## Wave Defined

U5P1a

- There are _____ basic ways that energy can move from one place to another: _____ and flows. A flow is when particles with mass _____. The proof that a _____ contains energy is that when a flow encounters another object, that object will "feel" the flow (i.e. a flow of air particles, called _____, _____ or a flow of lead atoms, called a _____, _____)
- **A wave also possesses _____, but does not possess _____**. A wave is the name given to a temporary disturbance of a medium away from its "natural" state (a.k.a. _____). The particles that make up the _____ react to any changes in their neighbors. So, when an external force affects a part of a medium, the neighboring portions of the medium react to match the affected area. Then the neighbors to the neighbors adjust to _____, and so on. This chain reaction is called "wave propagation". The proof that a _____ contains _____ is that when a wave _____, that object will _____.
- The key difference between flows and waves is this. With the flow, the involved particles _____ _____ (more or less). With the wave, the original affected particles _____ travel, they _____. It is the _____ of the medium that travel.

A wave pulse is a _____ (non-repeating) disturbance of a _____.

A periodic wave is a continuous (_____) _____ _____.

A simple harmonic wave is _____ and wave.

*Two people shaking a slinky.*

## Three Important Wave Sources

_____: When the strain built up inside of a rock layer is released by the rocks fracturing, that change in strain "_____" through the ground.

_____: When a sudden change in air density _____ through the ____.

_____: When a sudden change in an electron's orbital position creates an electromagnetic pulse that _____ through _____.

## Wave Energy Transmission

- When a wave encounters a change in medium _____ possible things can happen. That energy can be *reflected*, be *absorbed*, or be *transmitted*.
- If the change in the medium is very small, virtually all the energy will be _____, which means _____. (So, if someone is in an air-conditioned building with an open window, he can _____ talk to a person outside surrounded by hotter air.)
- If the change in the medium is large, the energy will tend to be _____, meaning _____ _____ or be _____, meaning _____. (So, the conversation described above will be _____ if that window is _____.)

**Parts of a Wave** U5P1b

Note: amplitude is measured from _____ to _____, not _____ to _____

Note: period is measured from _____ to _____ or _____ to _____, not _____ to _____.

A period measures _____ it takes a periodic wave to _____. Units (___)
Frequency measures _____ repetitions in a certain amount of time. Units (___) = (___)

So, period = ___ = _____ = _____

At a certain surfing competition the ocean generates one wave every 20 seconds and judges sit on a pier watching surfers go by.

1. What *period* of time must the judges wait between surfers?

2. How *frequently* do surfers pass the judges?

**Wave Types**

Transverse wave – the wiggle is _____(_____) the direction energy flows.

Longitudinal wave – the wiggle is _____(_____) to the direction of _____.

Note: Transverse waves require _____ to transfer energy, so they work in _____.
Longitudinal waves use _____ to transfer energy, so they work in _____.

**Wave Speed**

- In elementary school you learned that distance = _____ * _____. First of all, please FORGET THAT FORMULA. The correct formula is speed = _____.
- On your formula sheet this is written ___ = _____
  but examining the units we see = _____
  So, alternatively we can say = _____ = _____
  Or = _____ = _____
- The correct formula to use depends on _____.

**Waves Reminders** U5P1c

***** Note: Since it takes _____ to make a medium vibrate, a wave's _____, measures how much _____ is in the wave. *****

***** Note: Since the vibration of a wave starts at a specific point (like a music speaker), the wave's source controls the wave's _____. *****

***** Note: Since waves travel either through _____ or _____ between particles in a medium, the _____ controls the wave's _____. *****

***** Note: The combination of a wave's _____ and _____ result in the wave's _____. *****

- So, wave speed in a slack slinky is _____ wave speed in a taut slinky, because a taut slinky has more _____ to pull the slinky back toward _____ faster. The wave _____, however, just depends on how you _____.
- The speed of a high pitch sound is _____ the speed of a low sound, but the speed of sound in hot air is _____ the speed in cold air, because hot molecules move _____.

