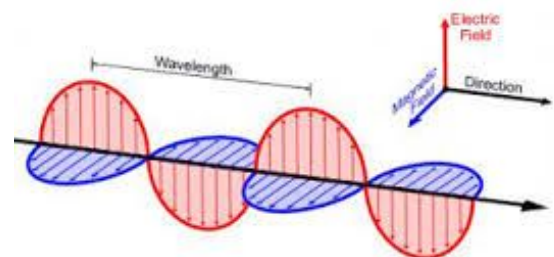
## The Electromagnetic Spectrum and Sight

### Electromagnetic Light Show

#### What is the nature of light?

- \_\_\_\_\_ waves are \_\_\_\_\_ from other kinds of waves.

- When an electrically charged particle \_\_\_\_\_, its fields also vibrate, producing an electromagnetic (EM) wave.



- Light waves are vibrating \_\_\_\_\_ and \_\_\_\_\_ fields that transfer \_\_\_\_\_ through space.

- EM waves travel \_\_\_\_\_ to both electric and magnetic fields.

- \_\_\_\_\_ is energy that has been transmitted by waves or particles. This transfer of energy is called EM radiation.

- All EM waves \_\_\_\_\_ at the \_\_\_\_\_ speed in a \_\_\_\_\_: the speed of light.

- EM waves can \_\_\_\_\_ through \_\_\_\_\_ materials.

#### What determines the color of light?

- Different \_\_\_\_\_ of light are \_\_\_\_\_ by our eyes as different \_\_\_\_\_.

- \_\_\_\_\_ light is what we perceive when we see \_\_\_\_\_ the wavelengths of light at once, in equal proportions.

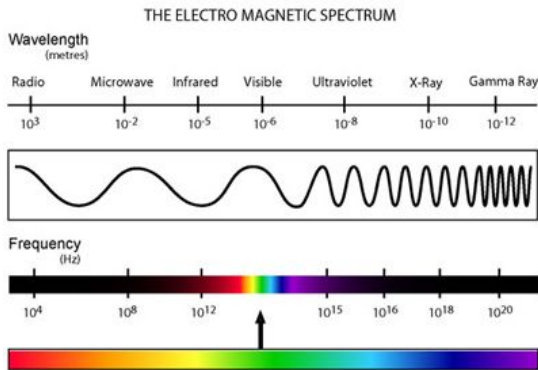


• Our eyes only register \_\_\_\_\_ colors of light: \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_. All other colors we see are a \_\_\_\_\_ of these three colors.

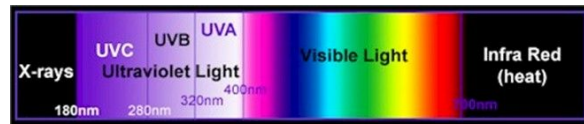
## Invisible Colors

### What are the parts of the EM spectrum?

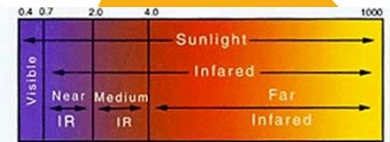
The range of \_\_\_\_\_ that EM waves can have is called the \_\_\_\_\_



- \_\_\_\_\_ light has slightly longer wavelengths than red light has.
- \_\_\_\_\_ (UV) light has slightly shorter wavelengths than violet light has.



IR Band	Wavelength Range
IR-A	700nm - 1400nm
IR-B	1400nm - 3000nm
IR-C	3000nm - 1 mm



