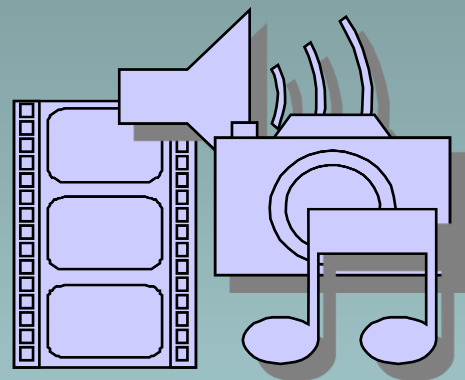
Waves in the GPS



Donna Barrett

Metro RESA

donna.barrett@mresa.org

Science

S8P4. Students will explore the wave nature of sound and electromagnetic radiation.

a. Identify the characteristics of electromagnetic and mechanical waves.

b. Describe how the behavior of light waves is manipulated causing reflection, refraction, diffraction, and absorption.

c. Explain how the human eye sees objects and colors in terms of wavelengths.

d. Describe how the behavior of waves is affected by medium (such as air, water, solids).

e. Relate the properties of sound to everyday experiences.

f. Diagram the parts of the wave and explain how the parts are affected by changes in amplitude and pitch.

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Science

Benchmarks - Waves

By the end of the 8th grade, students should know that

- Light from the sun is made up of a mixture of many different colors of light, even though to the eye the light looks almost white. Other things that give off or reflect light have a different mix of colors.
- Something can be "seen" when light waves emitted or reflected by it enter the eye-just as something can be "heard" when sound waves from it enter the ear.
- An unbalanced force acting on an object changes its speed or direction of motion, or both. If the force acts toward a single center, the object's path may curve into an orbit around the center.

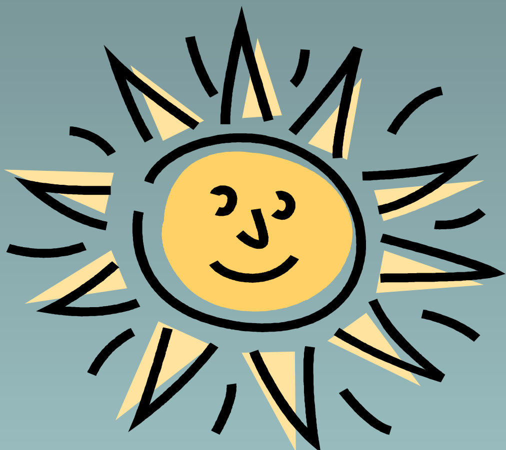
Benchmarks - Waves

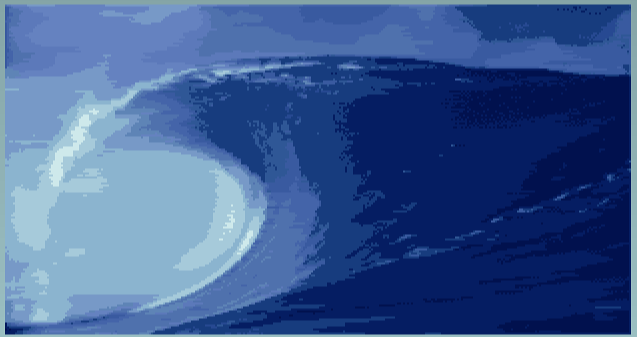
By the end of the 8th grade, students should know that

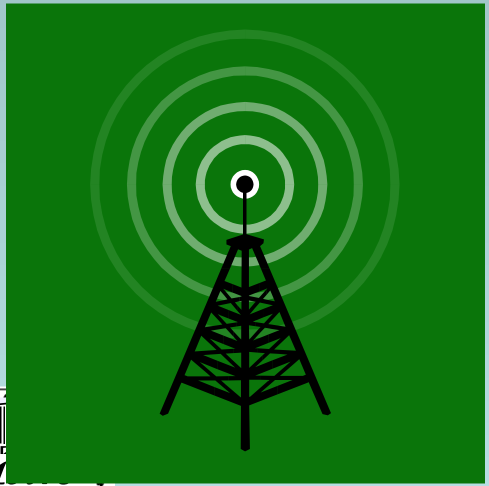
- Vibrations in materials set up wavelike disturbances that spread away from the source. Sound and earthquake waves are examples. These and other waves move at different speeds in different materials.
- Human eyes respond to only a narrow range of wavelengths of electromagnetic radiation-visible light. Differences of wavelength within that range are perceived as differences in color.

Science

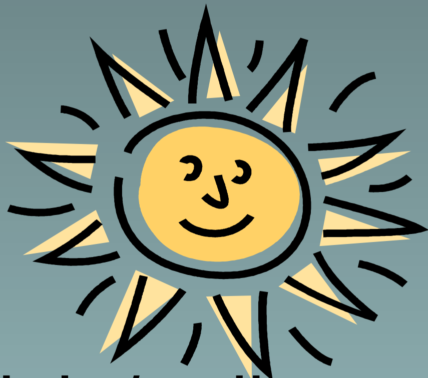
How many different waves are below?



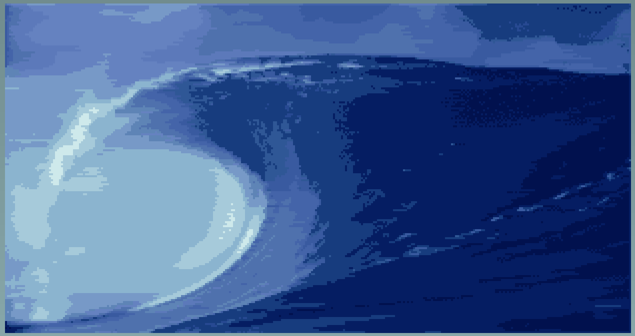




Science

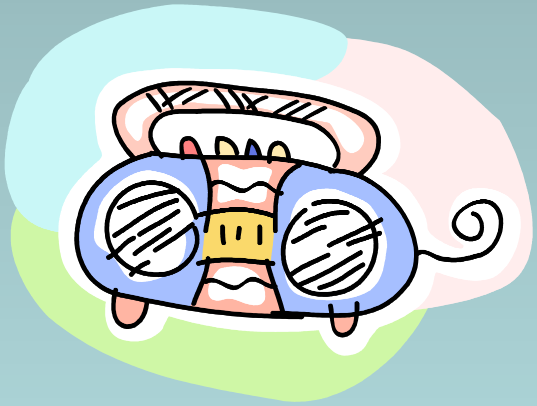


Light/radiant waves

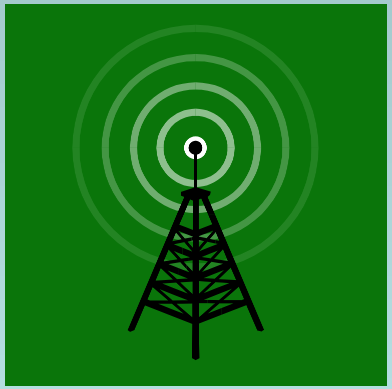


Water Waves

Radio waves



Microwaves



Sound waves

Radio - Microwaves

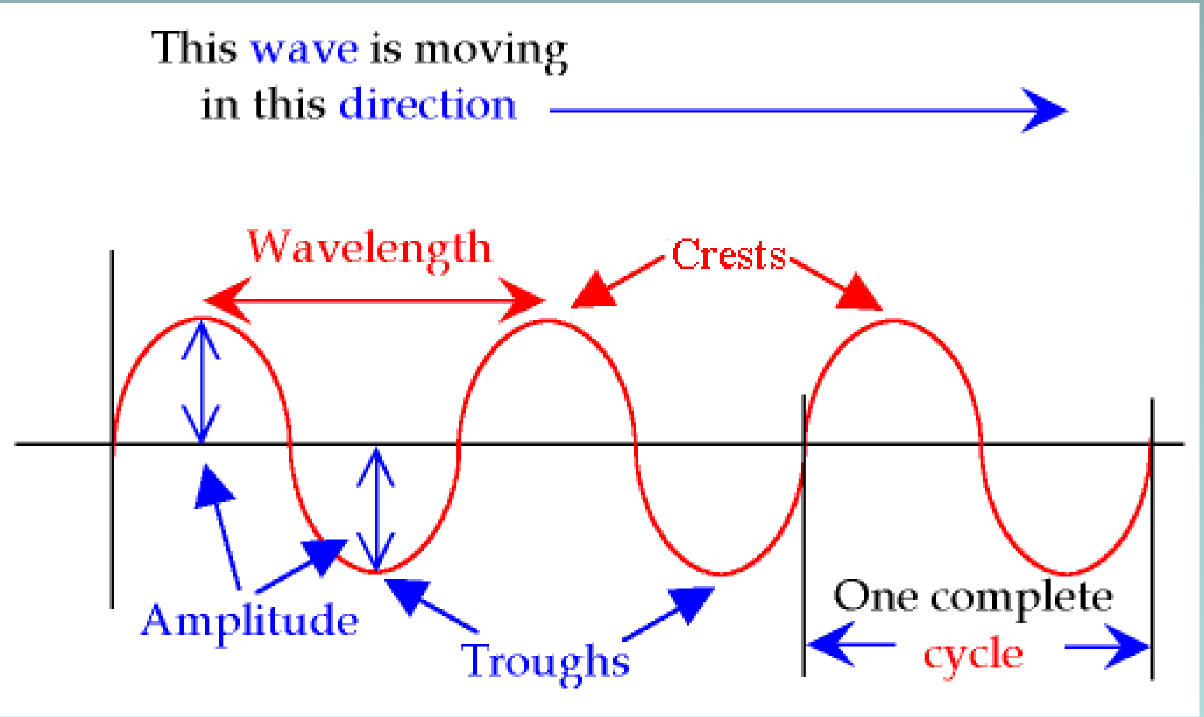
Science

Engage: Air Zooka

- Air Zooka used to move energy from one place to another.
- Discuss speed and energy.
- Compare the Air Zooka to a spring.
- Wave terms: crest, trough, frequency, wavelength, and velocity

Explain: Parts of a Wave

- TERMS: wavelength, frequency, velocity, amplitude, crest, trough, cycle.



http://science-class.net/Notes/Images_8th_Notes/Transverse-Wave.png

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Science

Explore: Human Wave Model

- 10 Volunteers – stand shoulder to shoulder
- Gently push on the first person in line. That person is to match that energy as close as possible and lean into the person next to them.
- Energy transfer is in the direction to the motion of the wave.
- This is an example of LONGITUDINAL wave.
- Everyday examples: tsunami, sound, dominos falling, deep water waves, seismic waves, etc.

Discussion

- How could you calculate the speed of the wave?
  - Distance/time or Wavelength/Frequency
- Define frequency and how could the frequency of the wave be determined?
  - Complete waves/Time – waves/second
- Discuss what would happen if more energy was applied?
  - “amplitude” - height of a wave and it is a measure of energy if the frequency and speed are kept constant
- Represent differences between solids, liquids and gases and calculate the speed in each medium.
  - Because of the larger space between particles the sound would travel slower in a gas than in a solid.

