

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

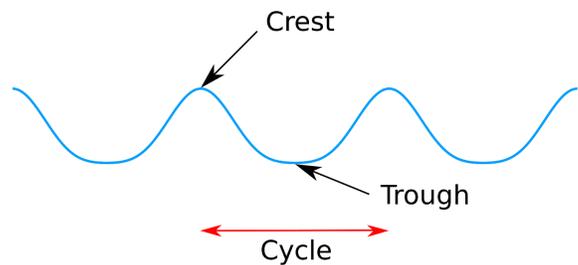
What are waves?

• _____ 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.

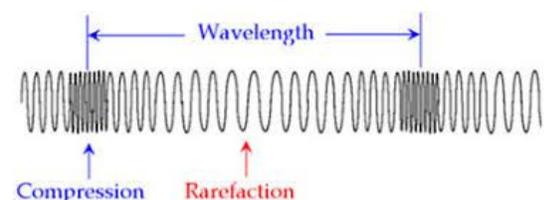
Different Ways to Transfer Energy

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



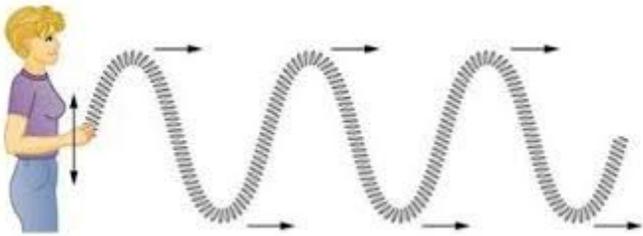
_____ , when the coils are _____ apart.

• 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.

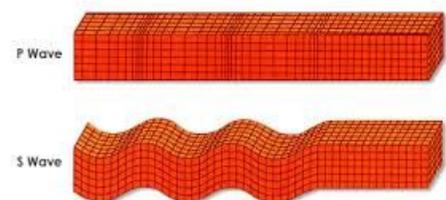
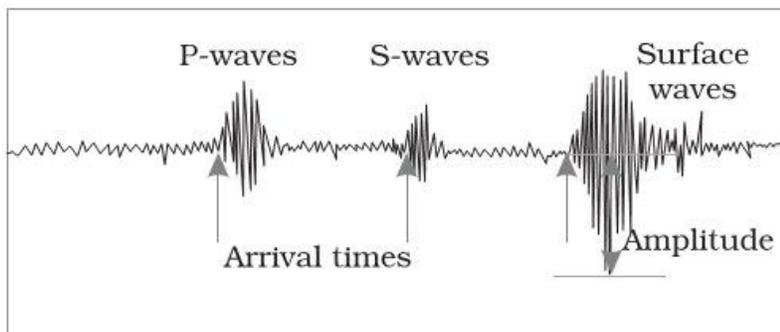


• _____ send out both types of waves.

• 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.

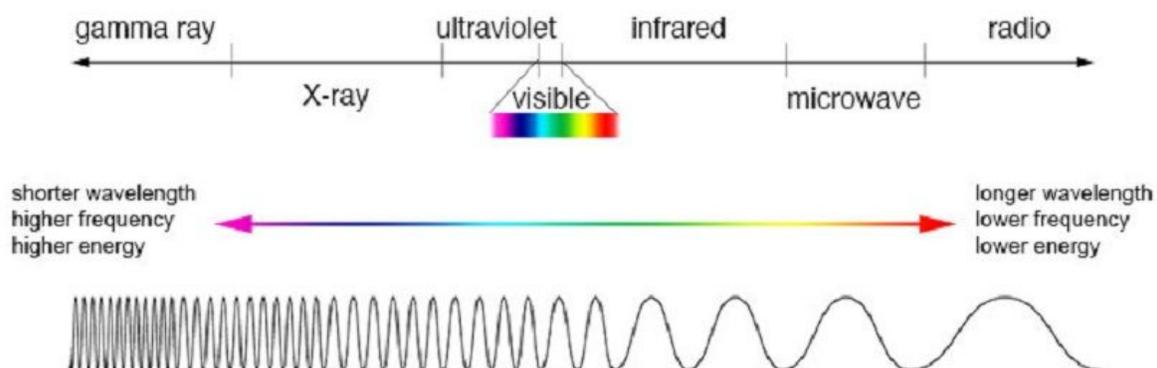


Making Waves

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 _____.