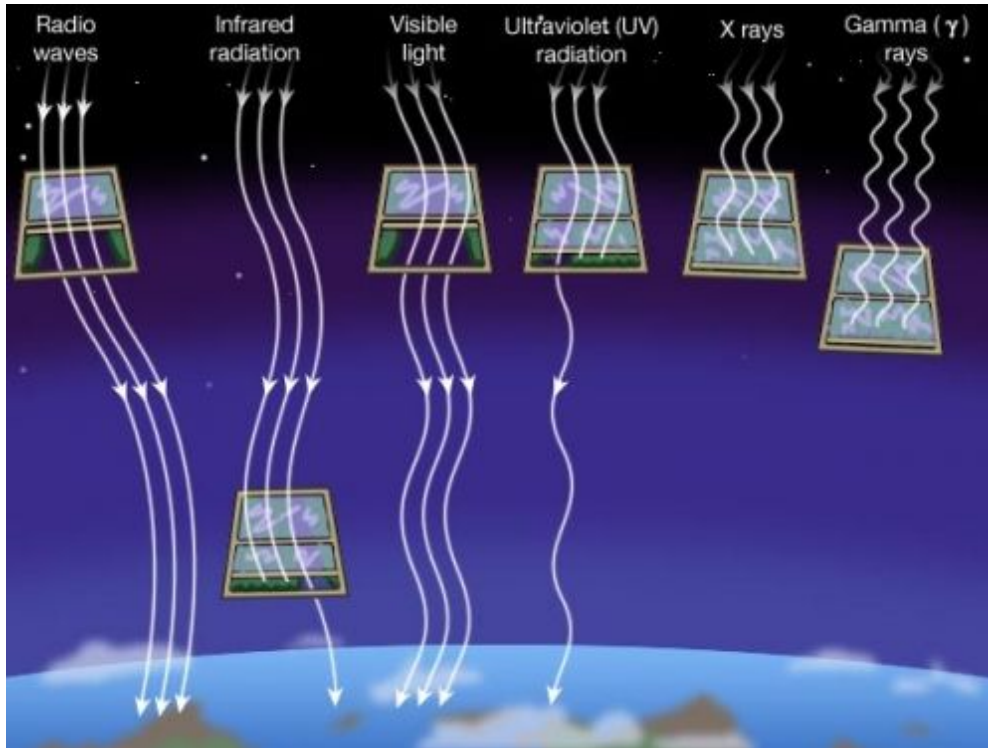
## Star Light, Star Bright

### How much of the sun's energy reaches us?

• Most of the sun's energy is in the narrow \_\_\_\_\_ light range, but the sun gives off some \_\_\_\_\_ in every part of the spectrum.

• \_\_\_\_\_ all wavelengths of light \_\_\_\_\_ the atmosphere equally. \_\_\_\_\_ waves penetrate the \_\_\_\_\_ easily.





- Some EM radiation can be \_\_\_\_\_ to humans, so we take extra steps to protect ourselves.
- \_\_\_\_\_ light can be harmful. It can penetrate \_\_\_\_\_.
- In \_\_\_\_\_, the \_\_\_\_\_ from EM radiation are very \_\_\_\_\_ because there is \_\_\_\_\_ atmosphere to filter the radiation.

## Frequency Asked Questions

### How much energy does EM radiation have?

- Different frequencies of EM waves carry \_\_\_\_\_ amounts of \_\_\_\_\_.
- \_\_\_\_\_-frequency EM waves have \_\_\_\_\_ energy than \_\_\_\_\_-frequency EM waves have.
- Because \_\_\_\_\_-frequency waves, such as \_\_\_\_\_ waves, carry \_\_\_\_\_ energy, they are \_\_\_\_\_. Walkie-talkies and baby monitors use radio waves.

- \_\_\_\_\_-frequency waves, such as \_\_\_ light, carry \_\_\_\_\_ energy and can be \_\_\_\_\_. UV light causes sunburns, and X-rays require precautions.

# Interactions of Light

## Shedding Light on the Matter

### How can matter interact with light?

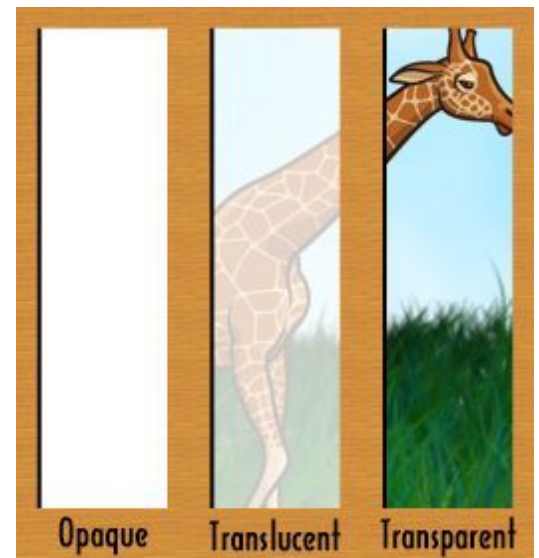
- \_\_\_\_\_ forms of matter-light interactions play an important role in how people see light.

- When light enters a medium, the medium lets all, some, or no light pass through.

- Matter that transmits light is \_\_\_\_\_.

- Matter that transmits light but scatters it in all directions is \_\_\_\_\_.

