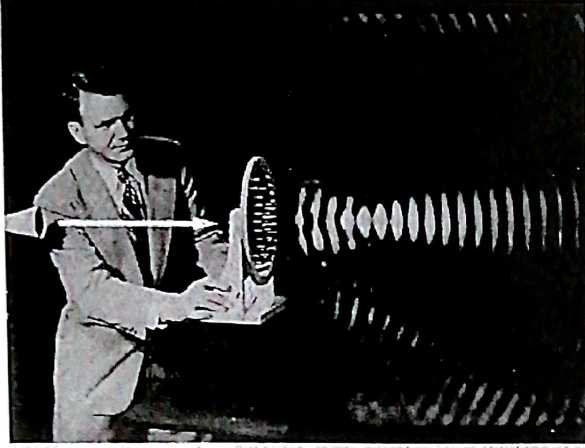


Waves

8th Grade Science
Standard 8-6



Properties and Behaviors of Waves

- Waves transmit energy but not matter.
- **Energy** - the ability to cause something to happen or change

Waves

- **Wave** - a repeating disturbance, vibration, or movement that transfers or moves energy from place to place.
- Waves carry energy through empty space or a **medium** (material through which waves can travel) without transporting matter.

Characteristics of Mechanical and Electromagnetic Waves

- **Mechanical waves** - waves that travel through matter.

- The *medium* can be a solid, liquid or gas, or a combination of these.
- The particles of matter vibrate by pushing together and moving apart, or by moving up and down, as the waves travel through them to transfer the energy through the medium

Mechanical Waves



- Sound waves, for example, are *mechanical waves* that require particles to vibrate in order for energy to be transferred.
- Sound waves cannot be transferred or transmitted through space.
- Water waves and the waves that travel down a rope or spring are also mechanical waves.

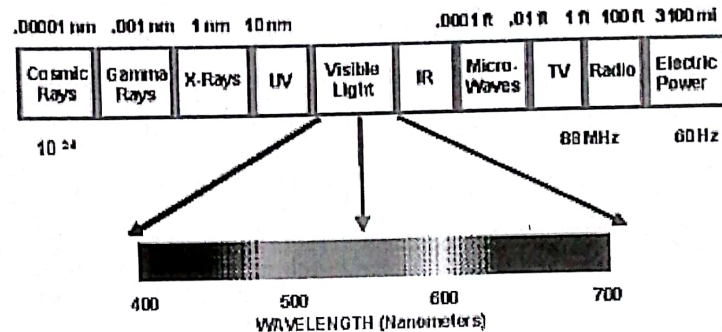
Electromagnetic Waves

- **Electromagnetic waves** - waves that can travel through empty space where matter is not present.
- Instead of transferring energy from particle to particle as is done by mechanical waves, electromagnetic waves transfer energy through space.

Electromagnetic Waves

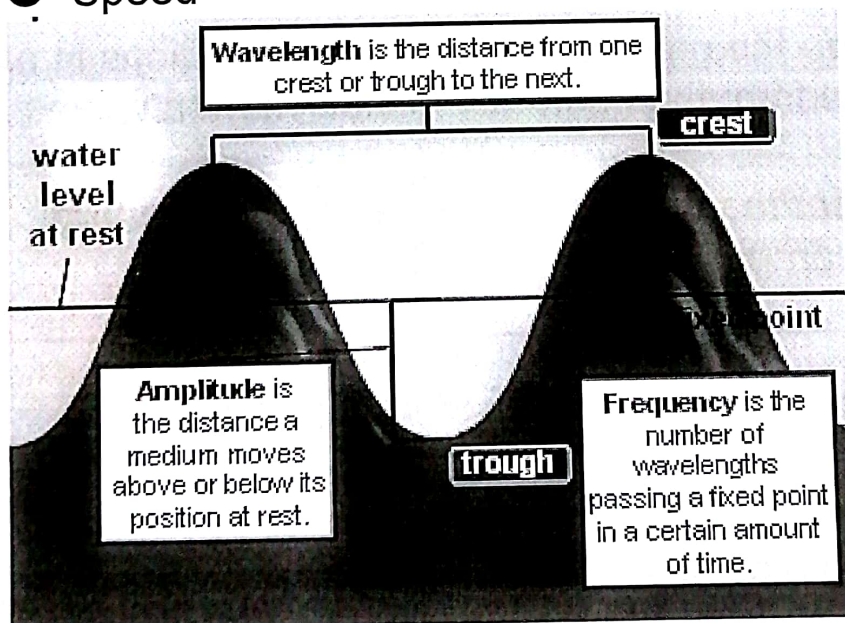
- Radio waves, microwaves, infrared rays, visible light,

ultraviolet rays and x-rays are all forms of energy that travel in *electromagnetic waves*.