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Science

Human Wave Model: Transverse Wave:

- The first student will squat down about 20cm and rise back up. Then the next student will do the same and so on.
- Discuss the source of the wave and the direction of its transfer of motion.

Science

Discussion

- Calculate the speed of the wave by measuring the total distance for the line of students and the time it took for the wave to start and finish.
- Identify a wavelength, frequency, crest and trough.
- Measure a wavelength [(total length of the row of students)/(# of students)]
- Measure the frequency [#STUDENTS/total time].
- Multiply the wavelength and frequency, then compare their value with the speed.
- How could you change the amplitude? How do you feel after changing the amplitude?

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Science

What is a wave?

A disturbance that transmits energy through matter or space

The wave medium is not the wave nor does it make the wave. The medium carries or transports the wave from its source to other locations.

Metro RESA

Science

Wave Motion

- http://outreach.physics.utah.edu/labs/waves/wave_basics/waves.htm

What do waves carry?

ENERGY

Energy is carried away from a source, but the material the wave travels through does not move with the energy.

Science

Explore: Stadium Wave

- *Doing the wave as a class – arrange seats in a circle with class members sitting – simulate a wave at a sports event*
- A noticeable ripple is produced which travels around the circular stadium or back and forth across a section of bleachers.
- The observable ripple results when a group of enthusiastic fans rise up from their seats, swing their arms up high, and then sit back down.
- The *wave* is passed from row to row as each individual member of the row becomes temporarily displaced out of their seat, only to return to it as the *wave* passes by.
- The medium through which the stadium wave travels is the fans who are in the stadium.
- And in the case of a stadium wave, the *particles* or interacting parts of the medium are the fans in the stadium.

Science

http://www.glenbrook.k12.il.us/GBSSCI/PHYS/Class/waves/u10l1c.html#emmech

A Wave Transports Energy and Not Matter

- When a wave is present in a medium (that is, when there is a disturbance moving through a medium), the individual particles of the medium are only temporarily displaced from their rest position.
- There is always a force acting upon the particles which restores them to their original position. In a slinky wave, each coil of the slinky ultimately returns to its original position.
- In a water wave, each molecule of the water ultimately returns to its original position.
- In a stadium wave, each fan in the bleacher ultimately returns to its original position.
- A wave is said to involve the movement of a disturbance without the movement of matter.
- The particles of the medium (water molecules, slinky coils, stadium fans) simply vibrate about a fixed position as the pattern of the disturbance moves from one location to another location.

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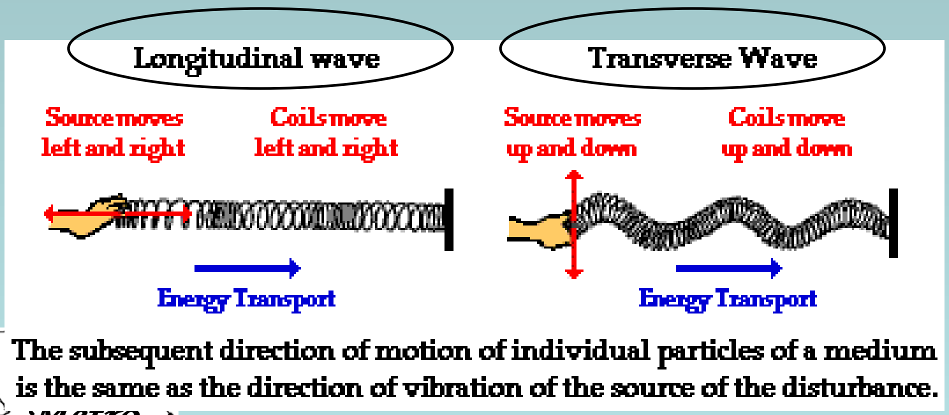
Science

How can we classify waves?

- Direction of movement of the individual particles of the medium relative to the direction which the waves travel
- Ability or inability to transmit energy through a vacuum (i.e., empty space):

Electromagnetic

Mechanical



http://www.glenbrook.k12.il.us/GBSSCI/PHYS/Class/waves/u10l1c.html#emmech

Transverse and Longitudinal

- Click on the link to see a comparison:
- http://einstein.byu.edu/~masong/HTMstuff/WaveTrans.html

Science

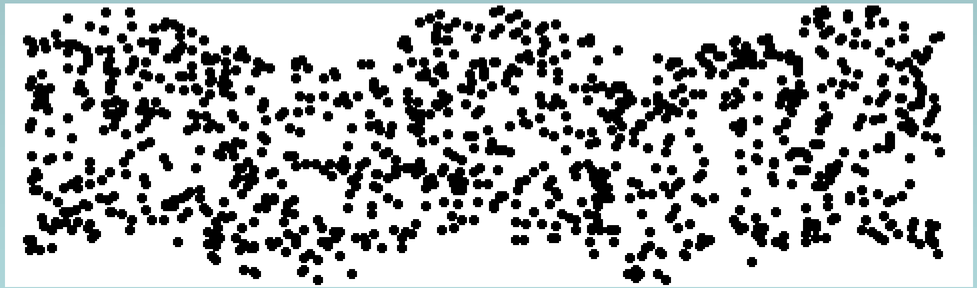
Transverse Wave

- Particles vibrate in up and down motion perpendicular to the flow of energy
- Means “moving across”
- Particles move perpendicular to direction wave is traveling.
- Highest point = crest
- Lowest point = trough
- All electromagnetic waves are transverse waves

Science

Transverse Wave

- Particle displacement is perpendicular to the direction of wave propagation.
- The particles do not move along with the wave; they oscillate up and down their positions as the wave passes by.



http://www.kettering.edu/~drussell/Demos/waves/wavemotion.html

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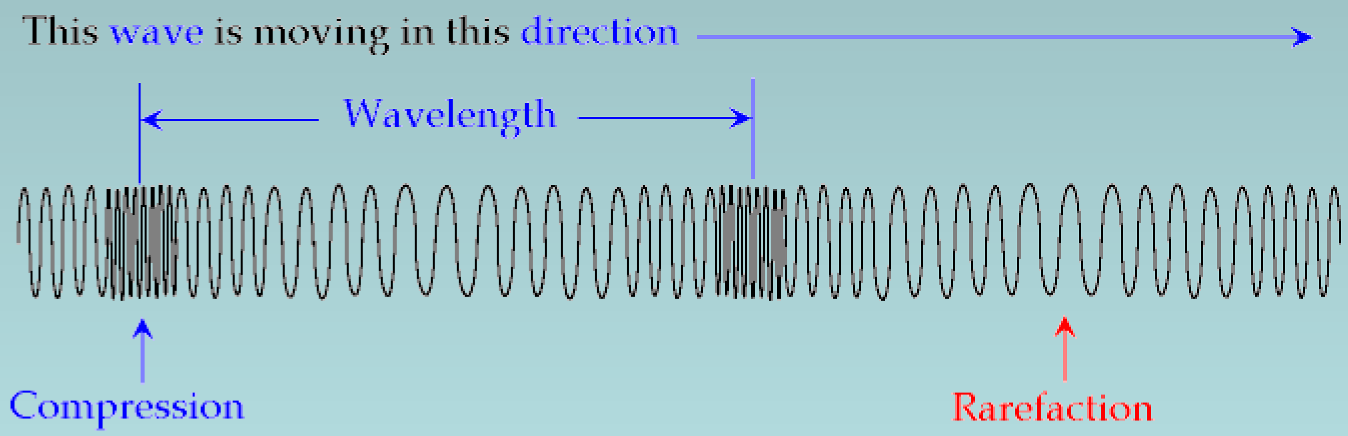
Science

Longitudinal Waves

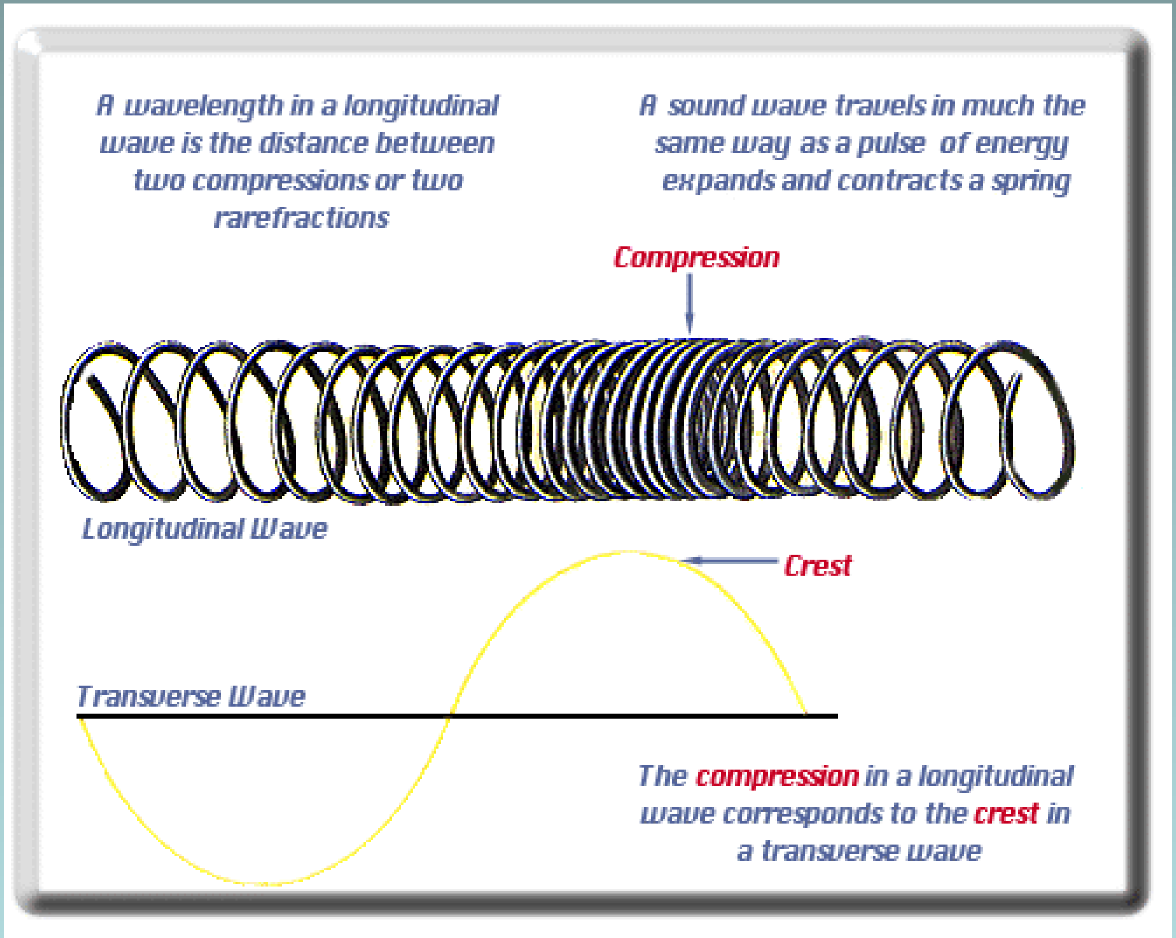
- Particles vibrate back and forth along path wave travels
- Compression = particles are crowded
- Rarefaction = particles less crowded



Science

science-class.net/Notes/Notes_waves.htm

Longitudinal Waves



http://www.lcse.umn.edu/specs/labs/glossary_items/sound_tran_long.html

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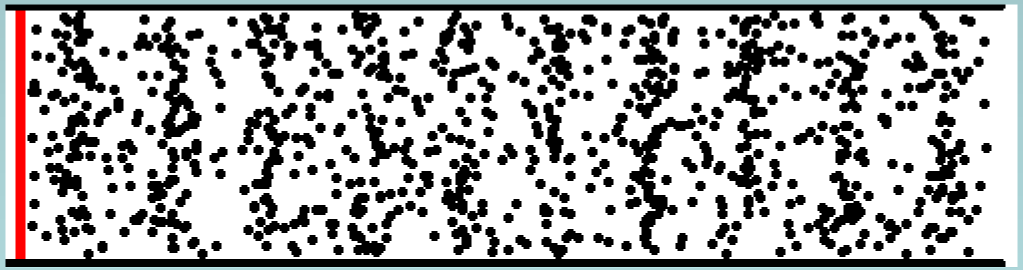
Science

Longitudinal Wave

- Particle displacement is parallel to the direction of wave propagation.
- The particles do not move with the wave; they oscillate back and forth about their positions.