- \_\_\_\_\_ can \_\_\_\_\_ light. When light enters a material but does not leave it, the light is absorbed.



- \_\_\_\_\_ is the transfer of light energy to matter.

- \_\_\_\_\_ materials do not let any light pass through them because they reflect light, absorb light, or both.

- Matter can reflect light. \_\_\_\_\_ is the bouncing of light off a surface.

- When light strikes a \_\_\_\_\_ surface, the light \_\_\_\_\_ off at an \_\_\_\_\_ equal to the angle at which it hit the surface, producing a \_\_\_\_\_ image.

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- When light strikes an \_\_\_\_\_ surface, the light is reflected in \_\_\_\_\_ directions. You see the object but do not see a reflected image of yourself.
  - Nearly everything we can see, we see because light is reflected off a surface.

## Color Me Impressed!

### What determines the color of objects we see?

- When \_\_\_\_\_ light strikes an object, the color of the object \_\_\_\_\_ on how the object transmits, reflects, or absorbs the colors of light.
- An object that \_\_\_\_\_ a certain color of light \_\_\_\_\_ to be that color.
- A frog appears \_\_\_\_\_ because its skin \_\_\_\_\_ all colors but green.
- An object that reflects \_\_\_\_\_ color appears \_\_\_\_\_.
- An object that \_\_\_\_\_ every color appears \_\_\_\_\_.
- When light is transmitted through an object, the object can absorb some colors and allow other colors to pass through.
- The color that passes through a transparent or translucent object determines the color of that object.
- Some matter absorbs certain types of electromagnetic waves and allows other types of electromagnetic waves to pass through.
- Sometimes the color of an object depends on what light shines on it.
- If a red filter is placed between a green frog and white light, the filter will absorb all colors of light except red, orange, and yellow.
- The frog reflects no light, and you perceive the frog's color as gray or black.

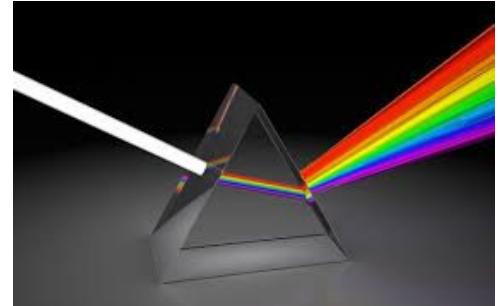
## What happens when light waves interact with matter?

•Light \_\_\_\_\_ when it passes at an angle from one medium to another.

•The bending of a wave as it passes from one medium to another is called \_\_\_\_\_.

•Refraction occurs because light \_\_\_\_\_ speed as it enters a medium at an angle.

•When light slows in a medium, it bends inward, creating a smaller angle.



•Light waves with \_\_\_\_\_ wavelengths bend more.

•The waves that make up white light have different wavelengths.

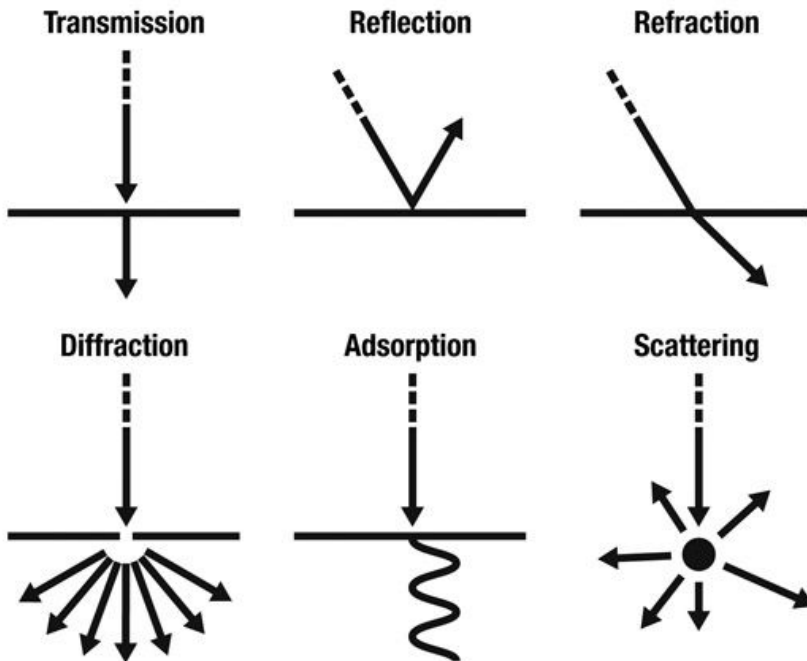
•As white light passes through a prism, the wavelengths refract at different angles and you see a spectrum of colors.

