

Term I Grade 8

Adv.

Final revision



CamScanner

Lessons included in EOT-1

Module1- Introduction to waves

1. Lesson-1 Wave Properties
2. Lesson-2 Mechanical wave interactions

Module2-Light

3. Lesson -1 How light travels
4. Lesson 2- Reflection and Mirrors
5. Lesson-3 Refraction and lenses
6. Lesson-4 Color of light

Module 10- Sound

1. Lesson-1 nature of sound
1. Lesson-2 Properties of sound
1. Lesson-3 Music
1. Lesson-4 Using sound

Module11-Electromagnetic waves

1. Lesson -What are electromagnetic waves
1. Lesson 2- The Electromagnetic spectrum
1. Lesson-3 Radiocommunication



CamScanner

Electromagnetic
waves

Reflection

Refraction

Color of light



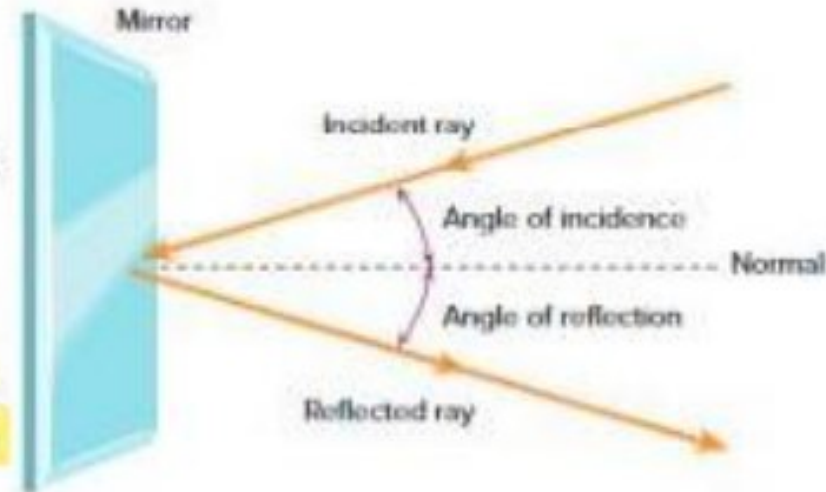
CamScanner

1

Students will develop and use models to investigate how light interacts with matter through reflection. They will examine the structure and function of plane, convex, and concave mirrors.

A line perpendicular to a reflecting surface is called the normal. The light ray moving toward the surface is the incident ray. The light ray moving away is the reflected ray.

Notice the angle formed where an incident ray meets the normal. This is the angle of incidence. A reflected ray forms an identical angle on the other side of the normal. This angle is the angle of reflection. According to the **law of reflection**, when a wave is reflected from a surface, the angle of reflection is equal to the angle of incidence.

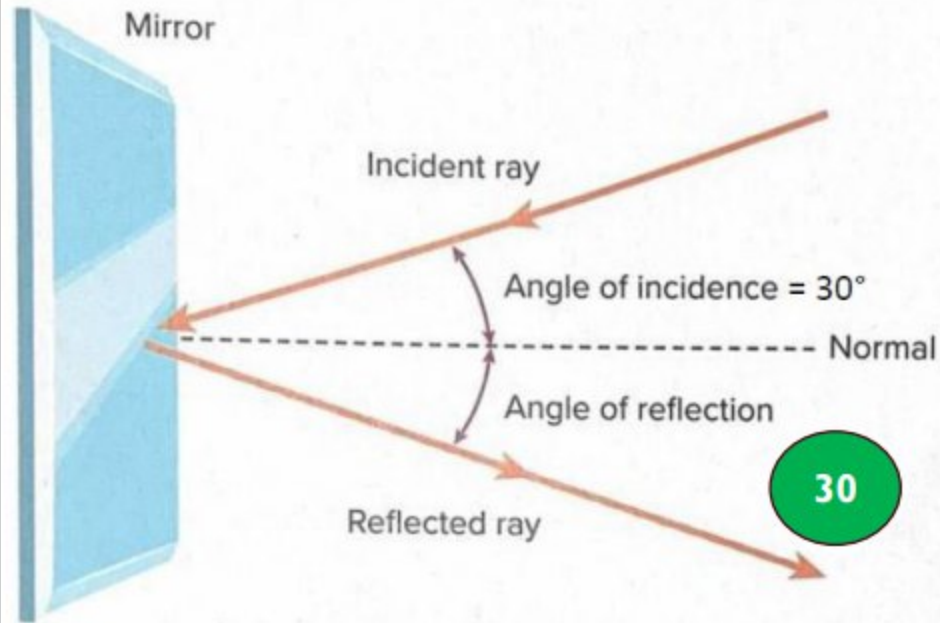


Explain how light reflects off a plane mirror.?

the law of reflection.



CamScanner



Calculate the angle of reflection shown in the figure above.

How does the law of reflection help identify the angle of incidence or the angle of reflection?

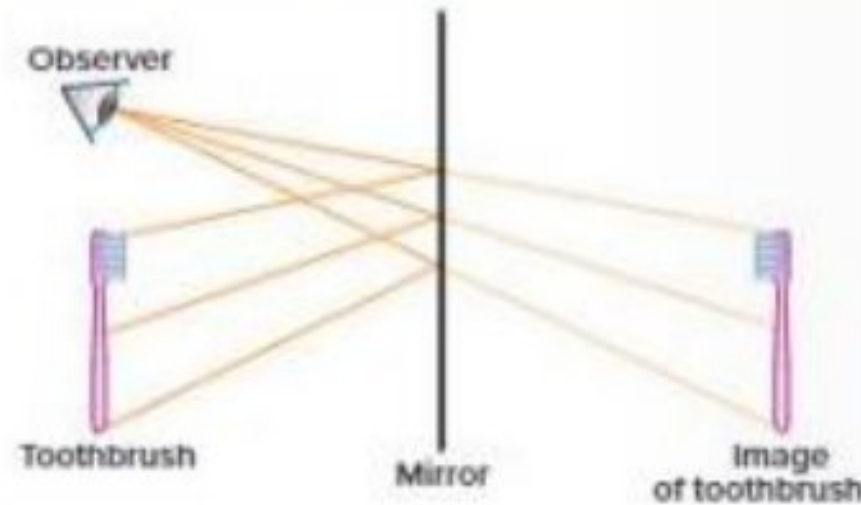
Angle of incident = Angle of reflection



CamScanner

When the light rays from the person strikes the mirror, it reflects by the same angle of incident then the extension of reflected rays will form an image equal to the object ,in this moment your brain will process the information and you can see the image

Images When you look into a mirror, it looks like you could touch the image in the mirror. When you look at ray diagrams, think about what you would see if the rays reflected into your eyes. Remember that your brain only perceives where the rays appear to come from, not their actual paths. Look at the figure to the right. The object is in front of the mirror, but you see the image of the object behind the mirror. A **virtual image** is an image that forms from light rays that diverge, or change direction. Your brain perceives the image where light rays do not pass. Objects seen in a plane, or flat, mirror are virtual images.



Define virtual image?