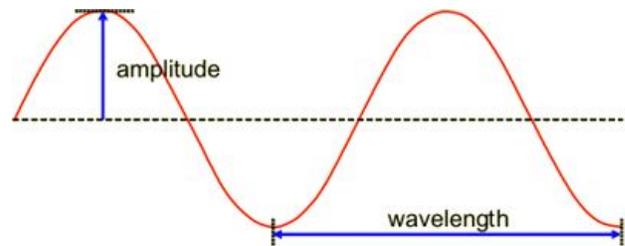
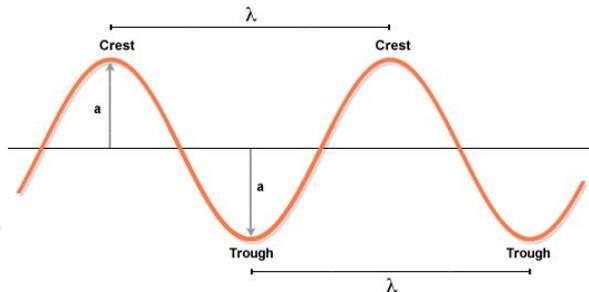


Properties of Waves

Amp It Up!

How can we describe a wave?

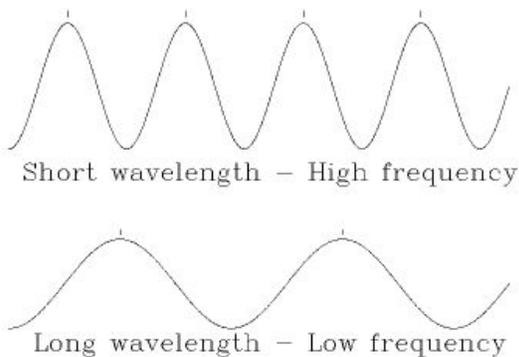
- A _____ is disturbance that transfers energy from one place to another.
- A wave's _____ is a measure of how far the particles in the medium move away from their normal rest position.



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

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.

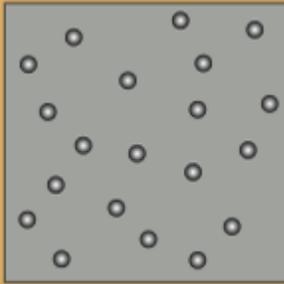
A Happy Medium

What determines the speed of a wave?

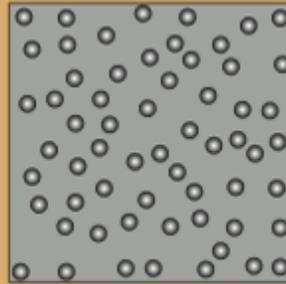
- _____, or the speed at which waves travel, depends on the properties of the medium.
- Waves tend to travel more _____ in a _____ medium.

How Sound Travels

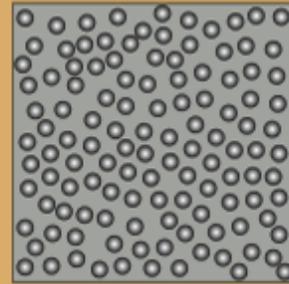
The speed at which **sound** travels from one place to another depends upon the **medium** and how closely packed the molecules are in the *matter*. A medium is a substance that allows sound waves to travel through it. Where there is no medium, no sound can be transmitted. Of the three mediums (solid,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



GAS
FAST



LIQUID
FASTER



SOLID
FASTEST!

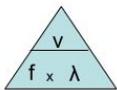
What determines the speed of a wave?

The Wave Equation

v = speed of wave (m/s)

f = frequency of wave (Hz)

λ = 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

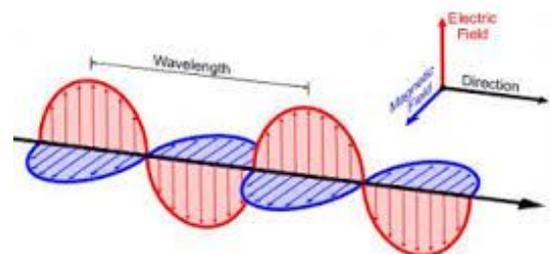
The Electromagnetic Spectrum and Sight

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 _____.

