Light and Sound

LEARNING OBJECTIVE

This lesson will help you to:

- Study about light and its related phenomenon.
- Learn about basic concepts of light.
- Study about sound and its related phenomenon.
- Learn about basic concepts of sound like Doppler effect.

Real-Life Examples

- When look into the mirror, we see ourselves. This is the example of reflection of light from the mirror which is producing the image of our face on the screen.
- People who tend to listen to loud music on a regular basis start listening loud due to the deafness of ears.

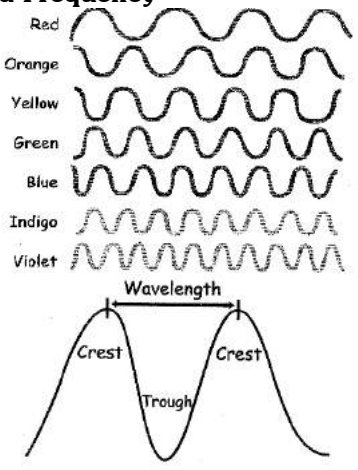
QUICK CONCEPT REVIEW

LIGHT

Photon

Photons are tiny little particles of light, far too small (to be seen individually. All light is made up of photons they are the fundamental particles of fight. The photon is massless and has no electric charge. In empty space the photon travels at the speed of light. The concept of the photon was developed by Albert Einstein.

Wavelength and Frequency



One of the characteristics of light is that it behaves like a wave. As a result, light can be defined by its wavelength and frequency. The frequency is how fast the wave vibrates or goes up and down. The wavelength is the distance between two peaks of the wave. Frequency and wavelength are inversely related, meaning that a low frequency wave has a long wavelength and vice versa.

LIGHT

- Light has no mass and is not really considered matter.
- Light is a form of energy made of photons.
- Light is uniq use in that it behaves like both a particle and a wave.
- Depending on the type of matter it comes into contact with, light will behave differently.
- Sometimes light passes directly through matter, like through air or water. This type of matter is called transparent.
- Other objects completely reflect light, like an animal or a book. These objects are called opaque.
- A third type of object does both to some extent and tends to scatter the light. These objects are called translucent objects.

Amazing Facts

- The sun is almost 93 million miles away from the earth. It takes around 8 minutes for light to get from the sun to the earth. It takes around 1.3 seconds for light to go from the moon to the earth.
- Dog can hear sound at a higher frequency than humans, allowing them to hear noise that we can't.
- The scientific study of sound waves is known as acoustics.
- Sunlight can reach a depth of around 80 meters (262 feet) in the ocean.
- UV light can be used to show things the human eye can't see, coming in handy for forensic scientists.

Light helps us to survive

Without sunlight our world would be a dead dark place. Sunlight does more than just help us see. Sunlight keeps the earth warm, so it's not just a frozen ball in outer space. It also is a major component in photosynthesis which is how most of the plant life on earth grows and gets nutrients. Sunlight is a source of energy as well as a source of vitamin D for humans.

The speed of light

Light moves at the fastest known speed in the universe. Nothing moves faster than (or even close to) the speed of light. Light travels in a straight path called a ray. Speed of light in air is 2.99 X 108 meter per second.

Colours of lights

What we are seeing when we see an object, is reflected light. When light hits an object some wavelengths are absorbed by that object and some are reflected. Light of different wavelength looks like different colours to us. When we see an object of a certain colour that means the light of that colour's wavelength is being reflected off the object. For example, when we see a red shirt, the shirt is absorbing all the colours of light except for the red colour.

White is a combination of all colours, so when we see white, the object is reflecting all the colours of light. Black is the opposite. When we see a black object that means almost all the colours of light are being absorbed

Historical Preview

- The Doppler effect is named for scientist Christian Doppler who discovered it in 1842.
- In about 300 BC, Euclid wrote Optica, in which he studied the properties that light travelled in straight lines and he described the laws of reflection and studied them mathematically.

Reflection of Light

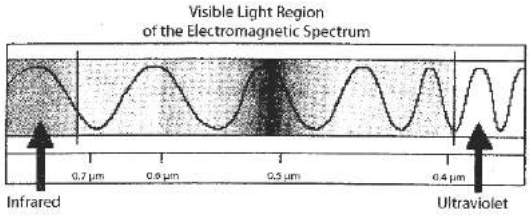
Reflection occurs when light bounces off objects. Amount of fight reflected depends upon how even the surface is. If the surface is rough, the light scatters. If the surface is smooth and flat, the light will bounce off it at equal angles. That is why a flat mirror reflects a good likeness of the object being reflected.

Refraction of Light

Normally, light travels in a straight path called a ray, however, when passing through transparent materials, like water or glass, light bends or turns. This is because different materials or mediums have different qualities.