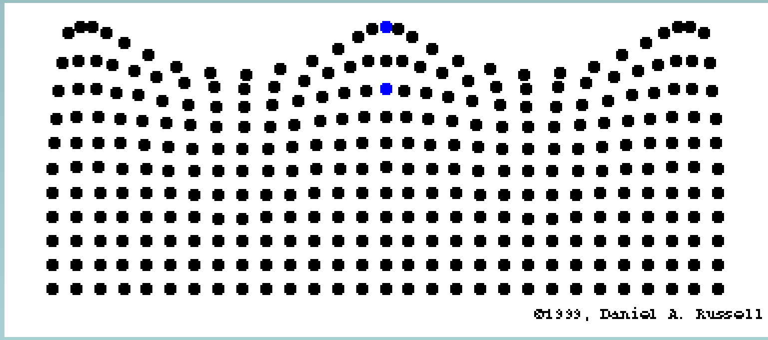


http://www.kettering.edu/~drussell/Demos/waves/wavemotion.html

Science

Water Wave – Surface Wave

- Combination of both longitudinal and transverse motions
- As a wave travels through the waver, the particles travel in *clockwise circles*.



http://www.kettering.edu/~drussell/Demos/waves/wavemotion.html

Science

Extend: Understanding Waves

Procedure:

1. Mark a starting line and a finishing line.
2. Measure the distance between these points. Use SI units.
3. Count the number of steps it takes for you to walk between these two points while your partner times the event. Have your partner call cadence --- LEFT -- RIGHT --etc.
4. Record distance, time and number of steps.
5. Repeat the procedure 2 more times. Average the number of steps and the time. Record your results on the data table.
6. Repeat for each member of your group. Everyone will have their own data.

Data

TRIAL	#1	#2	#3	Average
TIME				
# STEPS				

Calculations:

Average speed = total distance/time =________________

Average length of a step = total distance / # steps = _________

Java Applets

- physicsclub.net/physletIndex/waves.html
- Click on physlets:
- http://physicsclub.net/physlets/downLoaded/WaveTypes.html
- http://physicsclub.net/physlets/downLoaded/waterWave.html

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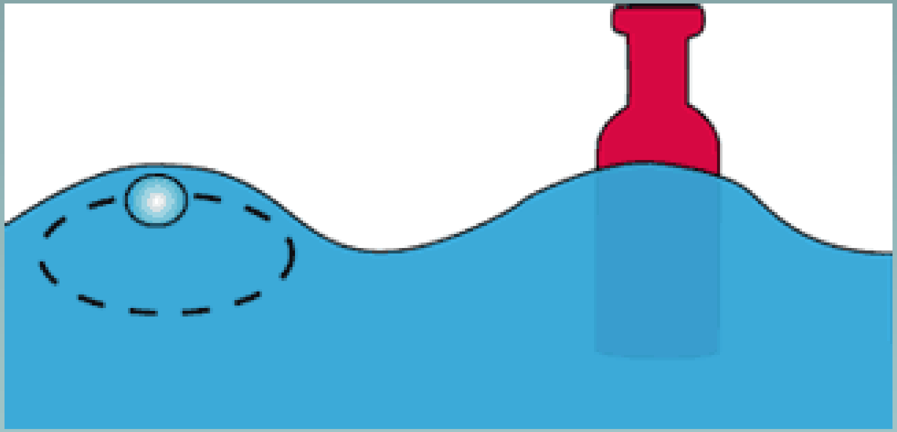
Science

Ocean Waves

- Watch the water droplet move in a vertical circle as the wave passes.
- The droplet moves forward with the wave's crest and backward with the trough.
- The most common cause of waves is wind.
- As wind passes over the water's surface, friction forces it to ripple.
- The strength of the wind, the distance the wind blows (**fetch**) and the length of the gust (**duration**) determine how big the ripples will become.



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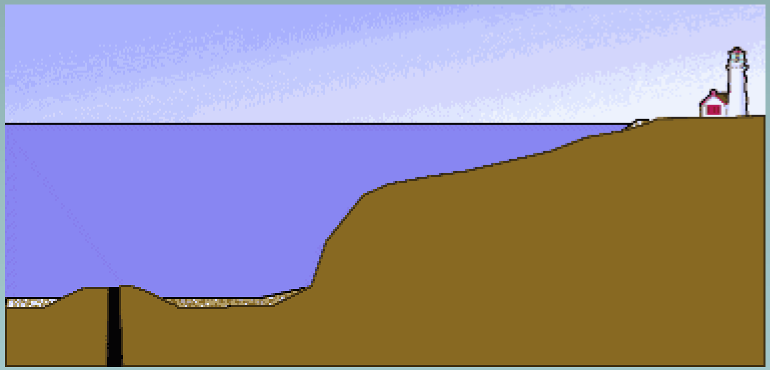
Science

http://www.onr.navy.mil/Focus/ocean/motion/waves1.htm

Tsunamis

- Sometimes reaching heights of 40 meters (120 ft.) or more, **tsunamis** are the most dramatic and destructive of waves.
- Underwater disturbances, such as volcanoes, earthquakes and landslides, are the cause of these waves.
- The larger the disturbance, the larger the tsunami will be.



RESA

Science

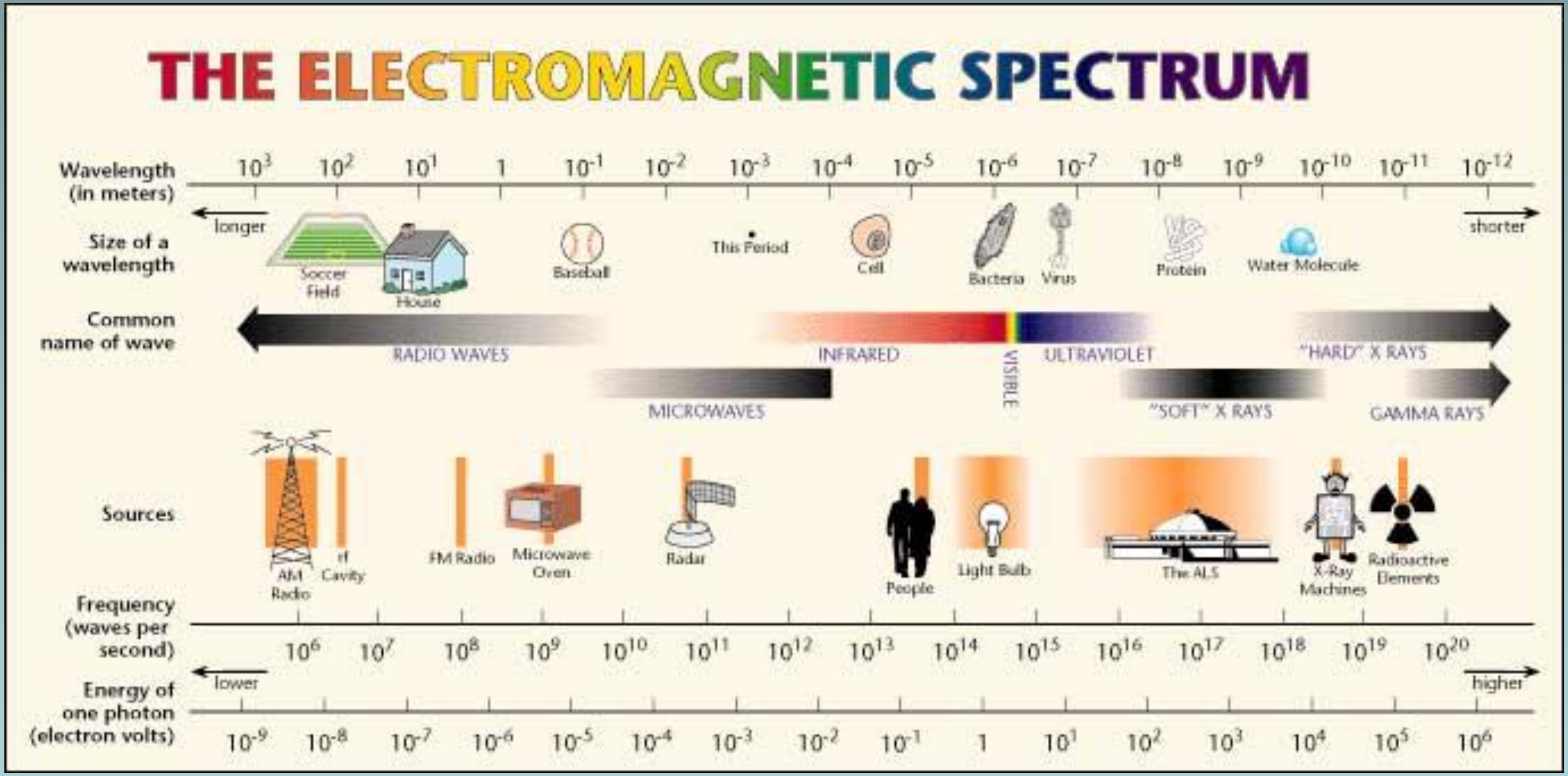
http://www.onr.navy.mil/Focus/ocean/motion/waves3.htm

Electromagnetic Waves

- Electromagnetic waves = **do not require** a medium
  - Ex. Visible light
  - Ex. Microwave
- Can travel through air, water, glass, and empty space
- All travel at the Speed of Light – 300,000,000 m/s or 186,000 miles/second

Science

Electromagnetic Waves



http://son.nasa.gov/tass/images/cont_emspec2.jpg

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Science

What is an Electromagnetic Wave?