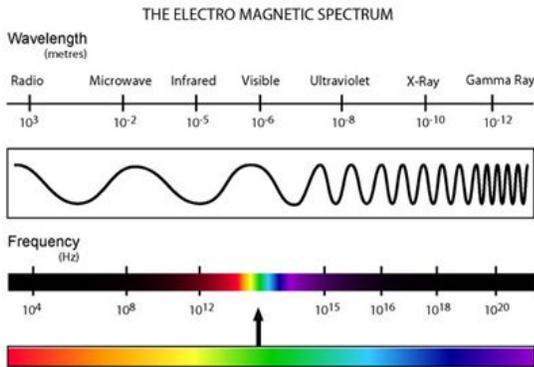
- _____ light is what we perceive when we see _____ the wavelengths of light at once, in equal proportions.

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

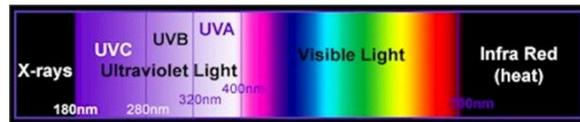
Invisible Colors

What are the parts of the EM spectrum?

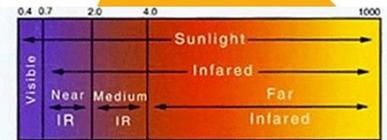
The range of _____ that EM waves can have is called the _____



- _____ 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



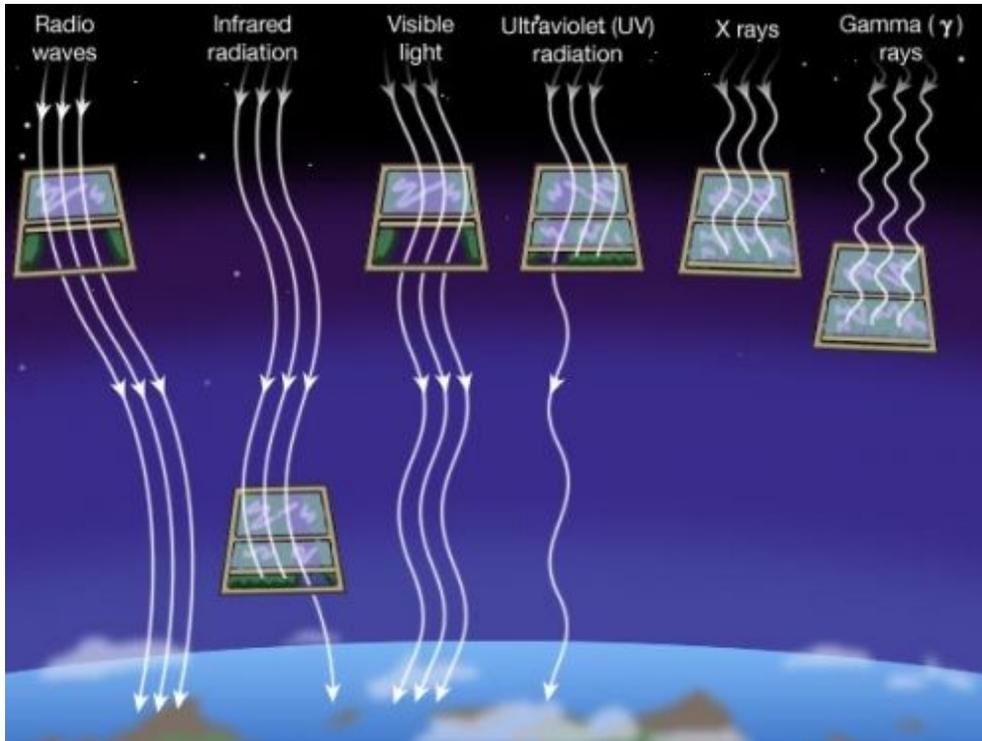
Star Light, Star Bright

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 _____.