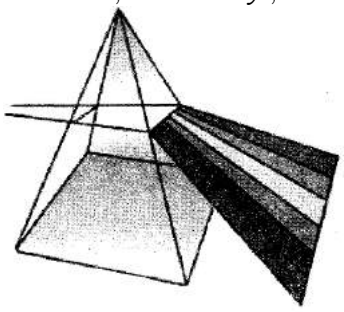
In each type of medium, whether it is air or water or glass, the wavelength of the light changes, but not the frequency. As a result, the direction and speed of the travelling light wave will change and the light will appear to bend or change directions.

ELECTROMAGNETIC SPECTRUM



In the visible spectrum of light, the colour of the light depends on the frequency. The visible spectrum is always the same for a rainbow or the separated light from a prism. The order of colours is red, orange, yellow, green, blue, indigo, and violet. A fun way to remember this is by using the first letter in each colour from reverse order to spell out the name VIBGYOR.

Some of the non-visible types of waves are radio waves, microwaves, infrared rays, and X-rays.



SUN

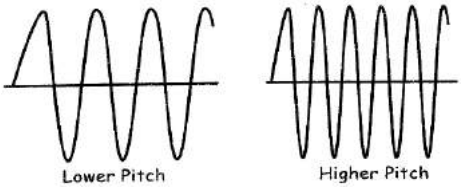
Most of the light on earth comes to us from the sun. The sun shoots out billions of photons every second in all directions, and the ones that happen to be pointed towards the earth come here. When these photons reach the earth, they first run into earth's atmosphere. Some of the photons get absorbed by the atmosphere itself, especially the ultraviolet ones whose wavelength is shorter. Rest of the photons reach the earth surface.

SOUND

Sound is a vibration, or wave, that travels through matter (solid, liquid, or gas) and can be heard.

PITCH AND FREQUENCY

- The quality of a sound is governed by the rate of vibrations producing it; the degree of highness or lowness of a tone is called pitch.
- Frequency can be defined as how fast the wave is oscillating. Frequency is measured in Hertz.
- The faster the sound wave oscillates, the higher the pitch it has.
- For example, on a guitar a big heavy string will vibrate slowly and create a low sound or pitch. A thinner lighter string will vibrate faster and create a high sound or pitch.



Misconcept/concept

Misconcept: Light can only be reflected from shiny faces such as a mirror.

Concept: All objects absorb and reflect light to different degrees. Our ability to see objects depends on the reflection of light!

Misconcept: The earth gets heat from the light!

Concept: The sun is actually too for from the earth to heat it directly. Instead, the light from the sun is reflected or absorbed by objects on earth. Absorbed light usually increases the object to heat up.

Misconcept: The more mass in a pendulum bob, the faster it swings.

Concept: The lighter the pendulum, the faster it swings or oscillates.

How does sound move or propagate?

The vibration is started by some mechanical movement, such as someone plucking a guitar string or knocking on a door. This causes a vibration on the molecules next to the mechanical event (i.e. where your hand hit the door when knocking). When these molecules vibrate, they in turn cause the molecules around them to vibrate. The vibration will spread from molecule to molecule causing the sound to travel.

Sound must travel through matter because it needs the vibration of molecules to propagate. Because outer space is a vacuum with no matter, it's very quiet. The matter that transports the sound is called the medium.

SPEED OF SOUND

The speed of sound is how fast the wave or vibrations pass through the medium or matter. The type of matter has a large impact on the speed at which the sound will travel. For example, sound travels faster in water than in air. Sound travels even faster in steel.

In dry air, sound travels at 343 meters per second. This rate sound wilt travel one mile in around five seconds. Sound travels 4 times faster in water (1,482 meters per second) and around 13 times faster through steel (4,512 meters per second).

SOUND BARRLER

- When airplanes go faster than the speed of sound, it's called breaking the sound barrier.
- Most airplanes don't go this fast, but some fighter jets do.
- When planes break the sound barrier they also create something called a sonic boom. This is a loud noise like an explosion that is generated from a number of sound waves that are forced together as the plane is now travelling faster than sound.

VOLUME

The volume of sound is the measure of loudness. To quantify volume we use decibels. The more the decibels, the louder the sound is. A soft sound, like a whisper will measure around 15-20 decibels. A loud sound like a jet engine is more like 150 decibels.

Loud sound can actually damage your ears and cause loss of hearing. Even sounds as loud as 85 decibels can ruin your ears if you listen to them over a long period of time.

TALKING

Sound is very important for communication. The process of making precise sounds for speech is very complex and involves many parts of the body working together. Sounds are made by our vocal cords vibrating in our throat. This way we can adjust our volume and our pitch. We also use our lungs to force air past our vocal cords and start them vibrating. We use our mouth and tongue as well to help form specific sounds.

THE DOPLER EFFECT

If you are standing still and a car drives past you, the frequency of the sound will change as the car passes you. This is called the Doppler Effect. The sound pitch will be higher as the car is coming towards you and then lower as the car moves away. The sound the car is producing is not changing. Its frequency is the same. However, as the car is travelling towards you the speed of the car is causing the sound waves to hit your ear faster or at a higher frequency than the car is making them. Once the car passes you, the sound waves are actually reaching your ear at a lower frequency.