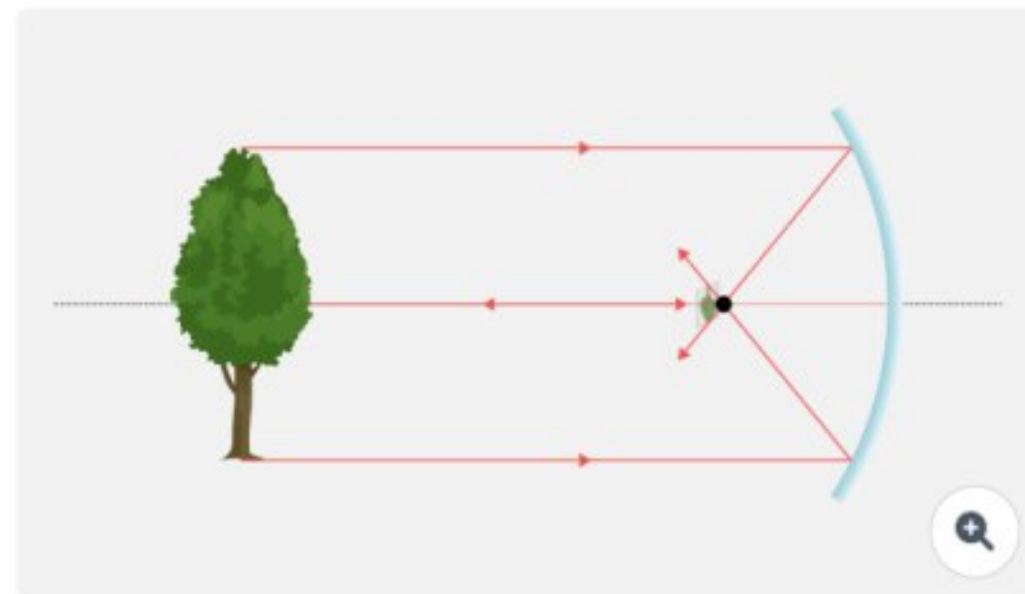
CamScanner



A **real image** is an image that forms where rays **converge**.

Concave mirrors form **real** or **virtual** images.

A concave mirror forms a virtual image if the object is between the **focal point** and the mirror. It forms a **real** image if the object is beyond the **focal point**.



THREE-DIMENSIONAL THINKING

Explain how you know light travels in straight lines and does not curve around objects. Support your explanation with evidence and reasoning.

When an object is placed in front of a ray of light, the object blocks the light ray. This supports the idea that light can travel only in straight lines.

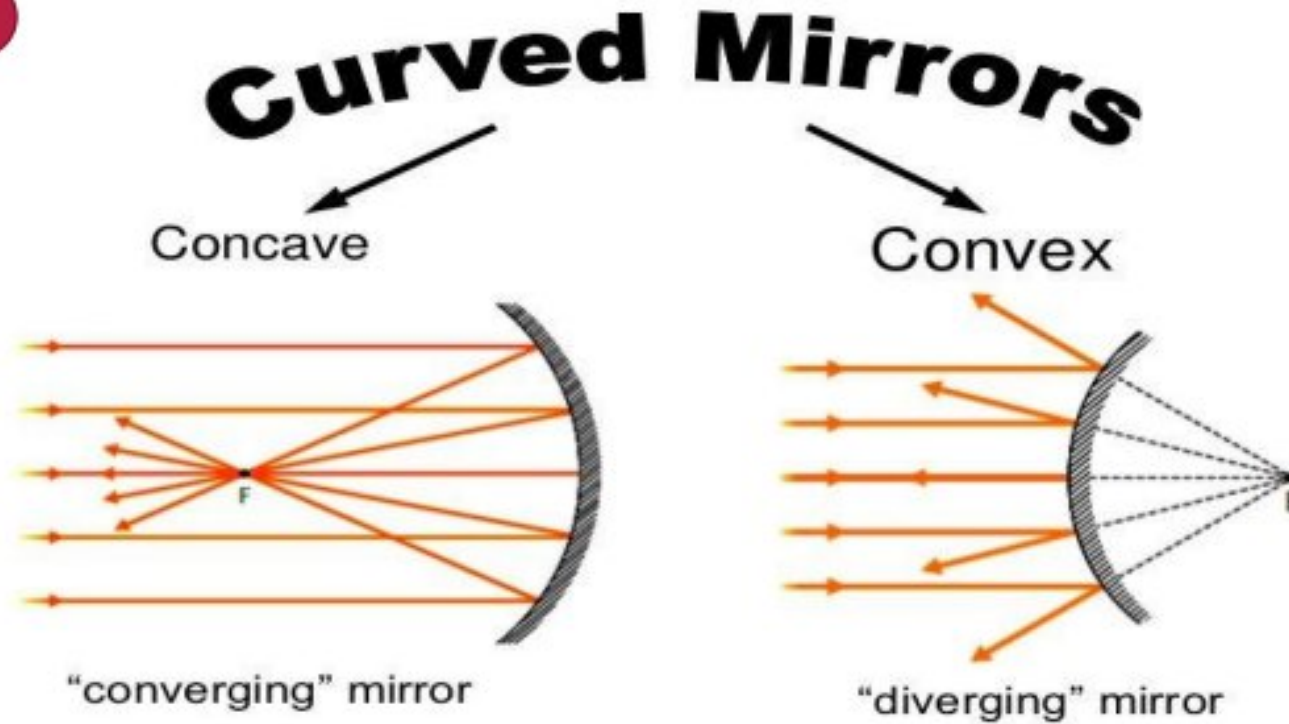


CamScanner

Define focal length?

Concave mirror

- The curved surface is inward
- It converges (get together) the light rays



Convex mirror

- The curved surface is outward
- It diverges (spread) the light rays

Focal point (F) :the point where the parallel light rays converge after reflecting by the concave mirror

Focal length :the distance between the mirror and focal point

The lesser is the curvature of the mirror the longer its focal length

CS

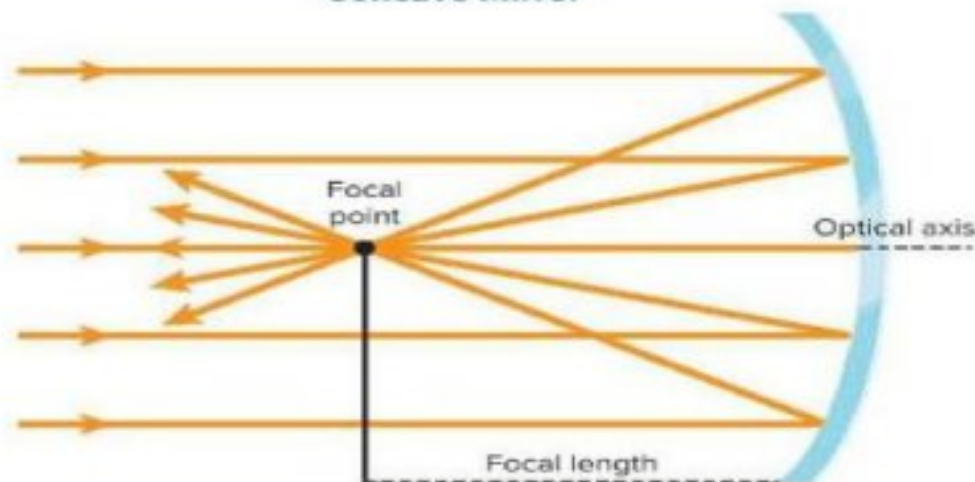
CamScanner



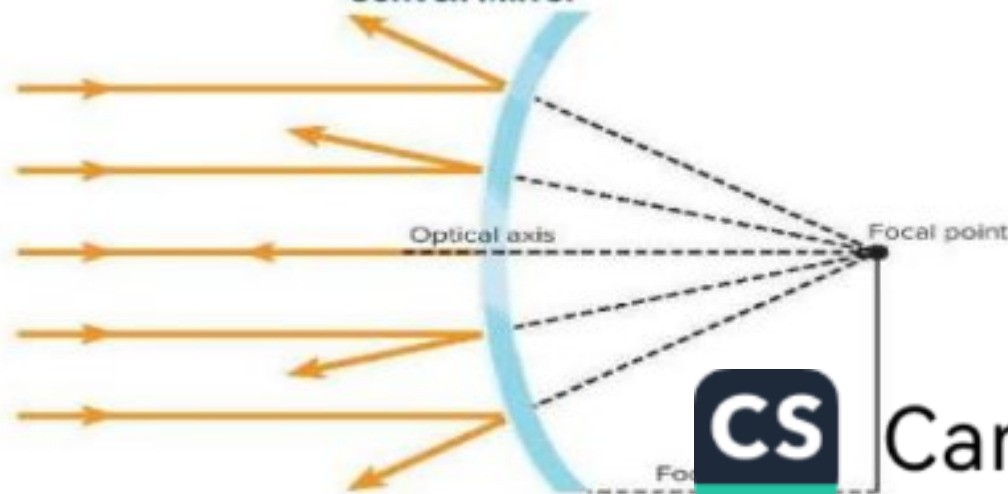
This explains how a satellite dish works. A satellite dish is a concave mirror that scientists use to communicate with objects in space. A satellite in orbit sends electromagnetic waves to Earth. The dish shape bounces the electromagnetic waves to the focal point. A sensor is placed at the focal point that receives the signal.