•When light strikes matter, the light can change direction. This is called \_\_\_\_\_.

•Light scattering \_\_\_\_\_ us to see objects that are not in the direct path of the light source.

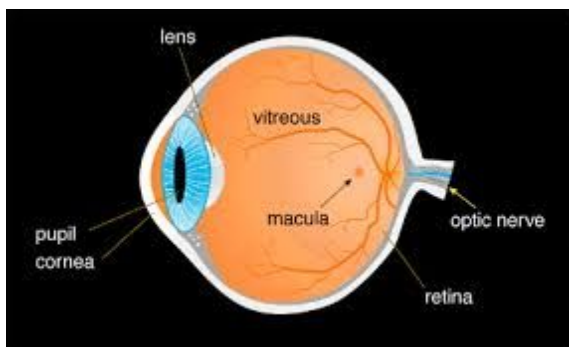
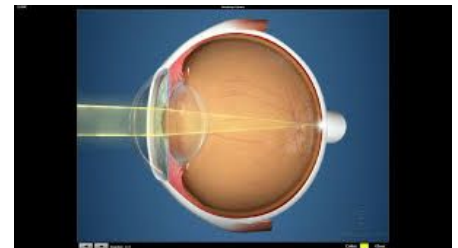
•Another result of scattered light is the \_\_\_\_\_ of the \_\_\_\_\_. Blue light is scattered \_\_\_\_\_ than other colors, so the sky appears blue.

•When the sun strikes Earth at an angle, light waves pass through more of the atmosphere. Only the \_\_\_\_\_-wavelength \_\_\_\_\_ light reaches Earth.



## Let's Focus

- You see an object when your eyes detect light and send \_\_\_\_\_ to your brain.
- Some objects produce their own light, while other objects reflect light.
- Light waves enter the eye through the \_\_\_\_\_, which is the transparent membrane that forms the front part of the eye.



- The cornea \_\_\_\_\_, or bends, the light so that it passes through the pupil at the center of the iris.
- The \_\_\_\_\_ changes the size of the pupil to \_\_\_\_\_ the amount of light that is let in.

## How do people detect and interpret light waves?

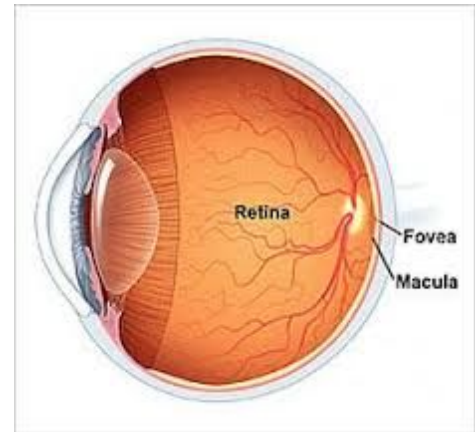
- The light \_\_\_\_\_ again as it enter the \_\_\_\_\_.
- \_\_\_\_\_ around the lens change its \_\_\_\_\_ so that objects at different distances can be seen in focus.

• Images are received by the \_\_\_\_\_, the light sensitive tissue that lines the inside of the eye.

• \_\_\_\_\_ cells and \_\_\_\_\_ cells in the retina detect light.

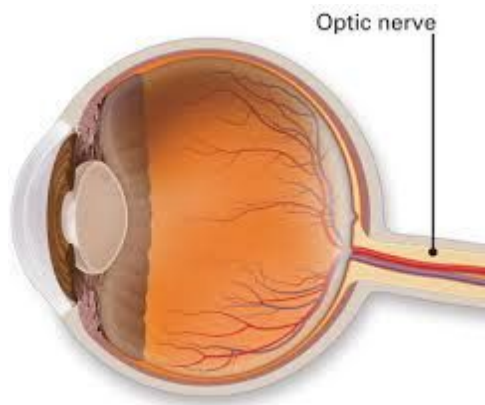
• \_\_\_\_\_ are very \_\_\_\_\_ even in dim light. \_\_\_\_\_ detect brighter \_\_\_\_\_ and \_\_\_\_\_.

• The retina is the part of the eye that \_\_\_\_\_ light and \_\_\_\_\_ signals to the brain.