Factors that influence the basic properties of waves:

- Wavelength
- Frequency
- Amplitude
- Speed



Wavelength

- **Wavelength**- the distance between one point on a wave and the nearest point just like it.
- The measure of the distance between any two successive identical parts of wave.
- The *greater the energy* carried by waves, the *smaller the wavelength*.

Frequency

- **Frequency** - the number of full wavelengths that pass a point each second.
- Also measures how rapidly vibrations occur in the medium, at the source of the wave, or both.
- The *greater the energy* carried by waves, the *greater the frequency*.

Amplitude

- **Amplitude** - the greatest distance that vibrations in a wave move from their normal position when a wave passes by.
- The *greater the wave's amplitude*, the *more energy* the wave carries.

Speed

- **Speed**- the distance per time that a given wave travels.
- A particular type of wave has a wave speed that is constant in a specific medium or in space.

Speed

- As a wave enters a different medium, the wave's speed changes.
- Waves travel at different speeds in different mediums.
- All electromagnetic waves travel at the same speed in empty space—300 million m/sec.

Behaviors of Waves

- Waves have the following behaviors:
 - Refraction
 - Reflection
 - Transmission
 - Absorption

Refraction

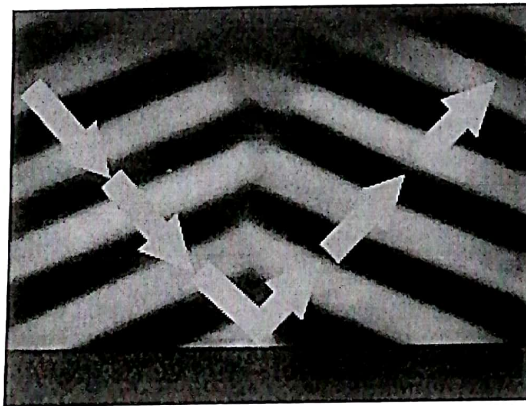


- **Refraction** - the bending of waves caused by a change in their speed as they pass from one medium to another.
- As waves pass at an angle from one medium to another, they may speed up or slow down.
- The greater the change in speed, the more the waves bend.

Refraction

- Refraction of light going from air through a *convex lens*, for example, can make images appear larger as the light waves bend.
- *Prisms* separate white light into its different components or colors by bending the light at different angles depending on the wavelength of the light passing through the prism.
- Different wavelengths of light travel at different speeds in a given medium.

Reflection



- **Reflection** - the bouncing back of a wave when it meets a surface or boundary that does not absorb the entire wave's energy.
- All types of waves can be reflected.

Reflection

- Reflections of sound waves, for example, are called echoes and help bats and dolphins learn about their environments.
- *Mirrors* and other smooth surfaces reflect light to form clear images.

Transmission

- *Transmission* - when they pass through a given point or medium.
- Light waves are transmitted by transparent materials that allow most of the light that strikes them to pass through them.
- Only a small amount of light is reflected or absorbed.

Absorption

- *Absorption*- when the energy is not transferred through the given medium or space.
- Absorption of waves causes the following behaviors depending on what type of wave is absorbed:
 - Color
 - Temperature Change

Color

- **Color** -The color of the object depends on the light wavelengths that are *absorbed* and reflected.
- Substances that absorb certain wavelengths of light reflect other wavelengths and have specific colors that are characteristics of that substance.
- *Color filters* allow only certain colors of light to pass/transmit through them; they absorb, or reflect,

all other colors.

Temperature Change

- **Temperature change** - Objects or substances that *absorb* infrared radiation become warmer as the infrared radiation is transformed to thermal (heat) energy by causing particles in the substance to move at a faster rate.