Convex Mirrors Have you ever seen a large, round mirror high in the corner of a hallway? The mirror enables someone to see places they cannot see with a plane mirror and around corners where someone else may be walking. A mirror that curves outward, like the back of a spoon, is called a **convex mirror**. Light rays diverge, or spread apart, after they strike the surface of a convex mirror.

Concave Mirror



Convex Mirror



CamScanner

Reflection and mirrors

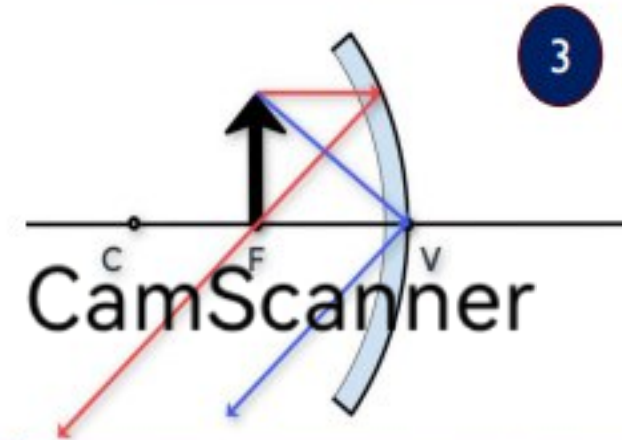
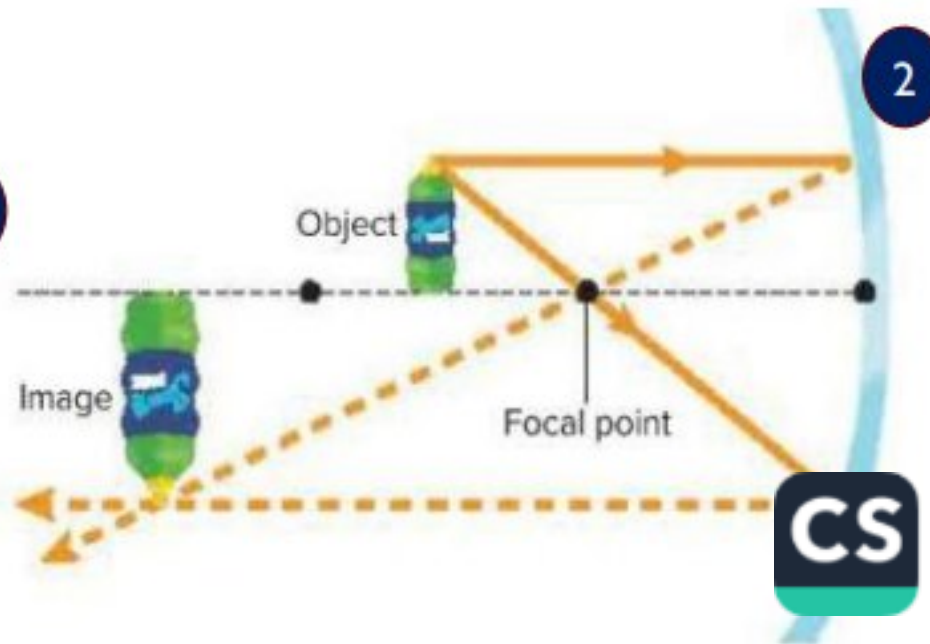
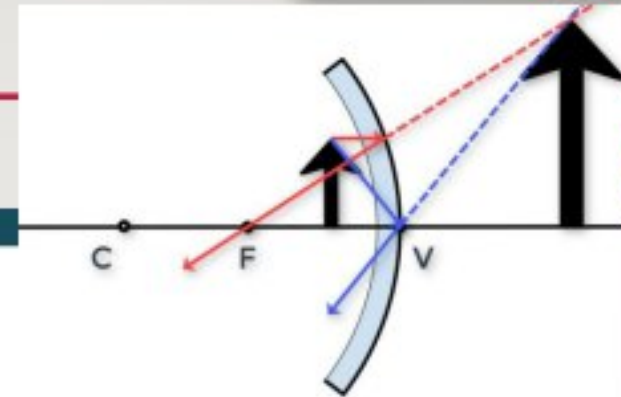
Learning Objective:

Compare between convex and concave mirrors and relate it with the type of image

Keywords: reflection , virtual image ,concave , convex

Types of images by concave Mirror

Types of Images As shown in the figure to the right, the image a concave mirror forms depends on the object's location relative to the focal point. The image is virtual if the object is between the focal point and the mirror. The image is real if the object is beyond the focal point. A real image is one that forms where rays converge. No image forms if the object is at the focal point.



Types of Reflection

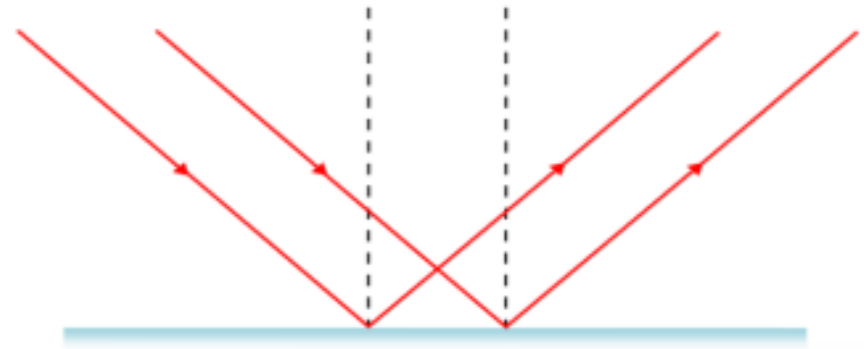
Regular Reflection



Regular reflection is the reflection of light from a **smooth**, shiny surface.

The parallel incident rays are reflected parallel to each other. This is why your image is clear and sharp in a plane mirror.

How does light reflect off rough surfaces?



Explain the difference between regular reflection and diffuse reflection.



Diffuse reflection is the reflection of light from a **rough** surface.

Rough surfaces obey the law of reflection, but each point of incidence is at a different angle. So, light rays reflect off an uneven surface in different directions.

Diffuse Reflection



Identify the different types of reflection?