- A transverse wave
- A wave that can travel through space or matter and consists of changing electric and magnetic fields.
- Waves are produced by the vibration and movement of an electron

Infrared

- Certain animals (like snakes) can "see" infrared light.
- This allows them to find prey in the dark because thermal energy is emitted in the infrared.
- Scientists have developed cameras that allow us to "see" infrared light.
- "False colors" have been used to indicate temperature.
-

http://son.nasa.gov/tass/images/cont_emspec2.jpg

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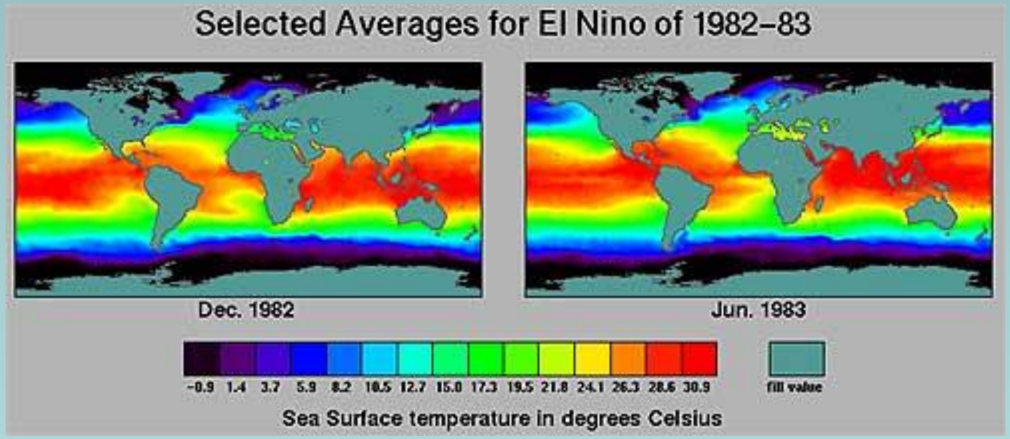
Science

Infrared

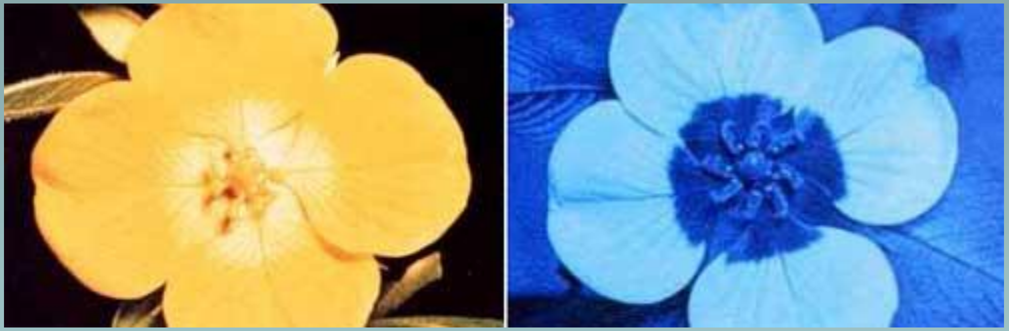
- These images of the Earth showing ocean temperatures were taken from a satellite.



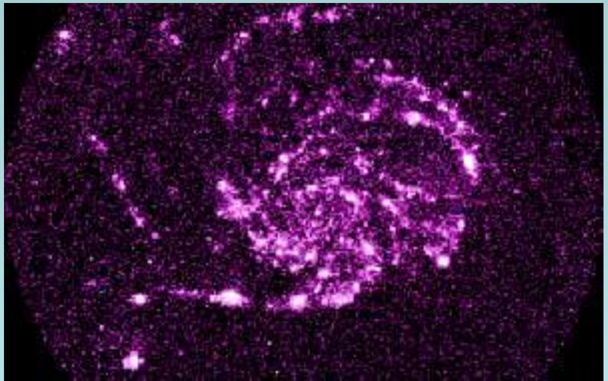
Science

Ultraviolet

- Bees are able to see “ultraviolet”



- Milky way – visible light vs. ultraviolet telescope



http://son.nasa.gov/tass/images/cont_emspec2.jpg

Radio Waves

- Arecibo Observatory – Puerto Rico - the site of the world's largest single-dish radio telescope
- Recognized as one of the most important national centers for research in radio astronomy, planetary radar and terrestrial aeronomy.

http://www.naic.edu/

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Science

X-Ray

- Emitted by
  - Astronomical objects
  - X-ray machines
  - CAT scan machines
  - Older televisions
  - Radioactive minerals
  - Airport luggage scanners
- Detected by
  - Space based X-ray detectors
  - X-ray film
  - CCD detectors

Science

Gamma Rays

- Emitted by
  - Radioactive materials
  - Exploding nuclear weapons
  - Gamma-ray bursts
  - Solar flares
- Sources
  - Pulsars, Black Holes, Supernovae
- Detected by
  - Gamma detectors and astronomical satellites
  - Medical imaging detectors

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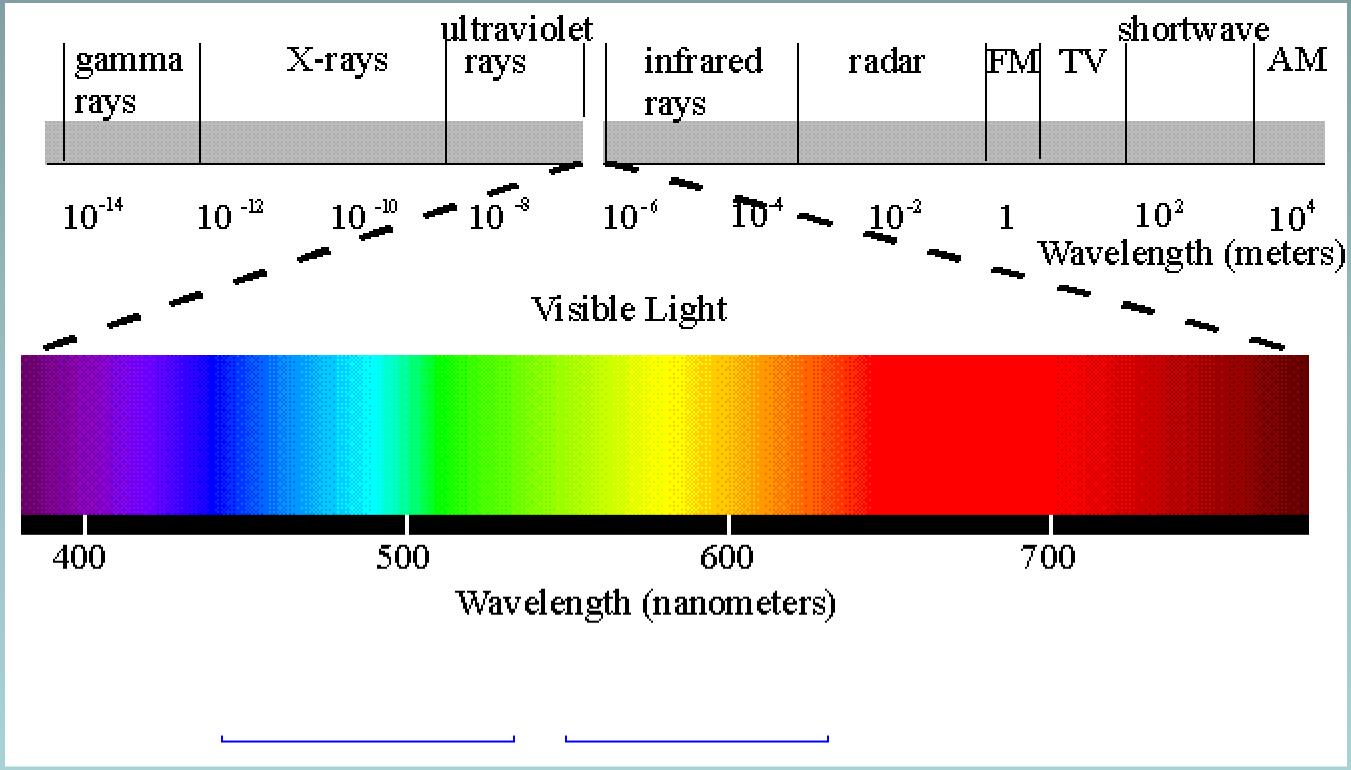
Science

Wavelengths



http://www.yorku.ca/eye/spectrum.gif

Mechanical Waves

- Mechanical waves = **require** a medium
- Medium = solid, liquid, or gas substance wave travels through
- Can be transverse or longitudinal
- Vibrations of particles move back and forth and pass energy to particle next to it.
  - Seismic waves (solid as medium)
  - Ocean waves (liquid as medium)
  - Guitar/cello strings (gas as medium)
  - Sound waves

W ____________________

A ____________________

V ____________________

E ____________________

S ____________________

The Last Word

Science

SOUND

Metro RESA

Science

Properties of Sound

- Sound is a form of energy produced by vibrating particles
- Particles transfer energy to each other through longitudinal waves
- Mechanical – require a medium

Science

Properties of Sound

- Speed varies based on: **medium**
  - Temperature, density, elasticity, source of vibration
- Pitch: sensation of frequency
  - Low pitch = low frequency
- Intensity: amount of energy in a wave; greater amplitude = more energy = greater the intensity – determines loudness or softness of a sound
- Intensity is measured in decibels
  - Small amplitude = Low intensity

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Science

Hearing Ranges of Animals

- Humans detect frequencies ranging from 20 Hz to 20,000 Hz
- Dogs from 50 Hz to 45,000 Hz
- Cats from 45 Hz 85,000 Hz
- Bats rely on sound echolocation for navigation and hunting and can detect frequencies as high as 120,000 Hz.
- Dolphins can detect frequencies as high as 200,000 Hz
- Elephant can detect infrasound, having an audible range from approximately 5 Hz to approximately 10,000 Hz

Science

http://www.glenbrook.k12.il.us/gbssci/Phys/Class/sound/u11l2a.html

Pitch

- How high or low a sound is
- Depends on how fast the particles vibrate
- Low – trombone, bass, tuba
- High – piccolo, violin, viola, flute, xylophone
- Soprano – 1000 Hz
- Thunder – 50 Hz

Explore

- Musical Test Tubes

Science

- Sound travels faster in liquids than in air
- Sound travels faster in solids than in liquids
- Sound does not travel through a vacuum
  - *there is no air in a vacuum so sound has no medium to travel through*

Decibel Scale Measures Intensity

Source	Intensity Level
Threshold of Hearing (TOH)	0 dB
Rustling Leaves	10 dB
Whisper	20 dB
Normal Conversation	60 dB
Busy Street Traffic	70 dB
Vacuum Cleaner	80 dB
Large Orchestra	98 dB
Walkman at Maximum Level	100 dB
Front Rows of Rock Concert	110 dB
Threshold of Pain	130 dB
Military Jet Takeoff	140 dB
Instant Perforation of Eardrum	160 dB

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Science

http://www.glenbrook.k12.il.us/gbssci/Phys/Class/sound/u11l2b.html

Speed of Light – Speed of Sound

- A sound wave travels at approximately 343 m/s or approximately 750 miles/hour
- Light travels through air at a speed of approximately 300,000,000 m/s
- Almost 900,000 times the speed of sound

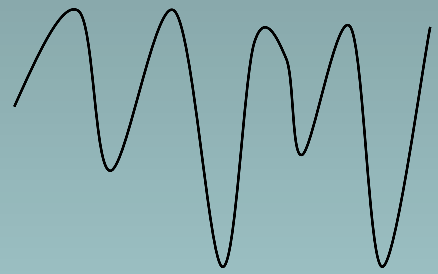
Science

Echo

- Reflection of a sound wave
- Time delay between the production of a sound and the arrival of a reflection of that sound off a distant barrier
- Can be used to calculate the distance to the barrier
- distance = v • t/2 = 345 m/s • 3s 2 = **1035 m**

Music vs. Noise

- Music produces a sound wave with a repeating pattern.