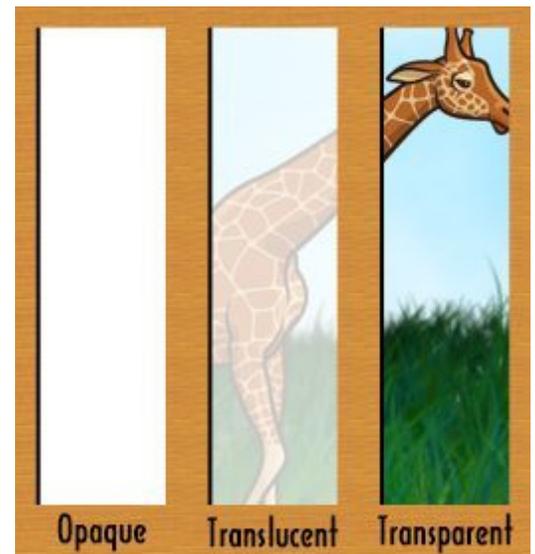
- _____ can _____ light. When light enters a material but does not leave it, the light is absorbed.

- _____ 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.



-
- 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.

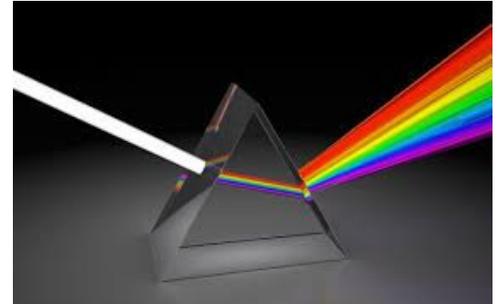
What happens when light waves interact with matter?

•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.

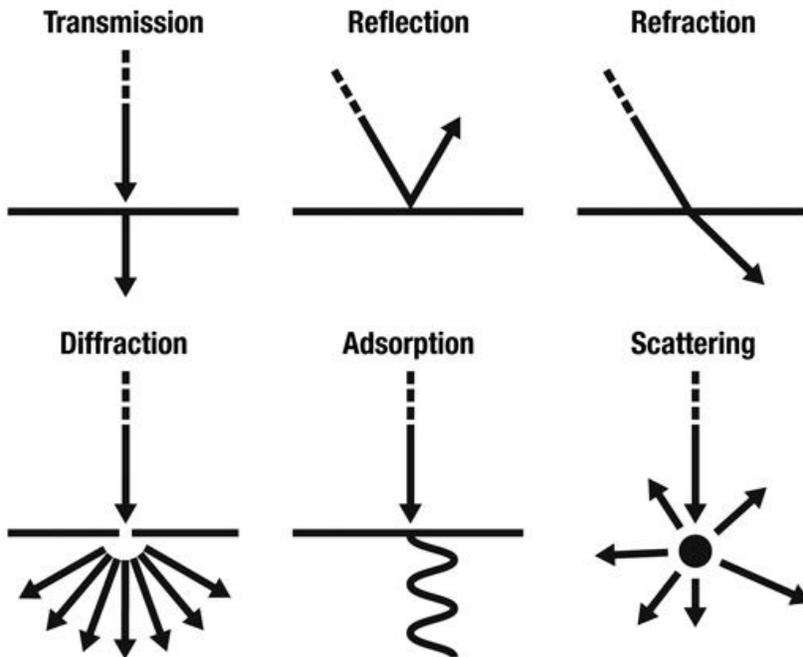
•As white light passes through a prism, the wavelengths refract at different angles and you see a spectrum of colors.

•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.

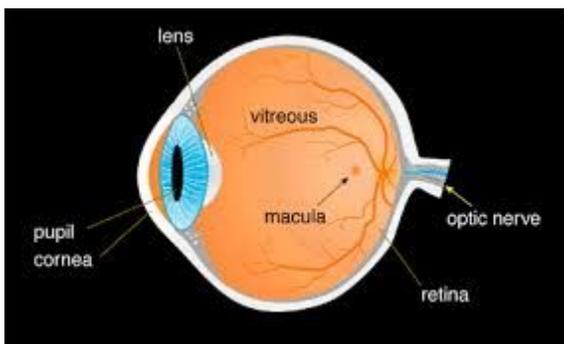
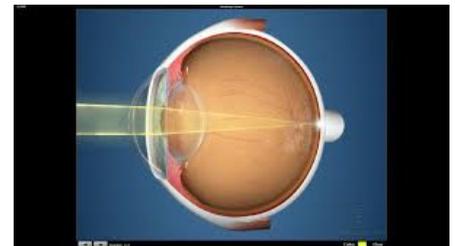
•Another result of scattered light is the _____ of the _____. Blue light is scattered _____ than other colors, so the sky appears blue.