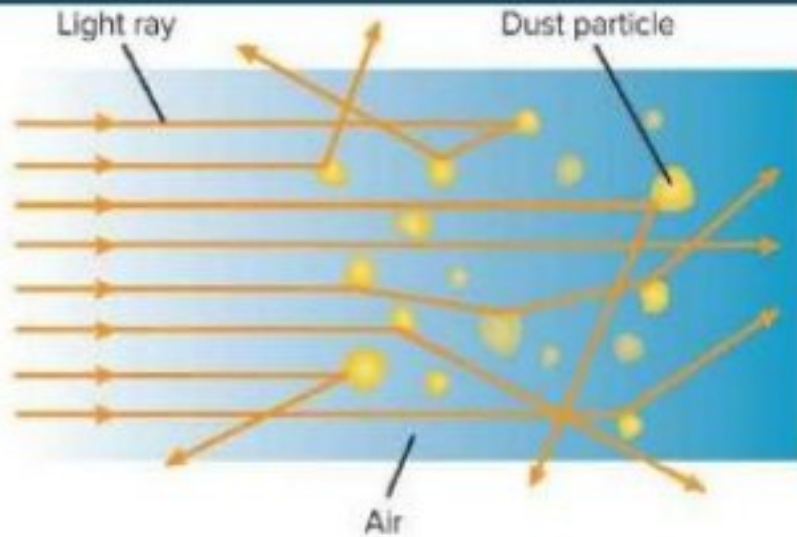
Scattering

Reflection and mirrors

Learning Objective:

Compare between convex and concave mirrors and relate it with the type of image

Keywords: reflection , virtual image ,concave , convex

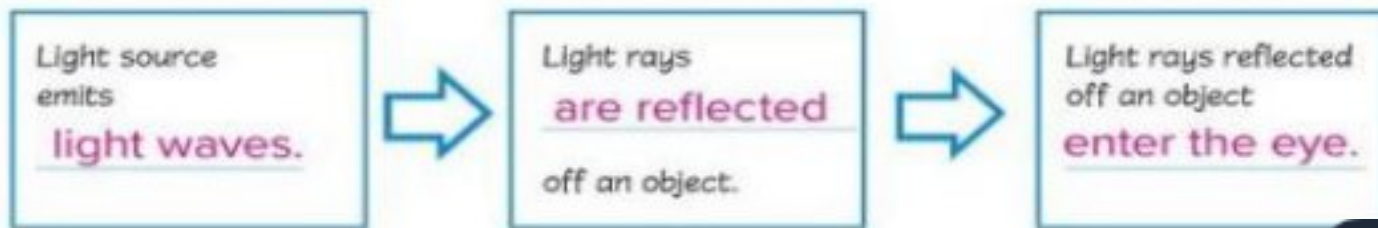
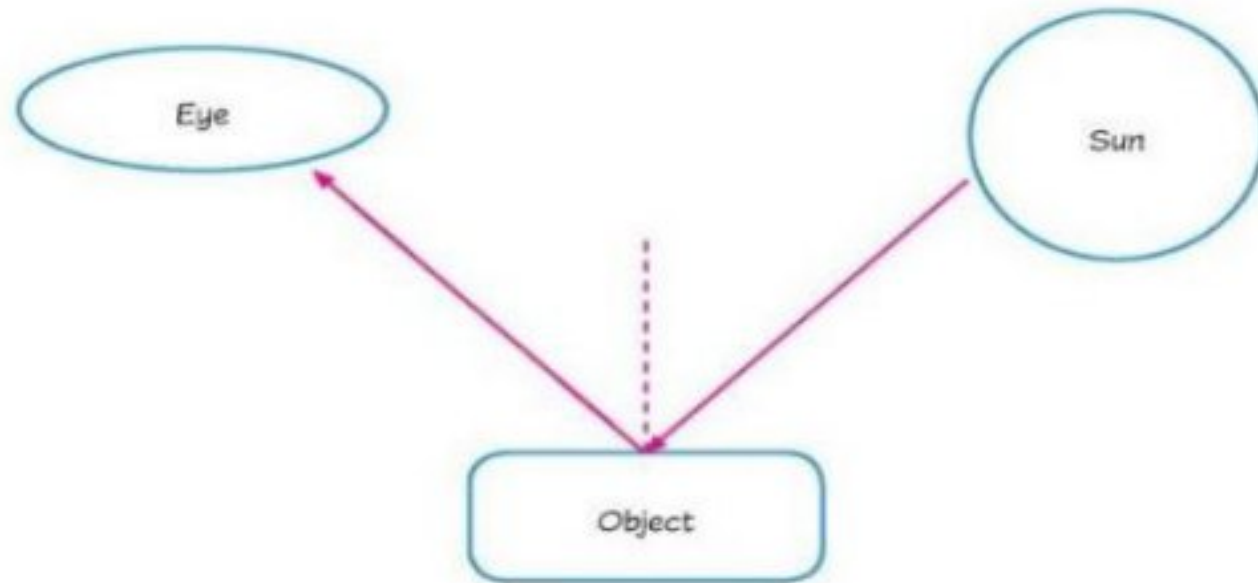


Copyright © McGraw-Hill Education McGraw-Hill Education

Scattering occurs when light waves traveling in one direction are made to travel in many directions. The dust particles scatter the light waves in a sunbeam. If there are enough particles in the air, all of the light will be scattered. When this happens, no light will be transmitted. This is why clouds and fog are opaque. The water particles in the air reflect light. All the Sun's light is scattered, so the cloud appears opaque.



CamScanner



CamScanner

Index of refraction

Refraction and lenses

Each material has a property called index of refraction

- If the medium has high index means the speed of light will be **Slow**
- If the medium has Low index means the speed of light will be **High**

Material	Index of Refraction	Wave Speed (km/s)
Vacuum	1.0000	300,000
Air	1.0003	299,920
Water	1.333	225,100
Glass	1.5	200,000