• The image is actually focused \_\_\_\_\_ down onto the retina.

• Rods and cones \_\_\_\_\_ the input into electrical signals that travel to the brain through the \_\_\_\_\_.



• Different parts of the brain take in signals and interpret the color, shape, movement, and location of an image.

• Although the image is upside down, the brain understands the image as being right-side up.

• The brain combines slightly different information from the left and right eyes to produce a sense of distance and depth.

## Out of Sight

### What are some common vision problems?

• \_\_\_\_\_ happens when a person's eye is too long, or the cornea is curved steeply.

• Nearsighted eyes produce an image in front of the retina, rather than on the retina.

- A nearsighted person can see something clearly only if it is nearby.
- \_\_\_\_\_ happens when a person's eye is too short, or the cornea is not curved enough.
- A farsighted person can see something clearly when it is a distant object; nearby things are blurry.
- People can be born farsighted. Some people grow out of farsightedness.
- About \_\_\_% to \_\_\_% of men and 0.5% of women in the world have a \_\_\_\_\_ deficiency.
- This condition is often called \_\_\_\_\_, but most people with color blindness can see some colors.
- Color vision deficiency happens when the \_\_\_\_\_ in the retina do \_\_\_\_\_ work properly.
- These people see certain colors, such as red and green, as a different color, such as yellow.

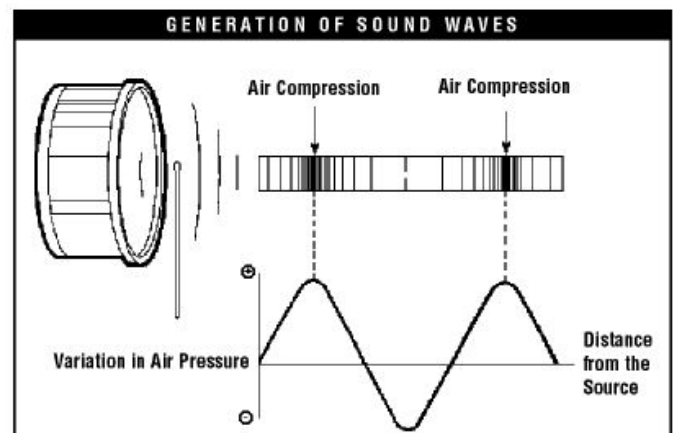
# Sound Waves

## Sound and Hearing

### Listen Up!

#### What is sound?

- A \_\_\_\_\_ is the complete back and forth motion of an object.
- Beating a drum causes the drum skin to vibrate, which causes the air around it to vibrate.





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## What are sound waves?

- A \_\_\_\_\_ is a longitudinal wave that is caused by vibrations and that travels through a \_\_\_\_\_.
- In a **longitudinal wave**, the particles of a medium \_\_\_\_\_ in the \_\_\_\_\_ direction that the wave travels.
- As the wave passes through a medium, its particles \_\_\_\_\_ together and then spread out.
- Longitudinal waves are also called \_\_\_\_\_ waves. They are made up of compressions and rarefactions.
- A *compression* is the part of a longitudinal wave where particles are \_\_\_\_\_ together.
- A \_\_\_\_\_ is the part of a longitudinal wave where particles are \_\_\_\_\_ apart.

## How do sound waves travel?

- Sound waves \_\_\_\_\_ in \_\_\_\_\_ directions away from their source.
- They can \_\_\_\_\_ travel through a medium.
- \_\_\_\_\_ matter—solids, liquids, and gases—is composed of \_\_\_\_\_. The particles in matter make up the medium through which waves can travel.
- The particles of a medium only vibrate back and forth along the path of the sound waves.
- \_\_\_\_\_ sounds travel through air, but some travel through other materials, such as water, glass, and metal.
- In a \_\_\_\_\_ there are \_\_\_\_\_ particles to vibrate, so no \_\_\_\_\_ can be made.
- Sound must travel through a medium to be detected.