**Wave Intensity**

- _____ measures the amount of _____ striking an _____. In 3-D, a wave spreads its energy across an ever growing _____-_____. In 2-D, energy is spread over the _____ of a _____. In 1-D, energy _____
- Thus, intensity α____ in 3-D, α____ in 2-D, α____ in 1-D

*An earthquake triggers an underwater landslide that triggers a tsunami. How will the destructive power of the wave compare at two identical beaches when one beach is 3 times further away than the other?*

*Suppose a single light bulb in a football stadium is 15 times brighter that a standard bulb, but is 20 times further away than a typical lamp, how will the brightness of the two light bulbs compare?*

*What if a parabolic mirror backs the lights so that the light shines out as a beam?*

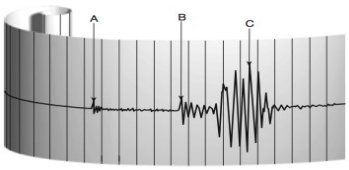
**Earthquakes** U5P1d

- Earthquakes are important to understand for us, because _____.
- Earthquakes are mostly _____, not _____. So, despite what movies show, once the shaking stops the ground is located _____ (± a couple inches).
- When the ground _____, two basic types of waves are produced underground _____ and _____. Since _____ travel faster, they are the first wave you feel and are thus called Primary Waves (a.k.a. _____). _____ waves are called _____ _____ (a.k.a. S-Waves). When wave energy reaches the surface the energy can't _____ into the air (because this is a _____). As a result, some energy is _____ and some energy is transformed into Surface Waves.

**How Seismographs Work**

Traditionally, _____ measured earthquake _____ by scrolling a piece of _____ past a pen attached to a mass on a long string. When the earth vibrates that paper (which is mounted to the _____, which is mounted to the _____) shakes, but the mass (which is hanging freely from the _____) tends to stay stationary. This lets the pen trace to movement of the _____.

**Finding the Epicenter**




- _____: the location on Earth's surface directly above the focus (where the quake starts underground).
- Since P-waves and S-waves travel at _____ speeds, it is possible to know how far away the _____ of a quake is by measuring the difference in their arrival times at a _____. Differences in the rocks in Earth's crust and Earth's spherical shape make things complicated, but roughly speaking _____ travel at 11,200mph and _____ travel at 6,700mph for quakes within 500 miles.

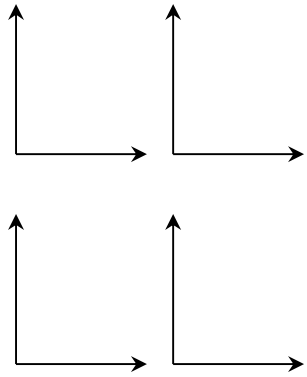
*Suppose an earthquake is 333 miles away, how far apart will the start of the P- and S-waves be?*

## What Is Sound

U5P1e

- Air is a _____, which means its particles _____ _____. Sound travels through _____, therefore sound must be a _____ wave.
- Audible sound is created when a surface/membrane moves _____ and _____ between 20Hz (_____ times per second, _____ seconds in a period) and 20,000 Hz (f =_____, T=_____). Infrasonic has a _____ frequency. _____ has a _____ As the surface moves forwards, the air molecules are _____ _____ forming _____ density _____ pressure air. As the surface moves backwards the air molecules are _____ _____ forming _____ density _____ pressure air. These regions of high and low pressure are transmitted away from the vibrating surface by _____ between air molecules.

## Elements of Sound



- The difference between high and low-pressure zones in air creates sound _____. Note: If air is high pressure, but not vibrating, you will hear _____.
- How frequently wave crests strike your ear drum creates sound _____. Note: high frequency sound travels with _____ speed compared to low frequency sound, because wave speed is controlled by _____ (or _____, _____ for air).

## How Megaphones and Speakers Work

- Megaphones / _____ rely on placing a vibrating object (_____ / magnet) near the tip of a _____ shape. This shape focuses the sound waves that are produced to travel mostly in one direction, instead of a _____-_____.