CamScanner

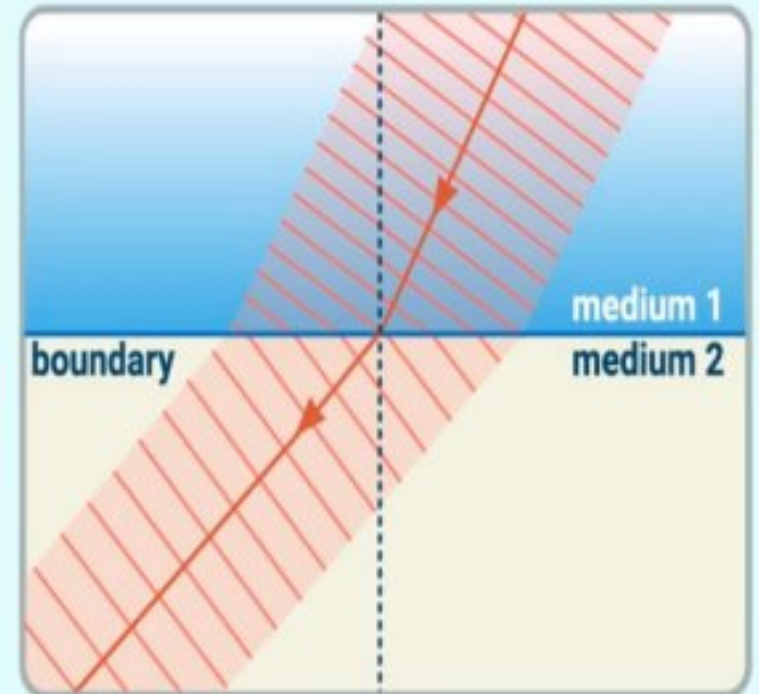
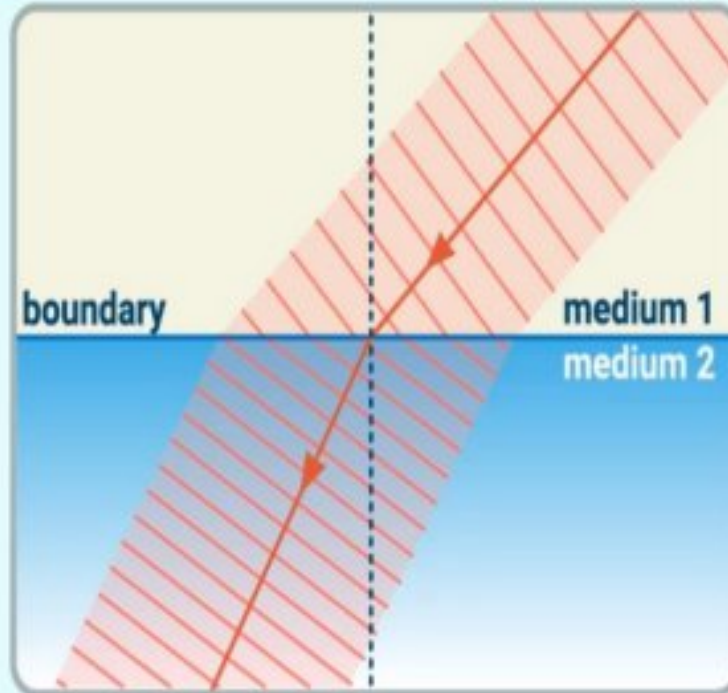
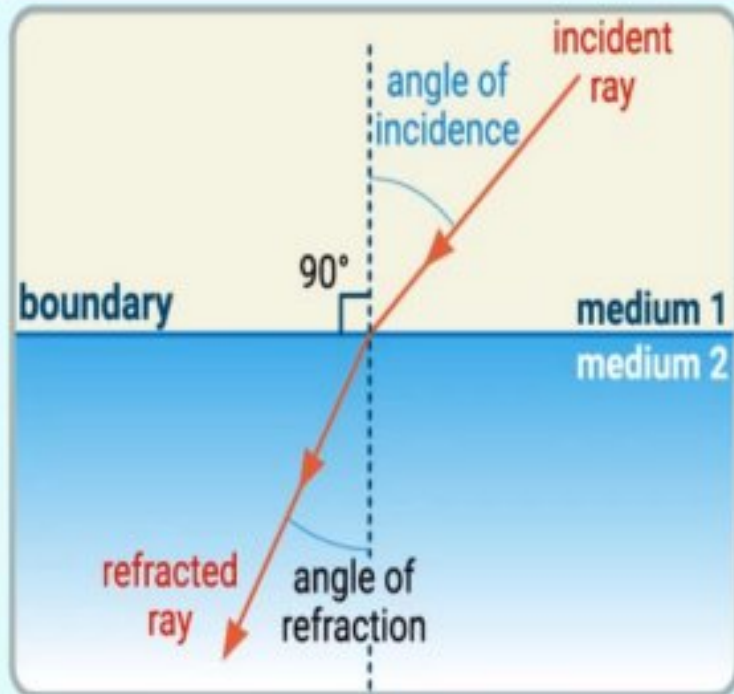
Refraction and lenses

Learning Objective:

Explain the refraction and relate it with changing the light speed

Keywords: refraction , lens , index of refraction

Refraction : changing the wave direction when it passes from one medium to another as the speed changes



Light travels at different speeds through different mediums.

A light wave traveling from a **fast** to a **slow** medium bends **towards** the normal.

A light wave traveling from a **slow** to a **fast** medium bends **away** from the normal.



CamScanner

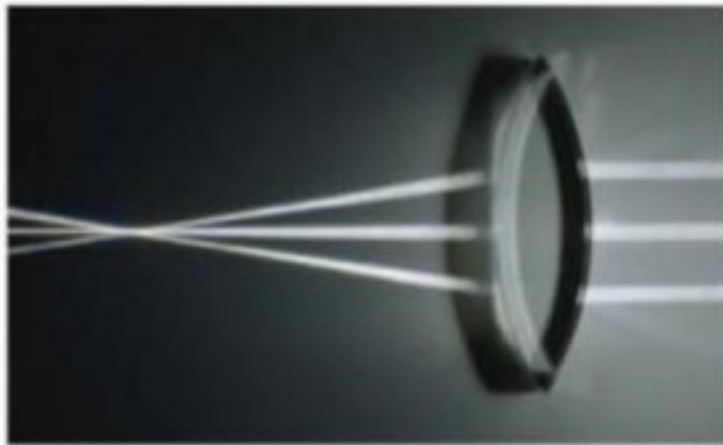
What is refraction?

Lens : is a transparent object with at least one curved side that causes the light to change direction (**Refraction**)

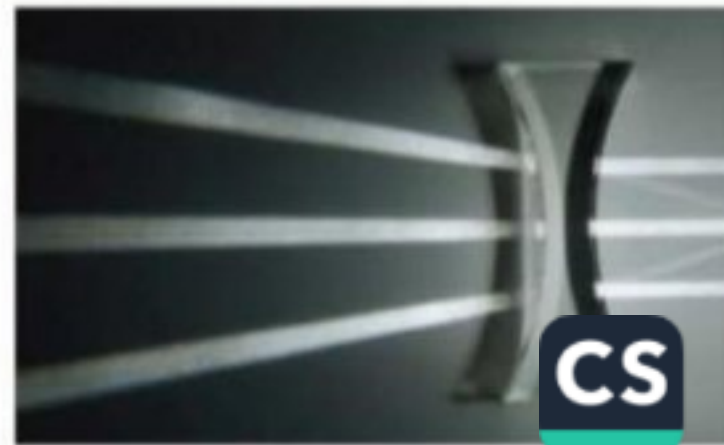
The lens that has great curve it refracts the light more

There are two types of lenses :

- Concave & convex



Convex Lens



Concave Lens



CamScanner

What is the difference between convex and concave lenses?

Concave

Convex

Curve inward

Curve outward

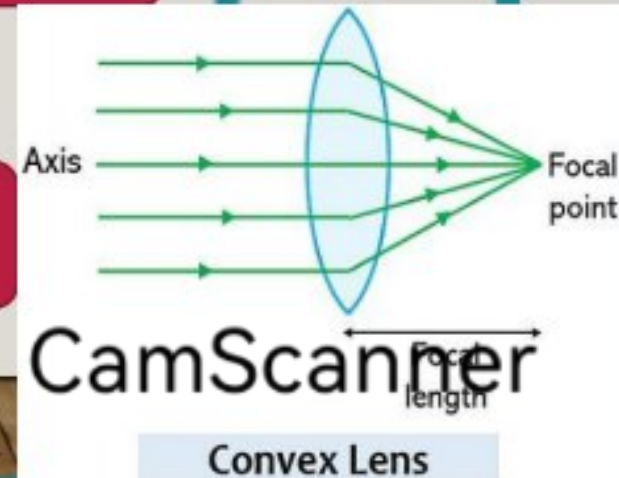
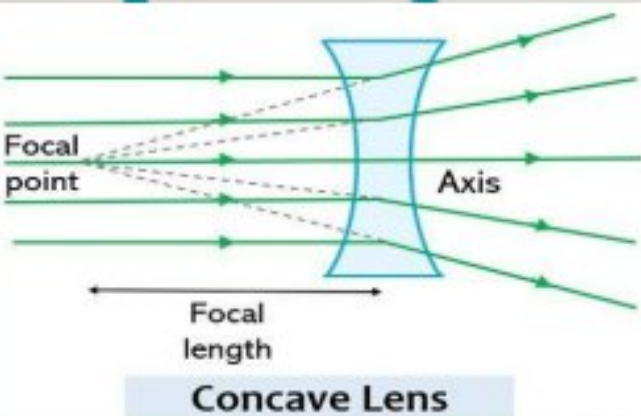
Makes light diverge

Makes light converge

Refract the light

Thicker at the edges than middle

Thicker in the middle than edges



Summarize It!

1. **Categorize** Complete the table by describing each type

Lens	Direction of Curvature	Direction of Refracted Light
Concave	curved inward	When parallel light rays hit the lens, they are refracted and spread out in all directions.
Convex	curved outward	When parallel light rays hit the lens, they are refracted so that they pass through a focal point.

Identify the different types of images caused by different lens ?