## Do You Hear That?

### How do humans hear sound?

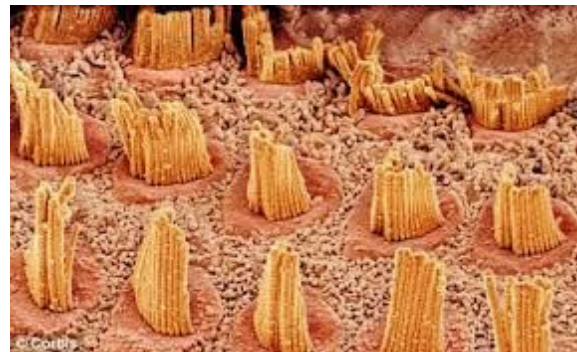
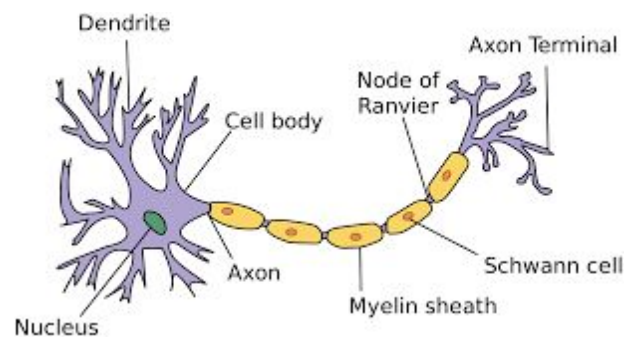
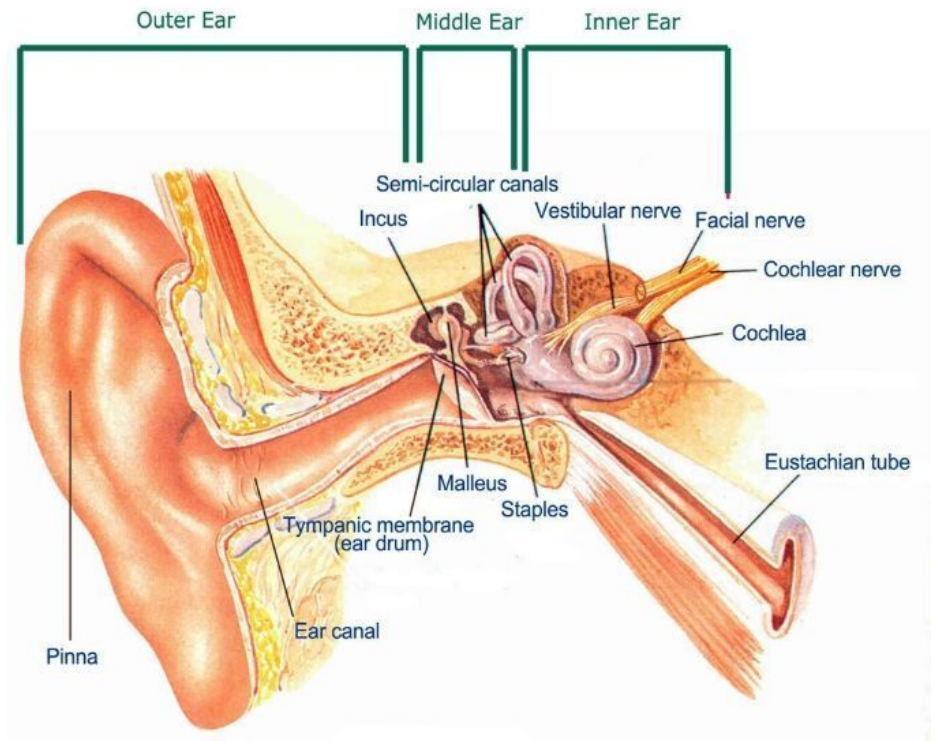
• Humans detect sounds with their ears, which act like funnels for sound waves.

• The ear directs sound vibrations from the environment to the \_\_\_\_\_ tiny bones in the \_\_\_\_\_ ear.

• These bones carry \_\_\_\_\_ from the eardrum to the oval window, which leads to the \_\_\_\_\_ ear.

• Vibrations travel through fluid to the \_\_\_\_\_, which has thousands of \_\_\_\_\_ cells.

• Each nerve cell has tiny surface \_\_\_\_\_ that \_\_\_\_\_ with the vibrations to \_\_\_\_\_ electrical signals to the \_\_\_\_\_, which \_\_\_\_\_ the signals as sound.



## Can You Hear Me Now?

### What determines pitch?

- \_\_\_\_\_ is how high or low you think a sound is.
- The pitch heard depends on the ear's sensitivity to pitches over a wide range.

• \_\_\_\_\_ is expressed in hertz (Hz).

• \_\_\_\_\_ hertz is \_\_\_\_\_ complete wavelength, or cycle, per \_\_\_\_\_.