•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.

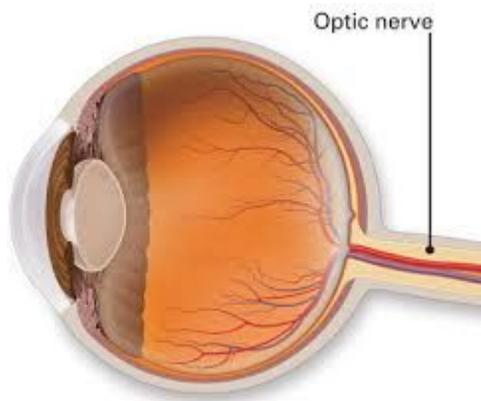
• _____ cells and _____ cells in the retina detect light.

• _____ 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.

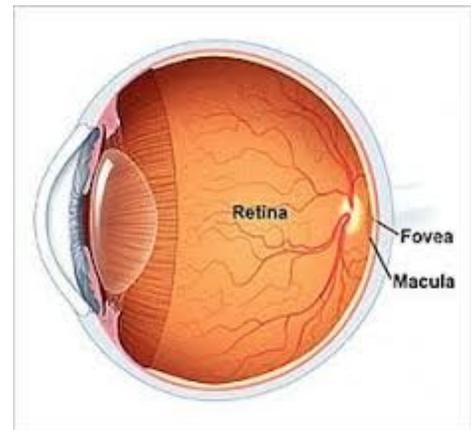
• The brain combines slightly different information from the left and right eyes to produce a sense of distance and depth.

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.

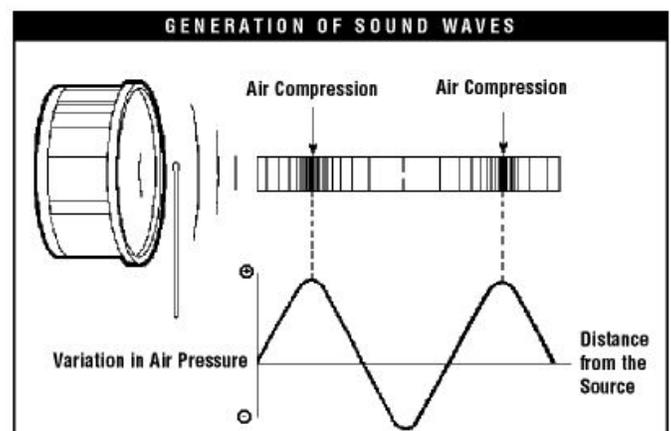
Sound Waves

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.



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?