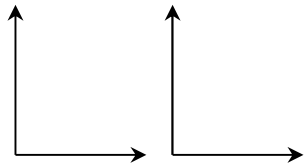
*Suppose a megaphone flares at a $30^0$ angle. Theoretically, how will this change the intensity of your voice at a distance (assume your mouth flares at $180^0$ for the purpose of emitting sound)?*

## What Is Light

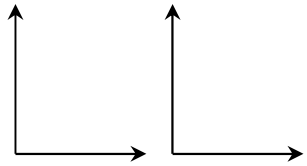
- While sound can travel through _____, light is special because it can travel through _____ and _____ _____. Since there is no matter in _____ _____, light is not a _____ wave. Yet, light definitely behaves like a wave (discussed in the next chapter) The fancier name for light is _____ radiation, because light is an oscillation of _____ and _____ fields created by _____.
- A medium that allows light to pass through it is easily is called _____ (ie._____)
- A medium that tends _____ light is called opaque (i.e. _____, _____).
- A medium that allows light to pass, but blurs it is _____ (i.e. _____).
- Objects that create light are _____(i.e._____). While illuminated objects only _____; like the _____.

## Elements of Light

U5P1f

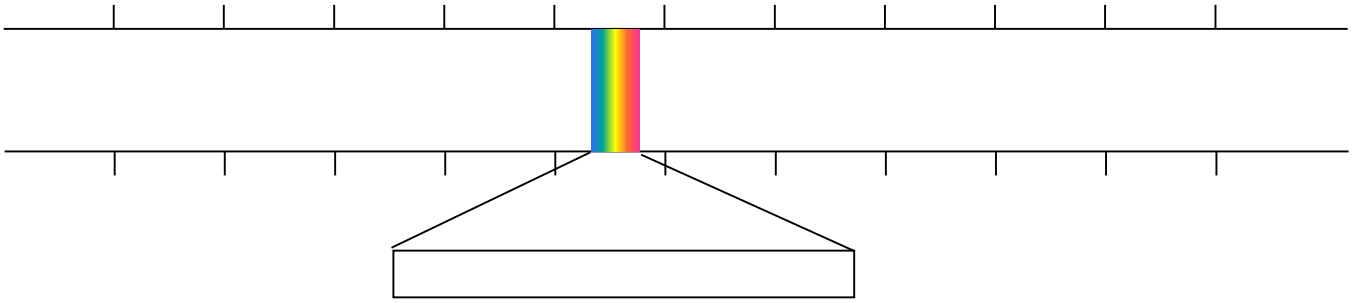


- Light with large amplitude field oscillations is _____.
- Light with high frequency field oscillations is _____ and, by the equation _____, must have _____ wavelength.
- If we think of a jump rope, it takes _____ energy to make the rope spin/oscillate faster. Ergo, high energy light has _____ frequency and appears _____.



## Electromagnetic Spectrum

- The human eye is best at seeing wavelengths of light that easily pass through _____. The outer layers of the atmosphere do an excellent good of blocking _____ energy radiation, otherwise all land organisms would be dead from _____. So, our eyes have no reason to be good at seeing _____, _____, or _____. Humidity in the air makes the air translucent instead of _____ for infrared radiation, so _____ vision is very _____ at a distance. _____ and _____ waves are also not biologically useful for more complex reasons. Nevertheless, all these different names for light are physically the same thing as the _____ light we see.
- You must know the frequency, wavelength and energy order for different types of light, not their numeric values. Remember, "scary" radiation (_____) is _____ energy. So, even small amounts can cause cancer. "Gadget" radiation (_____) is _____ energy. So, only amounts large enough to actually _____ you are usually dangerous.



## How Incandescent Bulbs and LED Bulbs Work

- Visible light is produced when _____ drop from an "excited" state in an atom's _____ _____ to a "lower" state (a larger orbit to a _____ orbit). So, in order to produce light you need to have a way to move _____ to _____.
- An incandescent bulb uses heat from electrical "friction". The hotter a wire gets, the _____ the atoms in the wire _____ into each other. If the _____ are hard enough, electrons can get "bounced" into an _____ state. Unfortunately, this technology produced way more _____ than visible light (efficiency ~2%).
- An LED is made of two semiconductor layers. One layer's chemistry creates an instability that causes the atoms to have missing orbits (holes). The other layer tends to have "extra" electrons. The electric field from a battery is used to push "extra" electrons into "_____". When an electron falls in, _____ is released. Because the height of the drop is controlled, _____ are roughly 10x more efficient than _____ blubs.