- Noise can be described as any undesired sound that includes a random mix of pitches

Science

Project Ideas

- Research how Chuck Yeager broke the sound barrier.
- Compare and contrast the hearing ranges of animals and how the ranges are of adaptive advantages.
- How do animals use echolocation to communicate?
- How can listening to loud music impact our hearing?
- How does a hearing aide work?
- How are ultrasounds or sonograms used in medical applications?
- Ask students who play instruments to bring them in and play for the class – explain pitch, sounds, etc.

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Science

Light & Sound Websites for Teachers

- Electromagnetic Spectrum: http://imagine.gsfc.nasa.gov/docs/science/know_l1/emspectrum.html
- Neighborhood Jam Session – make your own instruments: http://www.childrensmuseum.org/artsworkshop/jam.html

Science

Physical Science Frameworks

- www.georgiastandards.org
- Light and Sound
  - – Sound of Music – making instruments
  - – What a Colorful World – tiered task

SOUND MISCONCEPTIONS	PROPER CONCEPTIONS
You can see and hear a distant event at the same moment.	Sound and light do not travel with the same speed. Light travels a lot faster than sound and therefore we see distant events before we hear the sound that they produce.
Hitting an object harder changes its pitch.	Pitch is related to frequency. Hitting an object harder creates greater amplitude for the sound that it produces and amplitude is related to intensity. Hence, hitting harder causes louder sounds.
In a telephone, actual sounds are carried through the wire.	In a telephone, the sound is transformed into electrical impulses that travel through the wire. On the other end these electrical impulses and transformed back to sound by the speaker.
Sound moves faster in air than in solids (air is "thinner" and forms less of a barrier).	Sound moves faster in solids than in gases. Sound waves are mechanical waves; hence they need a medium to travel. The closer the particles that form the medium, the faster the sound will propagate.

LIGHT

Metro RESA

Science

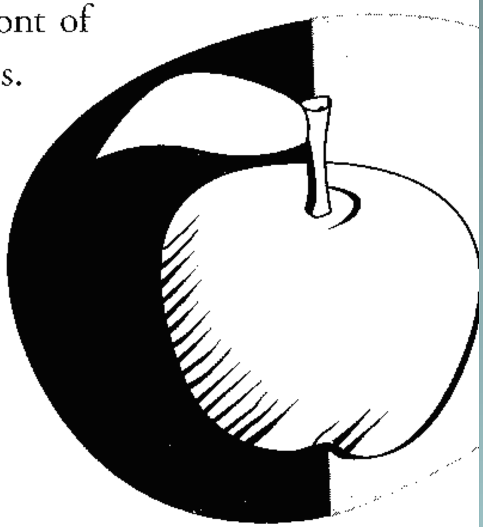
Anticipation Guide

Before		After
______	Sound travels faster in solids than in liquids.	______
______	Sound waves are examples of electromagnetic waves.	______
______	Diffraction is the bouncing back of waves after they strike a surface.	______
______	An echo is an example of refraction.	______
______	White light contains all colors in the visible light spectrum.	______
______	Light has properties of both particles and waves	______

Metro RESA

Science

Apple in the Dark



Imagine you are sitting at a table with a red apple in front of you. Your friend closes the door and turns off all the lights. It is totally dark in the room. There are no windows in the room or cracks around the door. No light can enter the room.

Circle the statement you believe best describes how you would see the apple in the dark:

A You will not see the red apple, regardless of how long you are in the room.

B You will see the red apple after your eyes have had time to adjust to the darkness.

C You will see the apple after your eyes have had time to adjust to the darkness, but you will not see the red color.

D You will see only the shadow of the apple after your eyes have had time to adjust to the darkness.

E You will see only a faint outline of the apple after your eyes have had time to adjust to the darkness.

Describe your thinking. Provide an explanation for your answer.

Science

Apple in the Dark

- Keely, Page. Uncovering Student Ideas in Science. Vol 1
- Answer: “The best response is A. In order to see an object, light must be emitted from or reflected off an object so that it reaches the eye. It is impossible to see in the absence of light (total darkness).”

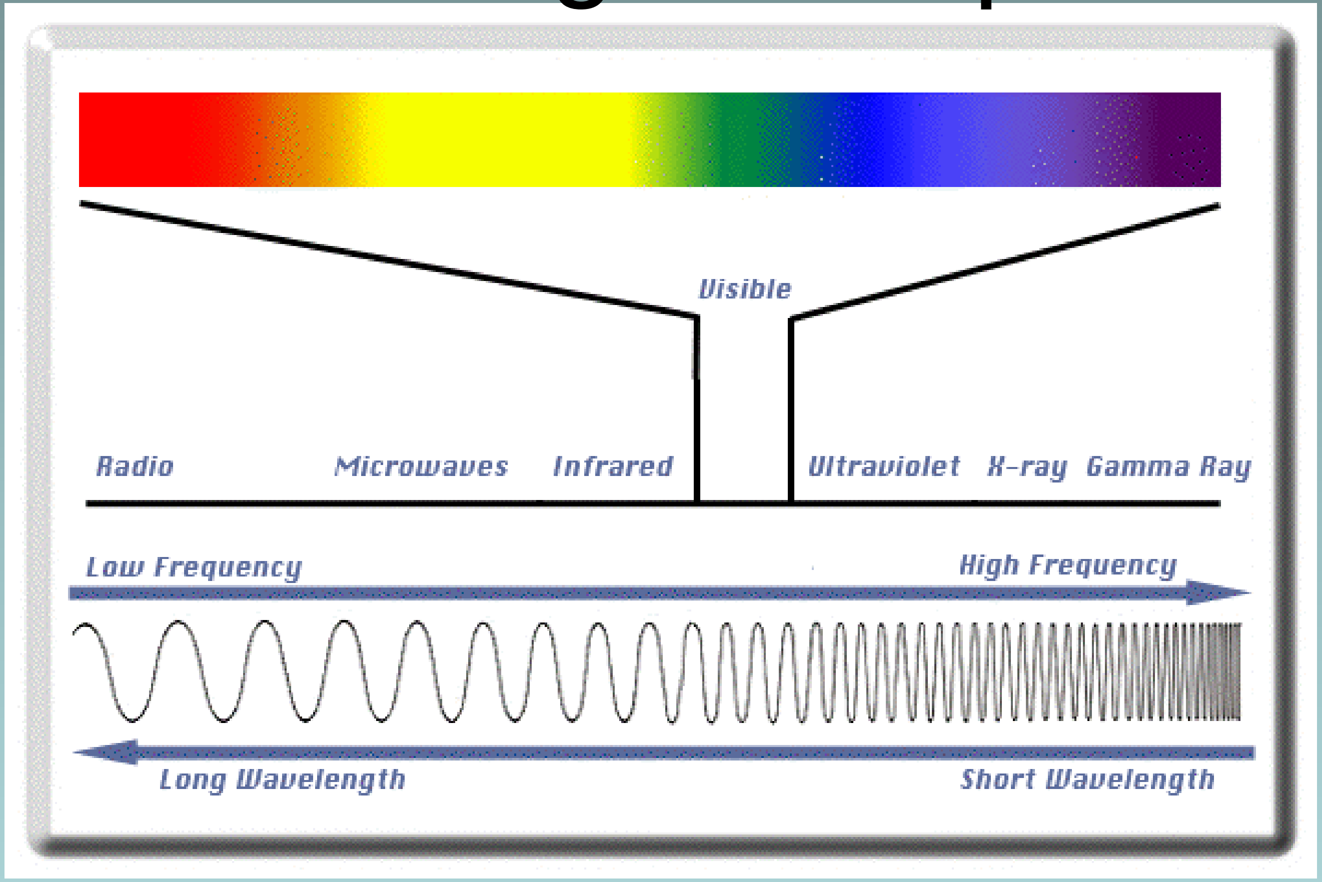
Science

What is LIGHT?

- A type of **electromagnetic wave**
- **Transverse Wave**
- Type of **energy** that travels as a wave
- NO medium is required
- We see things because light reflects off of them

Electromagnetic Spectrum

-



http://www.lcse.umn.edu/specs/labs/images/spectrum.gif

Metro RESA

Science

Visible Light

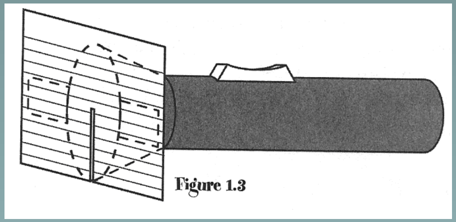
- We see different wavelengths as different colors
- When all colors are combined, we see white light
- When there are no colors, we see black

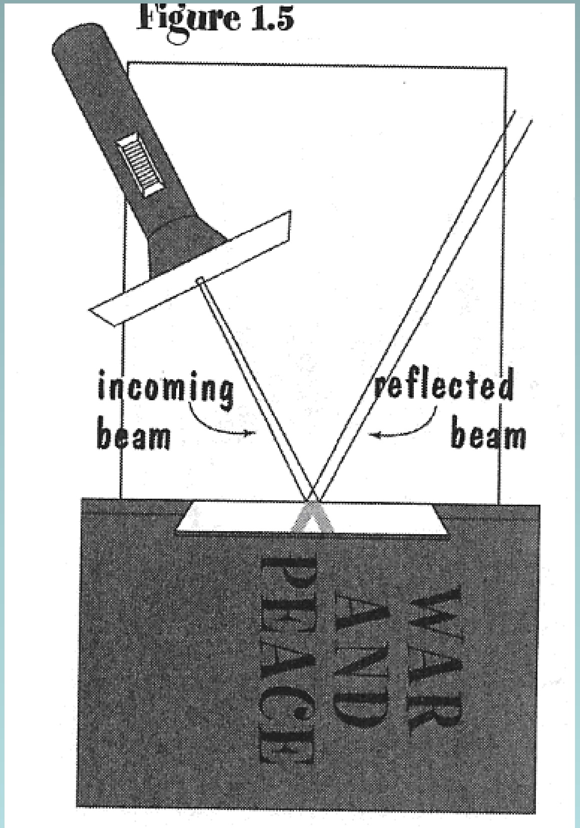
Visible Light

- Light behaves like a particle and a ray
- When shining a light, closer objects appear brighter, this appears for 3 reasons
  1. The beam of light spreads out
  2. Absorption
  3. Scattering