### What determines pitch?

• In a given medium, the \_\_\_\_\_ the frequency of a wave, the \_\_\_\_\_ its wavelength and the \_\_\_\_\_ its pitch.

• High-frequency waves have shorter wavelengths and produce [high-pitched sounds](#).

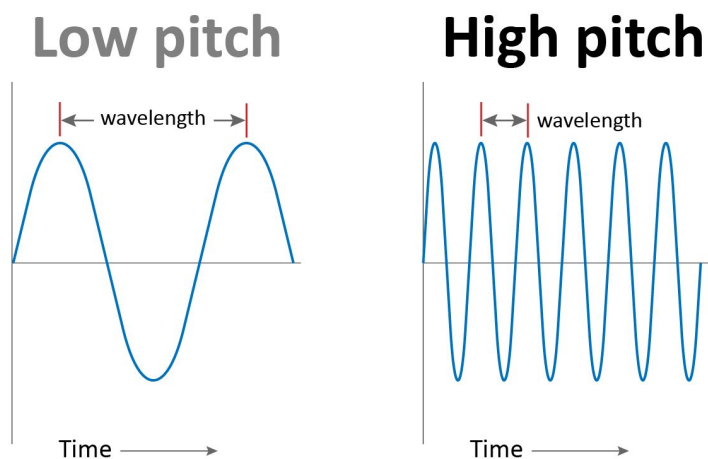
• \_\_\_\_\_-frequency waves have \_\_\_\_\_ wavelengths and produce [low-pitched sounds](#).

### What makes a sound loud?

• \_\_\_\_\_ is a measure of how well a sound can be heard.

• The \_\_\_\_\_ of how much \_\_\_\_\_ a sound wave carries is the wave's intensity, or amplitude.

• The \_\_\_\_\_ of a sound wave is the maximum distance that the particles of a wave vibrate from their rest position.



## What makes a sound loud?

- The \_\_\_\_\_ the amplitude, the \_\_\_\_\_ the sound.
- The \_\_\_\_\_ the amplitude, the \_\_\_\_\_ the sound.
- \_\_\_\_\_ can increase loudness by receiving sound signals and increasing the wave's amplitude.

## Turn That Down!

### How is loudness measured?

- Loudness is a \_\_\_\_\_ of sound that can be calculated from the \_\_\_\_\_ of a sound wave.
- The most common \_\_\_\_\_ used to express loudness is the \_\_\_\_\_ (dB).
- One decibel is one tenth of a *bel*, the base unit.
- The bel is named after Alexander Graham Bell, who \_\_\_\_\_ the telephone.
- The \_\_\_\_\_ sounds most \_\_\_\_\_ can hear are at a level of \_\_\_\_\_ dB.
- Sounds that are \_\_\_\_\_ dB or higher can be \_\_\_\_\_.
- \_\_\_\_\_ concerts usually measure about \_\_\_\_\_ dB.

### How loud is too loud?

- \_\_\_\_\_ exposures to sounds that are \_\_\_\_\_ enough to be \_\_\_\_\_ can cause hearing \_\_\_\_\_.
- Even loud sounds that are not painful can damage your hearing if exposed to them for long periods of time.
- Loud sounds can \_\_\_\_\_ the \_\_\_\_\_ on the nerve cells in the cochlea. Once damaged, these hairs do \_\_\_\_\_ grow back.
- Using earplugs to block loud sounds, lowering the volume when using

earbuds, and moving away from a loud speaker are all ways to protect yourself from hearing loss.

- Doubling the distance between yourself and a loud sound can reduce the sound's intensity by as much as one-fourth of what it was.

## Hello? Hello? Hello?

### How do sound and matter interact?

- Sound waves do \_\_\_\_\_ travel easily through all matter.
- Sound may \_\_\_\_\_ away from some surfaces. Sound may be \_\_\_\_\_ by other sources or transmitted through a barrier.
- \_\_\_\_\_ is the bouncing back of a wave when it hits a barrier. Sound waves reflect \_\_\_\_\_ off \_\_\_\_\_, \_\_\_\_\_ surfaces.
- Some matter absorbs sound waves better than other matter.
- A rough wall will absorb sound better than a smooth wall will.
- Soft materials, such as rugs and drapes, will \_\_\_\_\_ sound better than hard surfaces will.



Vocal cords open during breathing to allow air into lungs.



Vocal cords close when speaking so air from the lungs presses between them to cause the vibrations that produce sound.