Convex lens form real image , concave lens form virtual Image

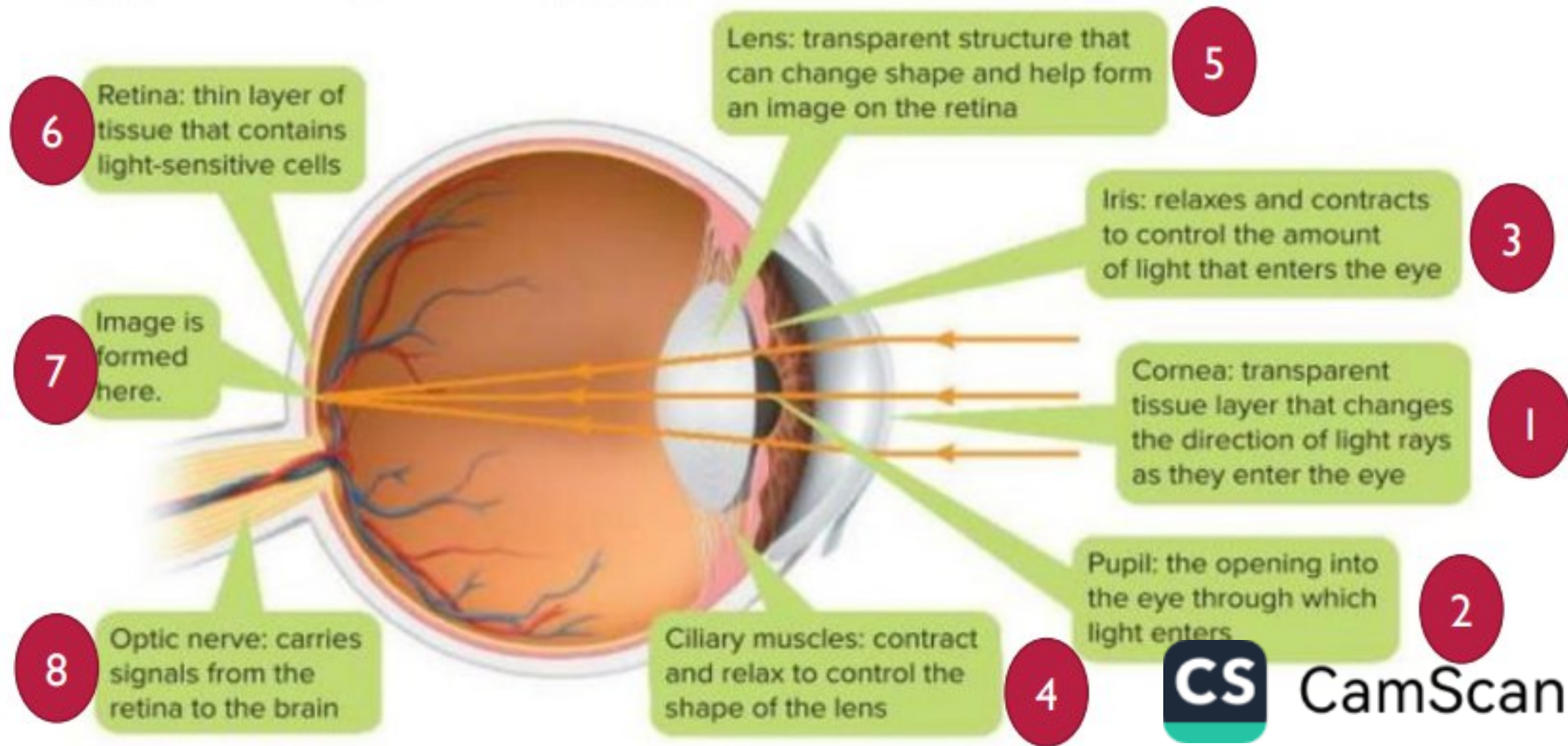
Explain how a concave lens can be used to start a fire.

By converging the sunlight in the focal point

Describe how your eyes detect color?

Light sensitive cells called **Cone** cells detect colors
Rod cells can detect shaded like grey , black

Human Eye



STUDENTS WILL DEVELOP AND USE MODELS TO INVESTIGATE HOW LIGHT INTERACTS WITH MATTER THROUGH TRANSMISSION AND REFRACTION

How does light interact with matter?

Like mechanical waves, light waves can be transmitted, absorbed, or reflected when they interact with matter.

Transmission Different types of matter interact with light in different ways. Air and clear glass transmit light with little or no distortion. A material that allows almost all of the light striking it to pass through, and through which objects can be seen clearly, is **transparent**. Examine the photo on the right. The squirrel is behind glass. It can be seen clearly because the glass is transparent. In the Lab *Light and Matter*, the water and the glass beaker were also transparent.

Materials such as waxed paper or frosted glass also transmit light, but you cannot see through them clearly. A material that allows most of the light that strikes it to pass through, but through which objects appear blurry, is **translucent**. In the figure on the right, you cannot clearly see the two people talking behind the frosted glass because the glass is translucent. The milk jugs from the *Light and Matter* lab are also a translucent material.



Absorption Some materials absorb most of the light that strikes them. They transmit no light. Therefore, you cannot see objects through them. A material through which light does not pass is **opaque**. In the figure on the right, the light-blocking curtains and the wooden frame are both opaque. You cannot see through them. You can only see through the transparent glass window panes.

Reflection When you look at a pane of glass, you sometimes can see an image of yourself. Light bounces off you, strikes the glass, and bounces back to your eye. Recall that the bouncing of a wave off a surface is called reflection. Reflected light allows an object to be seen.



CamScanner

How light travels

The relation between the light frequency and energy

Think about it

How does the energy of light depend on the frequency ?

High frequency means high energy

Wavelength of light is very short measured in nanometers (nm) .one nanometer equals one billion of a meter

Wavelength of light waves range from 700 nm to 400nm (smaller than the human hair)

The **energy** of electromagnetic waves is related to its **frequency** not the Amplitude like mechanical wave

Brightness is the person's perception of intensity(amount of energy passed through square meter per second)

CS

CamScanner

Transmission can be defined as _____.

How light travels

The definition of absorption is _____.

Light interact with different types of matter in 3 ways

1 – Transmission :

- When a material allows all the light striking to pass through and let objects seen clearly is called **Transparent**

Ex (glass ,water)

- When a material allows almost all the light striking to pass through but the objects appear blurry is called **Translucent**

Ex : Milk , frosted glass

- 2- Absorption :** some materials absorb most of the light strikes them , no objects can be seen through are called **opaque**

Ex : Blocked curtains , wooden frames

- 3- reflection :** when the light strikes a surface it bounces back

Ex Glass



er

How light travels

textbook
Pg 91

Interaction	Description
Reflection	Wave energy bounces back off matter.
Absorption	Wave energy changes to thermal energy and remains in matter.
Transmission	Wave energy is carried all the way through the matter.
Diffraction	The change in direction of a wave when it travels past the edge of an object or through an opening.

Summarize It!

- Restate** each term below in your own words. Use your classroom to find an example of each type of material, model light interaction in each system, and circle how light interacts with matter to produce the effect.