Science

Explore: Light Behavior





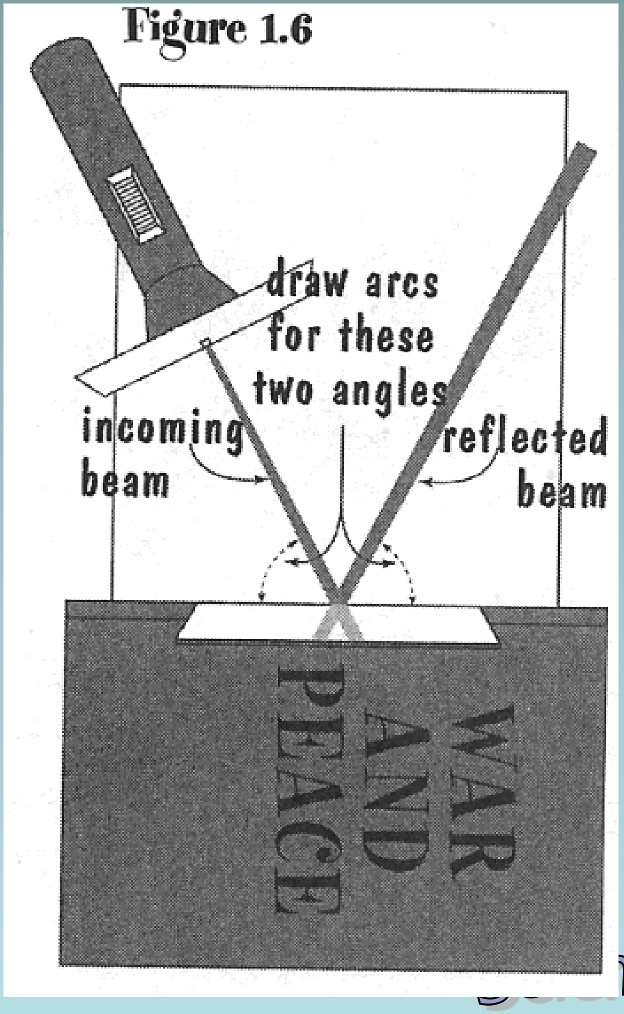
- Cut a narrow slit in an index card.
- Tape the index card over the front edge of the flashlight so that the open end meets the edge.
- Prop a mirror on the edge of a book so that it is standing vertical. Place a piece of white paper out from the book.
- Shine the flashlight toward the mirror so that you can see the incoming and reflected light.

Science

Source: Stop Faking It: Light

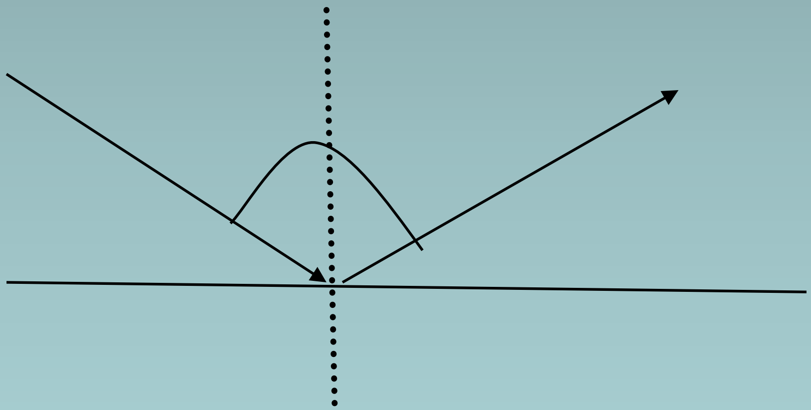
Explore: Law of Reflection

- Compare the incoming beam angle with the angle of the reflected beam
- Measure the angle with a protractor
- Repeat with 2 more angles



Law of Reflection

- Law states that:
  - angle of incidence = angle of reflection
  - Angle of Light going into surface **=** angle going out



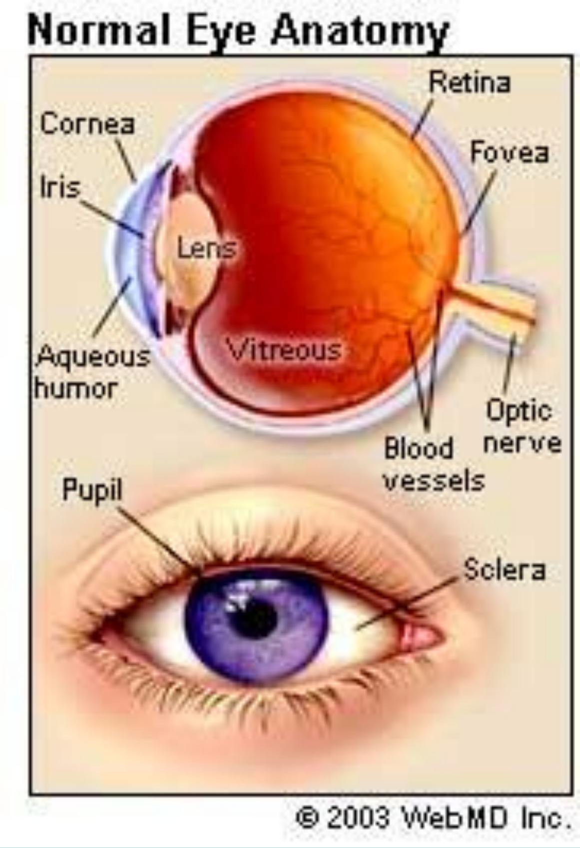
If the reflecting surface is smooth, then light reflects off of all points at the same angle.

If the reflecting surface is rough, then light reflects off at many different angles.

Science

How the Eye Sees

- Light enters through the cornea which helps to focus the light.
- The clear, watery fluid behind the cornea is the *aqueous humor* which keeps a constant pressure within the eye.
- Light next passes through the iris which is the colored part of the eye.
- Light then enters the pupil -- the black dot in the middle of the eye.
- Light next goes through the lens. Which focuses the light. The lens changes shape to focus on light reflecting from near or distant objects.
- This focused light now beams through the center of the eye. Surrounding the vitreous is the tough, fibrous, white part of the eye known as the sclera.
- Light reaches its final destination: the retina located at the back of the eye.



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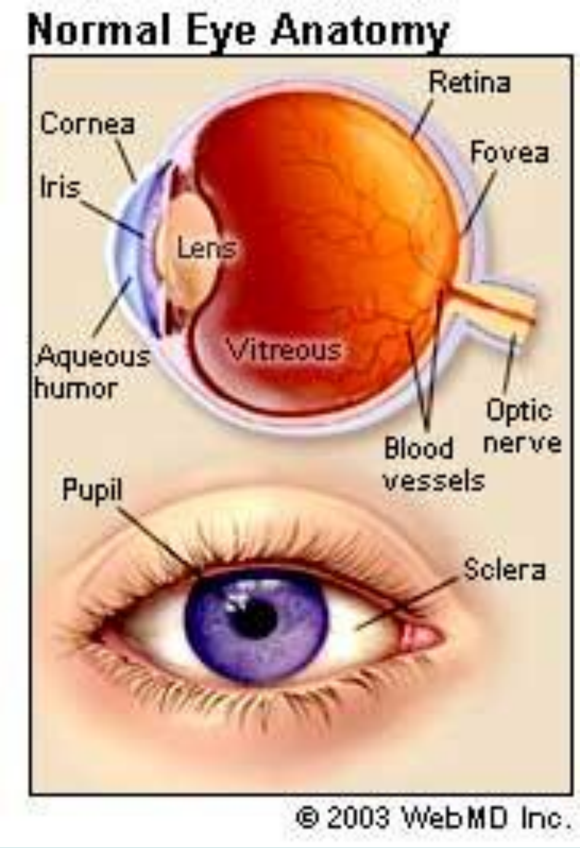
http://www.webmd.com/eye-health/amazing-human-eye

How the Eye Sees

- The focused light is projected onto the flat, smooth surface of the retina.
- The retina has many parts including the macula, blood vessels & photoreceptors.
- Photoreceptors (rods and cones) are specialized nerve endings that convert the light into electro-chemical signals. These signals travel to the optic nerve which carries all the information collected from the eye to the brain.
- Light has reflected from an object, entered the eye, been focused, and converted into electro-chemical signals. The brain then must receive -- and interpret -- the eye's signals. Once this is done, vision occurs.



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http://www.webmd.com/eye-health/amazing-human-eye

Seeing COLOR

- Human eyes have both light and color receptors (most mammals have only light receptors
- It is because visible light has color that we see objects as having different colors
- Grass appears green because grass reflects only green light and absorbs all other colors
- Our visual system perceives different wavelengths of light as different colors

Science

LIGHT & COLOR

- Light can interact with matter in 3 ways
  1. ***Reflected*** - light rays reflect at angle of incidence
  2. ***Absorbed*** - energy is transferred to the particles
  3. ***Transmitted*** - light passes through the matter
- TYPES OF MATTER
  - Transparent - light is easily transmitted
  - Translucent - transmits and scatters light
  - Opaque - does not transmit any light

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Science

COLORS of OBJECTS

- The color of an object is determined by the wavelength of color that reaches your eye.
- OPAQUE OBJECTS
  - When white light hits a colored object, some colors are absorbed and some are reflected
  - Only the light that is reflected reaches your eyes, this is the color that we see
    - White objects REFLECT ALL colors
    - Black objects ABSORB ALL colors
- TRANSPARENT OBJECTS
  - We see the color that is transmitted through the matter

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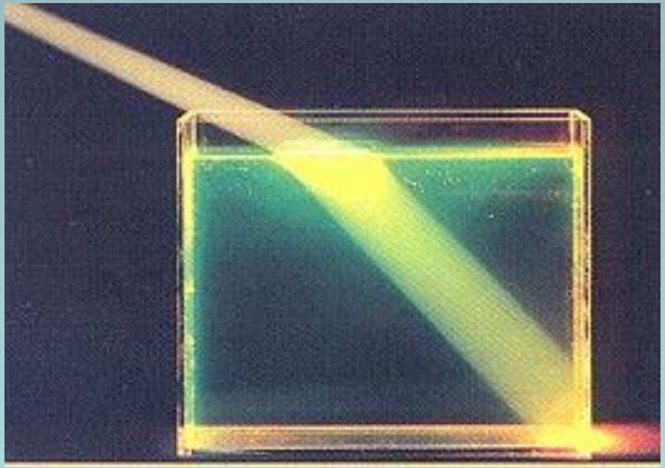
Science

Mixing COLORS of Light

- RED, BLUE and GREEN can be combined in different ratios to produce all colors of visible light
  - Called the Primary Colors
  - When they are mixed, they make secondary colors
- Mixing Colors of Pigment
  - Pigment - material that gives a substance color by absorbing colors of light and reflecting others
  - This is why we cannot mix red, blue and green paint to make white paint. Instead it is black. Why?