Sound Waves and The Ear

- The relationship between the three main parts of the ear and sound waves to explain hearing as follows:
 - Outer Ear
 - Middle Ear
 - Inner Ear

Outer Ear

- Sound waves are gathered by the *outer ear* made up of the ear, the ear canal, and the eardrum. ^{طبله}
- The outer ear is shaped to help capture the sound waves (energy transferred in particles of air) and send them to the ear canal, which transfers them to the eardrum.
- The vibrations of air particles cause the eardrum to vibrate.

Middle Ear

- The *middle ear* amplifies sound waves.

Inner Ear

- The *inner ear* transmits vibrations from the bones of the middle ear to the liquid in the inner ear. ^{العظام}
- The tiny hairs in the inner ear vibrate as the liquid

vibrates.

- The vibrating tiny hairs transmit the energy to nerves attached to the hairs.
- The nerve impulses are transmitted to the brain for connections in the brain for understanding of the sound as "hearing."

The Eye and Light Waves

- The interaction between the major parts of the eye and light emitted or reflected by an object to allow sight to occur as follows:

- Cornea
- Lens
- Retina

Cornea

- The *cornea* is a transparent tissue that transmits and refracts light to the pupil, the opening in the iris of the eye in front of the lens.

Lens

- The *lens* refracts the light further and focuses the light waves on the retina.

Retina

- The *retina* is located on the back of the inside of the eye and is composed of tiny nerves that transfer the energy of the light waves to nerve impulses transmitted to the brain for interpretation as *sight*.

Absorption/Reflection and

Perception of Color

- The absorption and reflection of light waves by various materials results in human perception of color as follows:

- Reflection
- Absorption

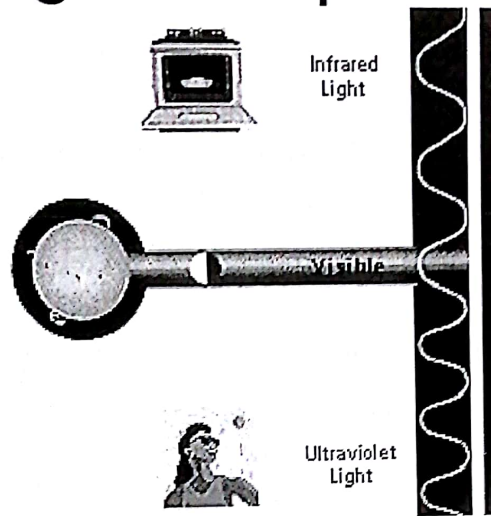
Reflection

- **Reflection** - of certain wavelengths of light by various materials causes those materials to appear as a certain color to humans.
- The color of materials depends on the wavelengths of light that are reflected by various materials and received by the eye.
- Certain nerves in the eye are sensitive to certain wavelengths of light these nerves transmit signals to the brain, where it is interpreted as color.

Absorption

- **Absorption** - of certain light waves by various materials causes those materials to not transfer those wavelengths of light to the human eye.
- Wavelengths of light that are *absorbed* by materials will not cause those colors to be perceived by humans.

Electromagnetic Spectrum



- **Electromagnetic spectrum** - the entire range of wavelengths

Infrared Radiation

- **Infrared radiation** - longer wavelengths than red wavelengths of visible light.
- Infrared radiation is *lower* in energy than visible light.
- All objects emit infrared radiation, and hotter objects emit more infrared radiation than cooler objects.
- Thermal energy is transmitted by infrared radiation.
- When objects absorb infrared radiation, they become warmer.

Visible Light

- **Visible light** - is the range of electromagnetic waves that can be detected by the human eye.
- The wavelengths are in the middle range of *wavelengths* of electromagnetic waves.
- Visible light is also in the middle of the *energy* range of electromagnetic waves.

Visible Light

- The longer the wavelength, the lower the energy of the wave.
- The eye reacts to different energies and wavelengths of light so that different colors are seen.
- Shorter wavelengths are perceived as violet colors and longer wavelengths are perceived as red colors.
- Shorter violet wavelengths are higher energy levels than longer red wavelengths of visible light.

Ultraviolet Radiation

- **Ultraviolet radiation** - has smaller wavelengths than violet wavelengths of visible light.
- Ultraviolet radiation is higher in energy than visible light.
- Too much exposure to the ultraviolet radiation from the Sun is damaging, but some exposure is healthy.