Type	Definition	Ray Model	Wave Interaction
Transparent	most light passes through; forms clear image	Models should show a light ray moving through a material and coming out the other side. Some of the light ray is absorbed by the material.	Reflected Transmitted Absorbed
Opaque	light does not pass through	Models should show some rays being reflected off the surface and some of the light rays being absorbed by the material.	Reflected Transmitted Absorbed
Translucent	some light passes through; forms blurry image	Models should show some rays being transmitted and some being absorbed. Fewer rays are transmitted than in transparent material.	Reflected Transmitted Absorbed

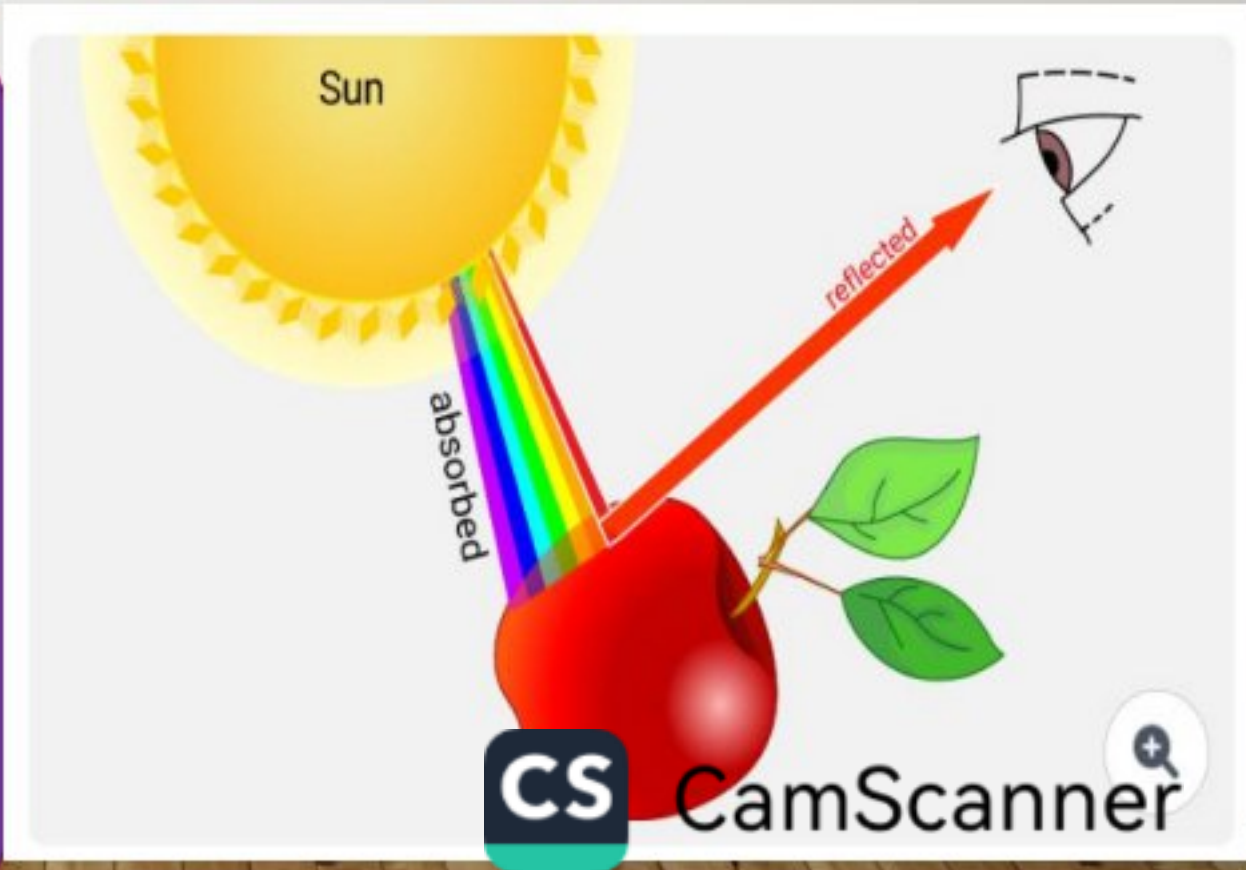


CamScanner

Color of light

How do you see the colors ?

- The objects absorb most of the light and reflect certain colors according to the object material
 - the apple absorbs all the light wavelength and reflects only red wavelength
- The leaves absorb all light wavelength and reflect green
- The cells in the retina send signals to the brain to recognize the color



What property of light allows you to see different colors?

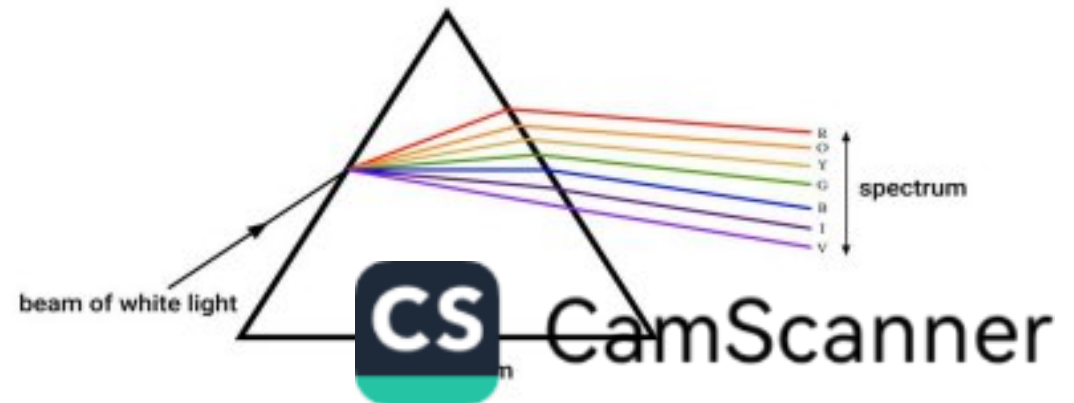
Color of light



The colors of light are: **red**, **orange**, **yellow**, **green**, **blue**, **indigo**, and **violet**.



White light **refracts** through a prism. A prism **splits** white light into **seven** different colors.

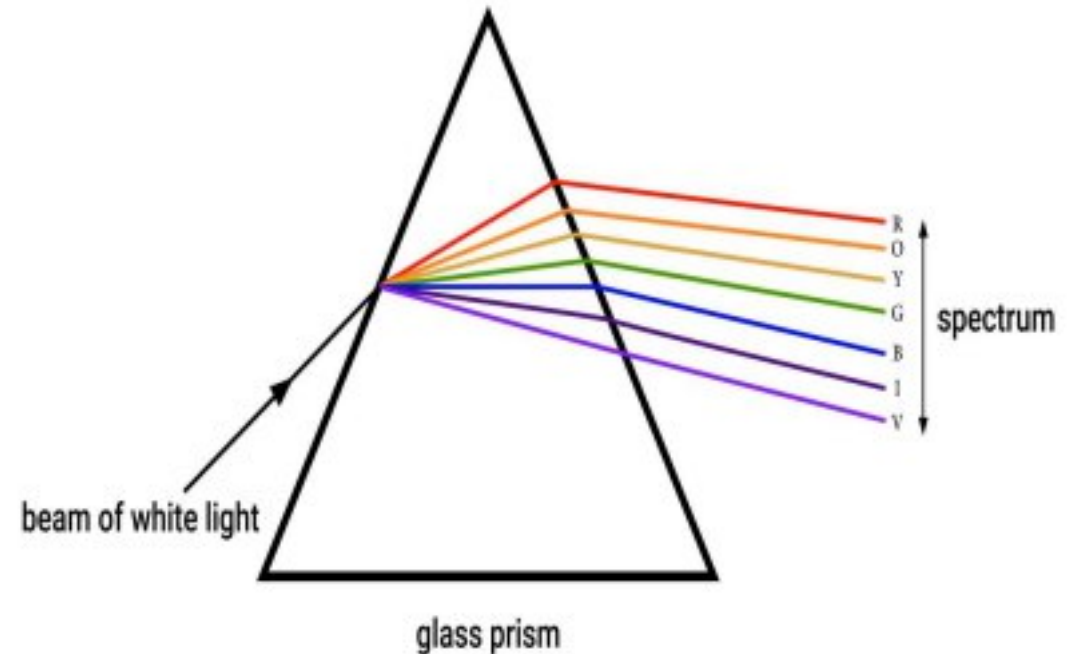


So light with a **longer wavelength refracts less** than light with a shorter wavelength.