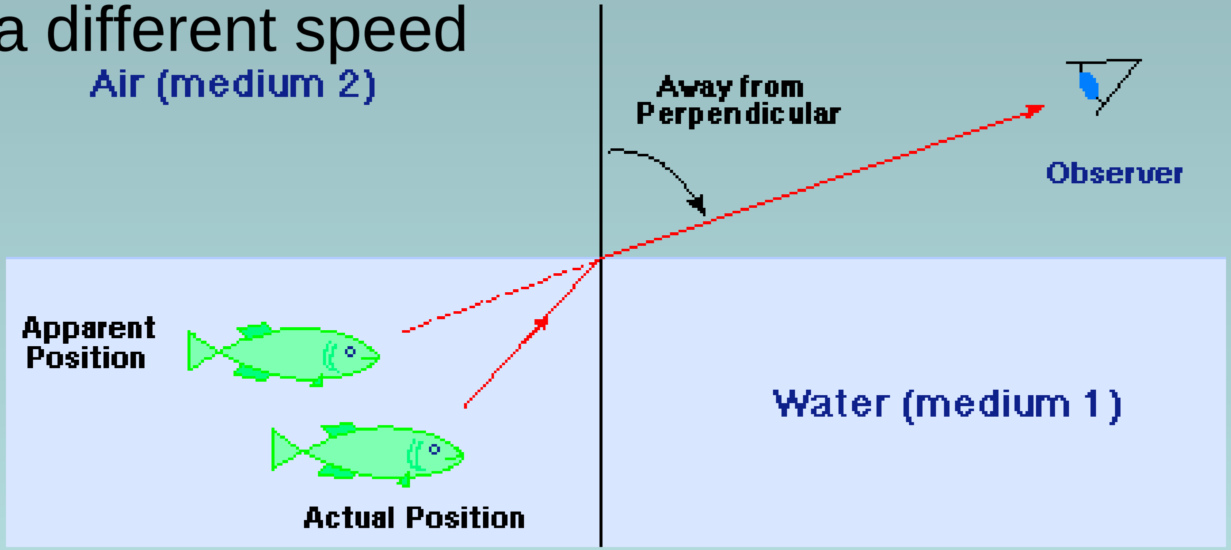
Refraction

- The bending of a wave as it passes at an angle from one medium to another.
- Example – looking into water.



Refraction

- The direction of light can be changed at the boundary of two media having different densities.
- When a wave enters a new medium at an angle, the wave that enters first begins to travel at a different speed



http://csep10.phys.utk.edu/astr162/lect/light/ref-diff.html

Refraction & Scattering Activities

1. Fill a 1 L jar or beaker with water and add a few drops of milk – shine a narrow beamed flashlight into the water - scattering
2. A. Place a penny at the bottom of a Styrofoam cup that you have cut in half. You may want to use tape to secure the penny to the center of the cup.

   B. Have your partner slowly slide the cup away from you until you can no longer see the penny. **Do not move.** Stay in this position until your partner has completed Step 3 below.

   C. Without disturbing the penny, have your partner slowly pour water into the cup until you can see the penny again. Reverse jobs and repeat the experiment.
3. Broken Pencil: Place a pencil in a beaker half filled with water – observe

Absorption & Scattering

- Absorption
  - the air particles around the light absorbs (takes) some of the energy from the light
- Scattering
  - Light scatters in all directions
  - The particles that absorb energy (around the light source) give off light energy
  - This makes us able to see things near the light that are not on the line that the light is traveling
  - Shorter wavelengths scatter more light than longer wavelengths.

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Refraction and COLORS

- White light is made up of all colors of visible light
- Each color has its own wavelength and energy
- When white light is refracted, the magnitude that the light bends, depends on the wavelength.
  - Light waves with SHORT wavelengths bend MORE
  - This allows white light to be separated into different colors during refraction
- This is why and how rainbows form

Science

Lenses Refract Light

- Lens - a curved, transparent object that forms an image by refracting, or bending light
- Classified by shape
  - Convex - thicker in the middle than at the edges
  - Concave - Thinner in the middle than at the edges

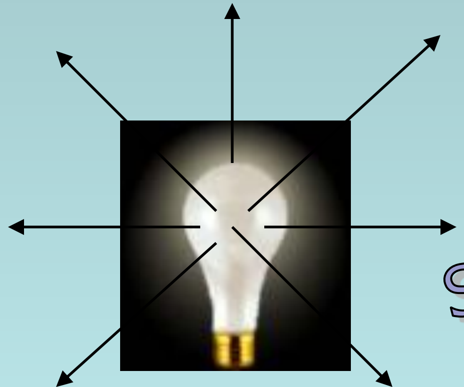
Science

Reflection

- Occurs when a wave “bounces” off a barrier
- Examples
  - Echoes
  - Light reflection (Moon)
  - Mirrors

MIRRORS----

- Images in mirrors are reversed left to right
- Light waves travel in straight lines in all directions from a light source
  - An arrow called a ray (vector) can represent the path and direction of the light wave
  - These rays are used to show the light after it is reflected or refracted- it shows the change of direction



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Mirrors Reflect Light

Mirrors are classified by their shape,

- **plane, concave, and convex**
- The shape of the mirror affects the way light reflects from it and how an image appears

Ever been

to a

Funhouse?

Science

Plane Mirrors

- A mirror with a flat surface
- When you look at it, your reflection is upright and the same size as you are
- Images are reversed from left to right
- Image appears to be the same distance from the mirror as in front of it
- Mirrors are opaque, light does NOT travel through them
- The image created is **virtual**-your brain sees the reflected light and thinks it is straight behind the mirror

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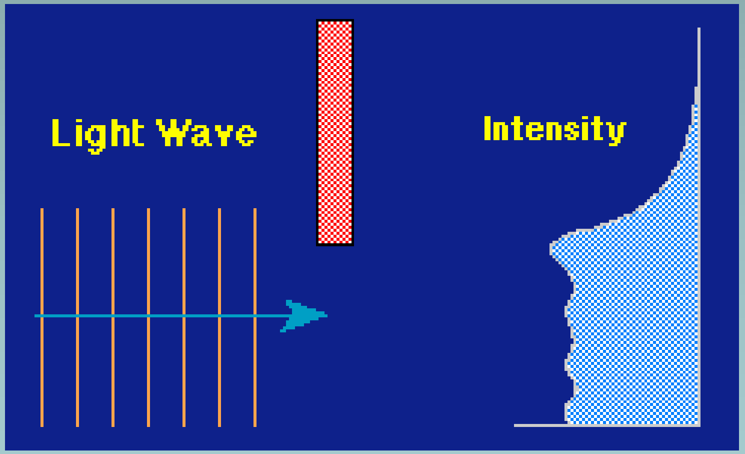
Diffraction

- Bending of waves around a barrier or through an opening.
  - Greatest amount of diffraction occurs when the opening is the same size as the wavelength or smaller
- Light waves cannot diffract around large obstacles
  - This is why you can't see around corners
  - Light waves always diffract a small amount

Diffraction

- Bending of light around corners
- Astronomy application: diffraction grating which can separate light into its constituent colors
- Microscopy: a means of identification of materials upon diffraction

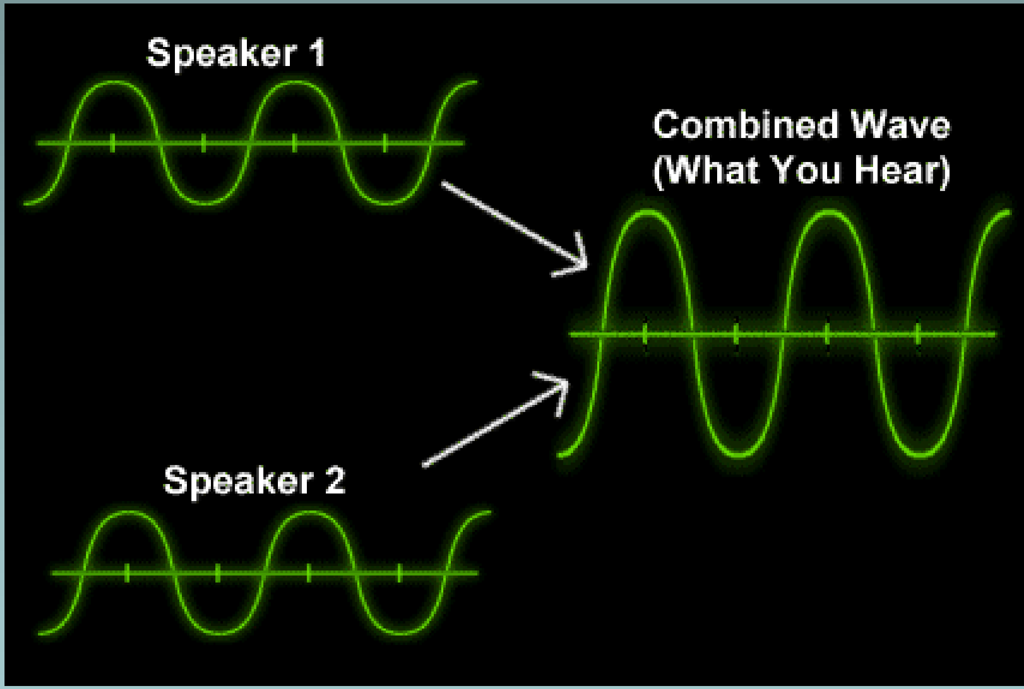


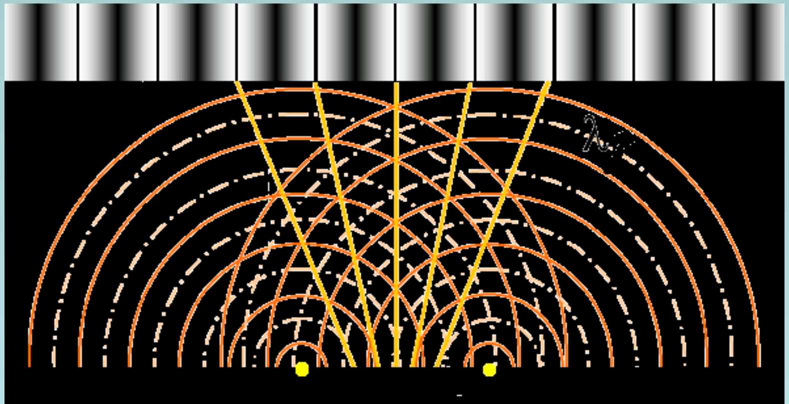
Science

http://csep10.phys.utk.edu/astr162/lect/light/ref-diff.html

Interference

- Two waves can occupy the same space
- The overlapping of two + more waves
- Constructive Interference increases amplitude
- Destructive Interference decreases amplitude