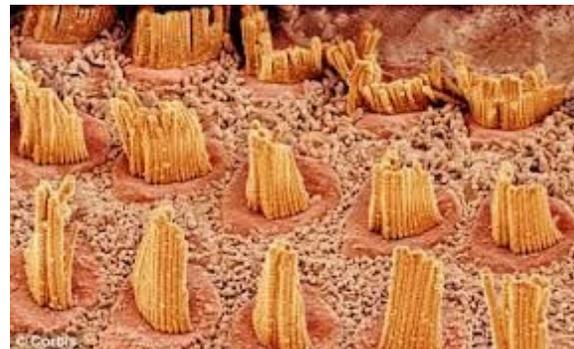
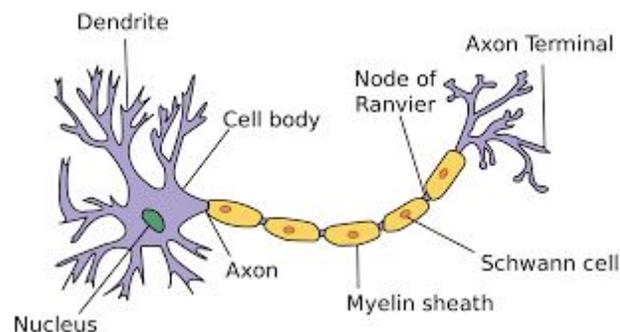
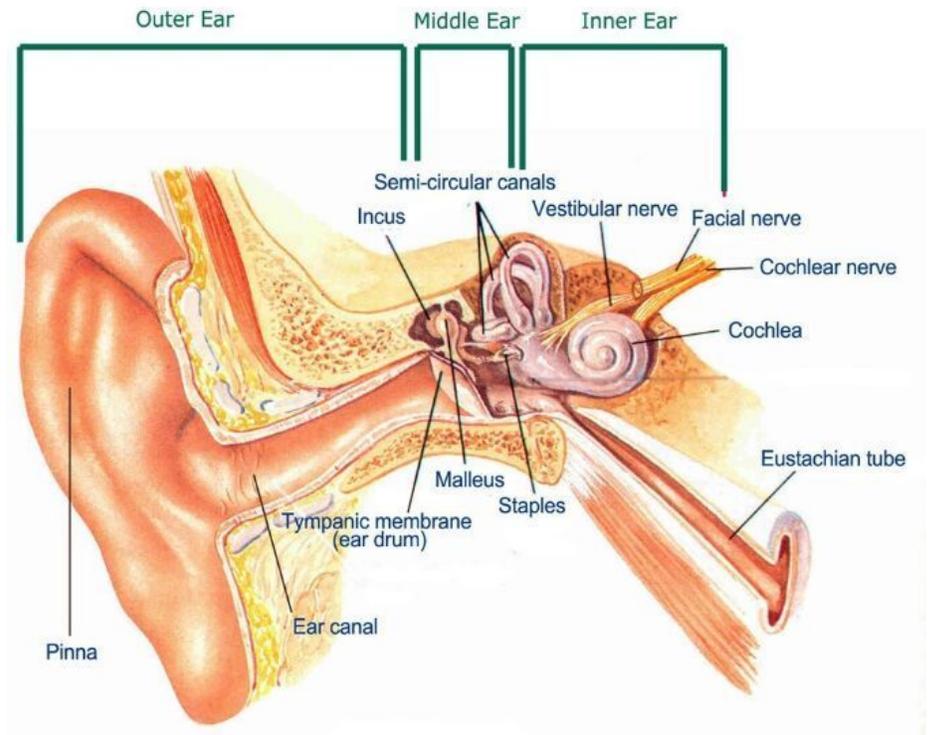
- Humans detect sounds with their ears, which act like funnels for sound waves.

- 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](#).

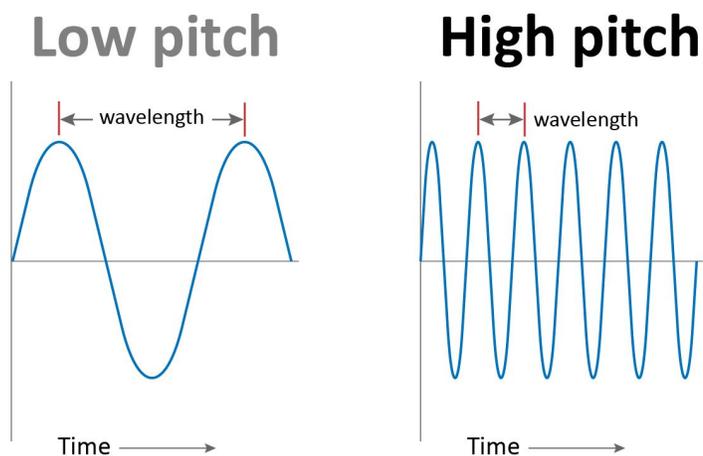
• _____-frequency waves have _____ wavelengths and produce [low-pitched sounds](#).

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

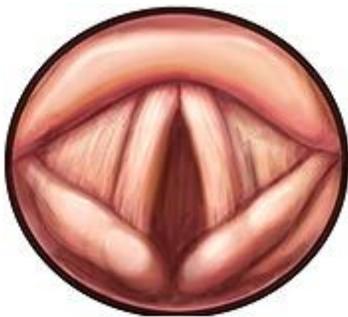
earbuds, and moving away from a loud speaker are all ways to protect yourself from hearing loss.

- 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.

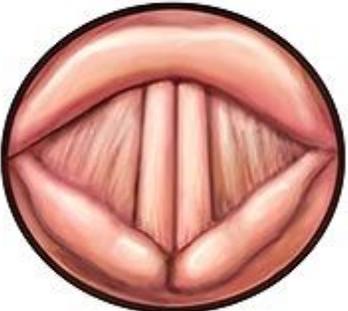
Hello? Hello? Hello?

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.