Earth Science Connection

Transparent	Translucent	Opaque
It's clear. You can see through it, like glass. A good test is to see if you can read writing through it.	If you hold it up to the light (such as a light bulb), you can see the light, but you can't see objects through it.	If you hold it to the light, it looks exactly the same as if you hold it away from the light.
	 Periodot	Jasper 
	Garnet 	Lapis Lazuli 

http://gwydir.demon.co.uk/jo/minerals/optical.htm

Optical Properties

- Some minerals have special optical properties
- Ulexite – TV Rock
- Calcite (transparent – Iceland Spar) – double refraction

http://gwydir.demon.co.uk/jo/minerals/optical.htm

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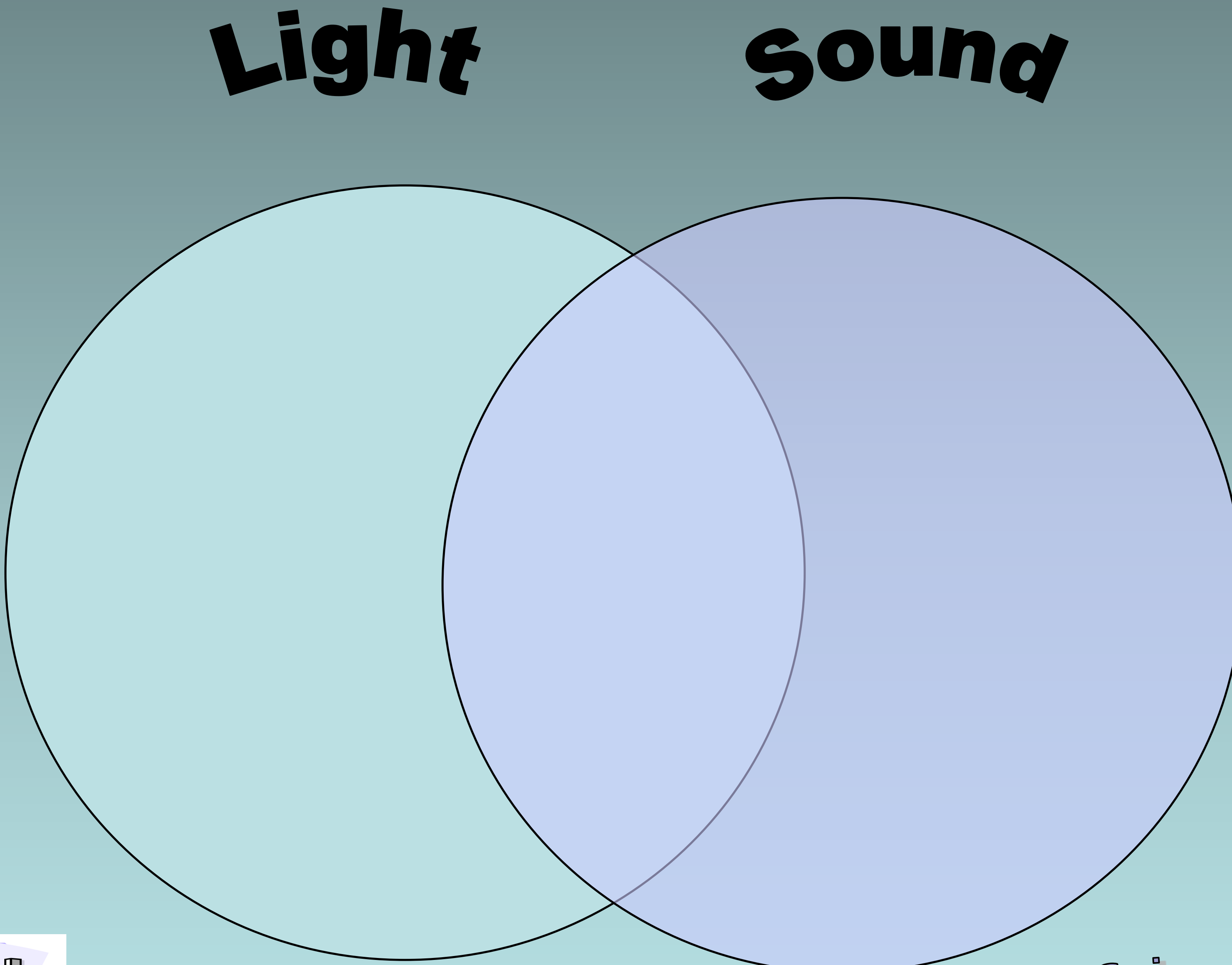
Light Stations

- Science of Light: http://www.learner.org/teacherslab/science/light/index.html
- Investigating Light Behavior Station
- Bubbles Article

Science



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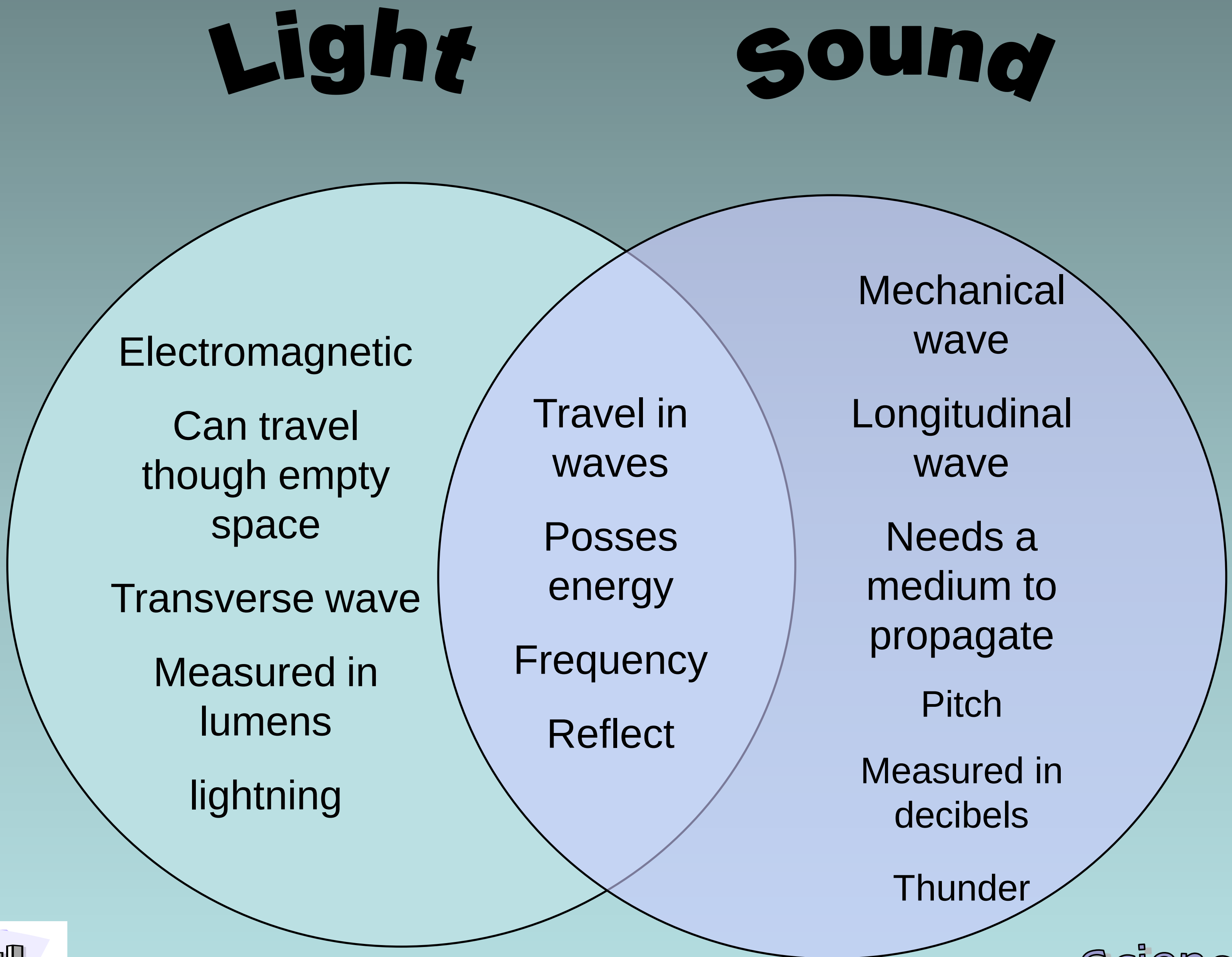
Light
Sound
Electromagnetic
Can travel though empty space
Transverse wave
Measured in lumens
lightning
Travel in waves
Posses energy
Frequency
Reflect
Mechanical wave
Longitudinal wave
Needs a medium to propagate
Pitch
Measured in decibels
Thunder

Science

Anticipation Guide

Before		After
_____	Sound travels faster in solids than in liquids.	___T__
_____	Sound waves are examples of electromagnetic waves. (Mechanical)	__F___
_____	Diffraction is the bouncing back of waves after they strike a surface.	__F___
_____	An echo is an example of refraction. (reflection)	__F___
_____	White light contains all colors in the visible light spectrum.	__T___
_____	Light has properties of both particles and waves	__T___

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Project Ideas

- Research different types of sightedness and how glasses correct for those.
- Compare and contrast the different types of eyes of animals and how they are of adaptive advantage.
- How do HDTV’s work?
- Work with the school drama teacher to find out how lighting is used in school plays.

Science

LIGHT MISCONCEPTIONS	PROPER CONCEPTIONS
Sunlight is different from other sources of light because it contains no color.	Light produce by the sun is similar to any other type of light. We see this light “without color” because it is the result of the superposition of all the different wavelengths of light.
A colored light striking an object produces a shadow behind it that is the same color as the light. For example, when red light strikes an object, a red shadow is formed.	Shadows are the result of an object blocking light that is shining on it. Therefore, any shadow will be always dark.
When a colored light illuminates a colored object, the color of the light mixes with the color of the object.	The color of an object is the result of the particular wavelength that the object reflects. When colored light illuminates an object, the color that we see is the result of the superposition of the different wavelengths reflected by the object.

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Light Websites for Teachers

- Molecular Expressions: http://micro.magnet.fsu.edu/optics/activities/students/index.html
- Learning Center Lab: http://micro.magnet.fsu.edu/optics/activities/students/properties.html
- Teacher Light Lab: http://www.learner.org/teacherslab/science/light/index.html
- Physics of Light and Color: http://www.olympusmicro.com/primer/lightandcolor/index.html
- Mixing Colors of LIGHT: http://mc2.cchem.berkeley.edu/Java/RGB/example1.html

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Resources

- http://www.mcasco.com/p1mw.html --good explanation of mechanical waves.
- http://www.glenbrook.k12.il.us/GBSSCI/PHYS/Class/sound/u11l1a.html --Excellent website for terms associated with mechanical wave. Also explains sound as a mechanical wave. Introduces the terms of pitch and frequency.
- http://www.glenbrook.k12.il.us/gbssci/Phys/Class/waves/u10l1c.html --same website as above but takes the user to the categories of waves, i.e longitudinal and transverse.
- http://id.mind.net/~zona/mstm/physics/waves/introduction/introductionWaves.html --higher level math would be needed to understand some of the frames at this website. Good graphics of waves
- http://www.physicsclassroom.com/Class/waves/u10l1c.html easy to navigate through all the concepts of wave characteristics and wave behavior.
- http://www.glenbrook.k12.il.us/gbssci/phys/Class/waves/u10l1a.html
- http://outreach.physics.utah.edu/ ASPIRE
- http://www.olympusmicro.com/primer/lightandcolor/index.html - Physics of Light and Color
- http://micro.magnet.fsu.edu/optics/lightandcolor/diffraction.html - Molecular Expressions
- http://www.cbu.edu/~jvarrian/applets/waves1/lontra_g.htm
- http://einstein.byu.edu/~masong/HTMstuff/WaveTrans.html

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