Tips

Color of light

- Violet wavelength refracts the most because it has higher frequency and short wavelength
- Red wavelength refracts the least because it has lower frequency and longest wavelength



CamScanner

Color of light

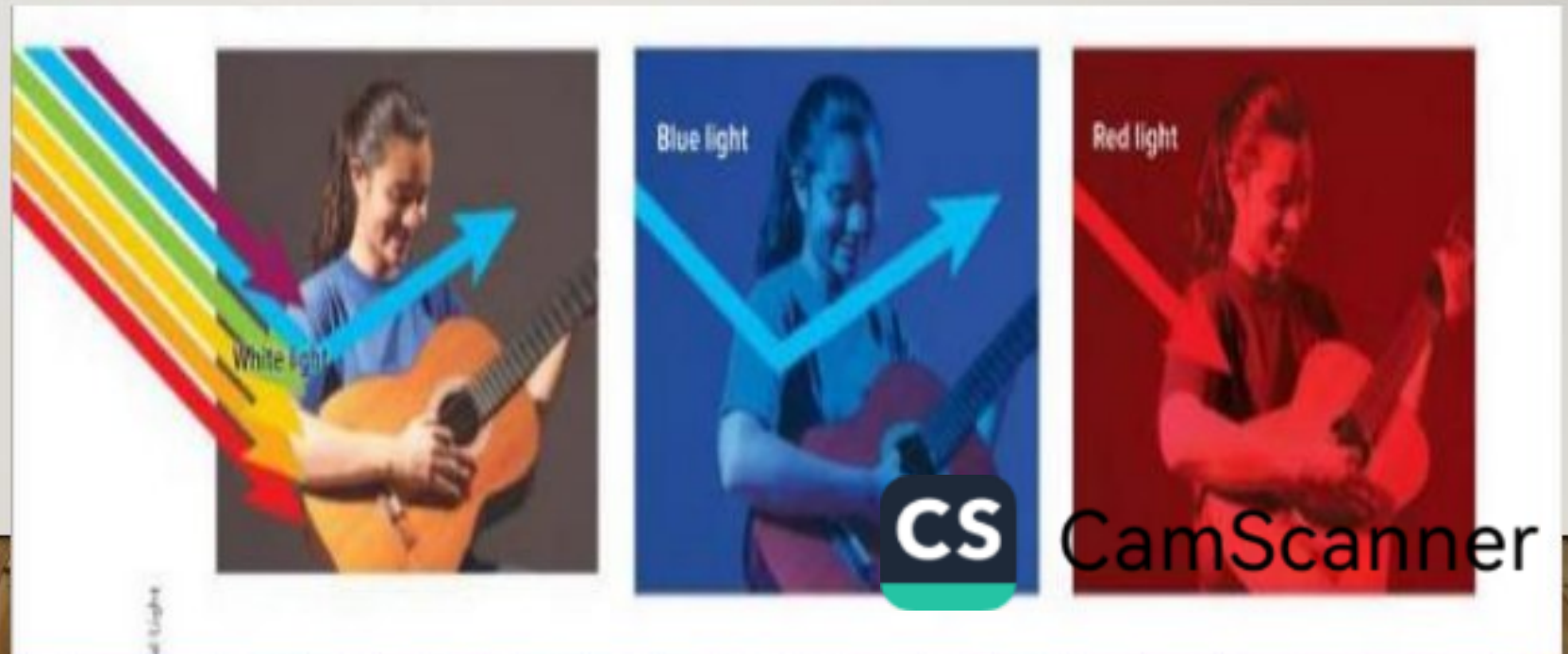
Color filter

Using filter with specific color will reflect this color only

Learning Objective:

Explain how light analyze into different colors through the prism

Keywords: prism , frequency , wavelength



Crayon Color



When you look around, there are many beautiful colors everywhere—reds, yellows, browns, blues. Why are you able to see that a blue crayon is blue?

- A. Blue is a property of the crayon.
- B. White light illuminates the blue crayon.
- ☒ C. Blue light is reflected off the crayon.
- D. The crayon is absorbing blue light.

6. What causes the sunlight to change as it passes through the prism?

The light is refracted through the prism. It also refracts as it leaves the prism.

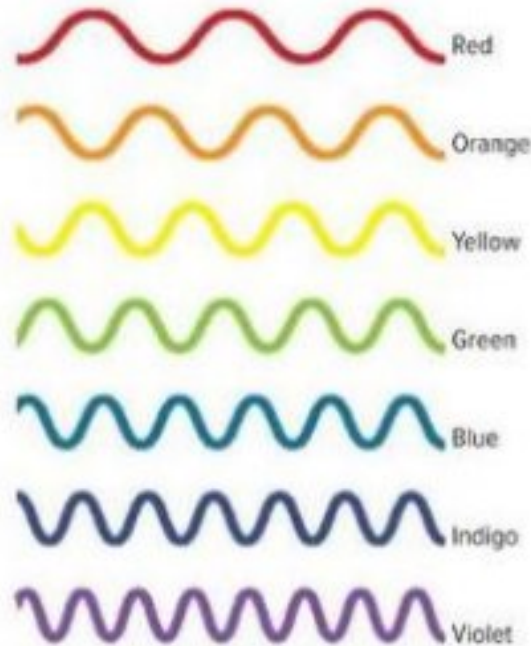
7. Did you observe the same effect with the flashlight as with the sunlight?

Why or why not?

The Sun produces all wavelengths of color, but light bulbs do not necessarily produce a full rainbow.

Light and Color Light that you see as white is actually a combination of light waves of many different wavelengths. When the white light refracts through a prism, you see different colors of light. The colors you may see include red, orange, yellow, green, blue, indigo, and violet. Each name represents a family of colors, each with a range of wavelengths. For instance, red light has a wavelength that varies from 780 nm to 622 nm, and blue light has a wavelength that varies from 492 nm to 455 nm.

Some lights, such as stage and neon lights, emit colored light. The color of an object that emits light depends on the wavelengths of the light given off. For example, a red neon light emits mostly red wavelengths along with some orange, yellow, and green wavelengths. It does not emit all of the wavelengths that the Sun emits.



In green light, red color appears

Black

When primary light colors get mixed they will form -----

white

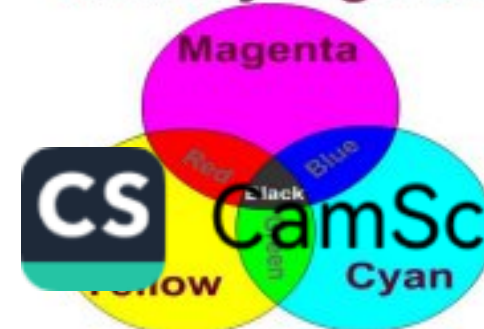
When primary pigments colors get mixed they will form -----

Black

primary pigments colors are (Magenta , cyan , Yellow)

Primary light color (Red , Green , Blue)

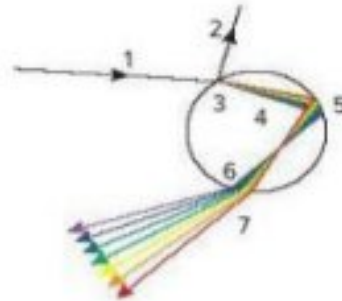
Primary Pigments



Secondary Pigments

CamScanner

Use the model below of light entering a raindrop to answer questions 2–4.



2. What produced the light represented by ray 2?

- A It was absorbed by the drop.
- ☒ B It was reflected from the drop.
- C It was refracted by the drop.
- D It was transmitted by the drop.

3. What caused the spread of the colors at point 7?

- A absorption
- B reflection
- ☒ C refraction
- D transmission

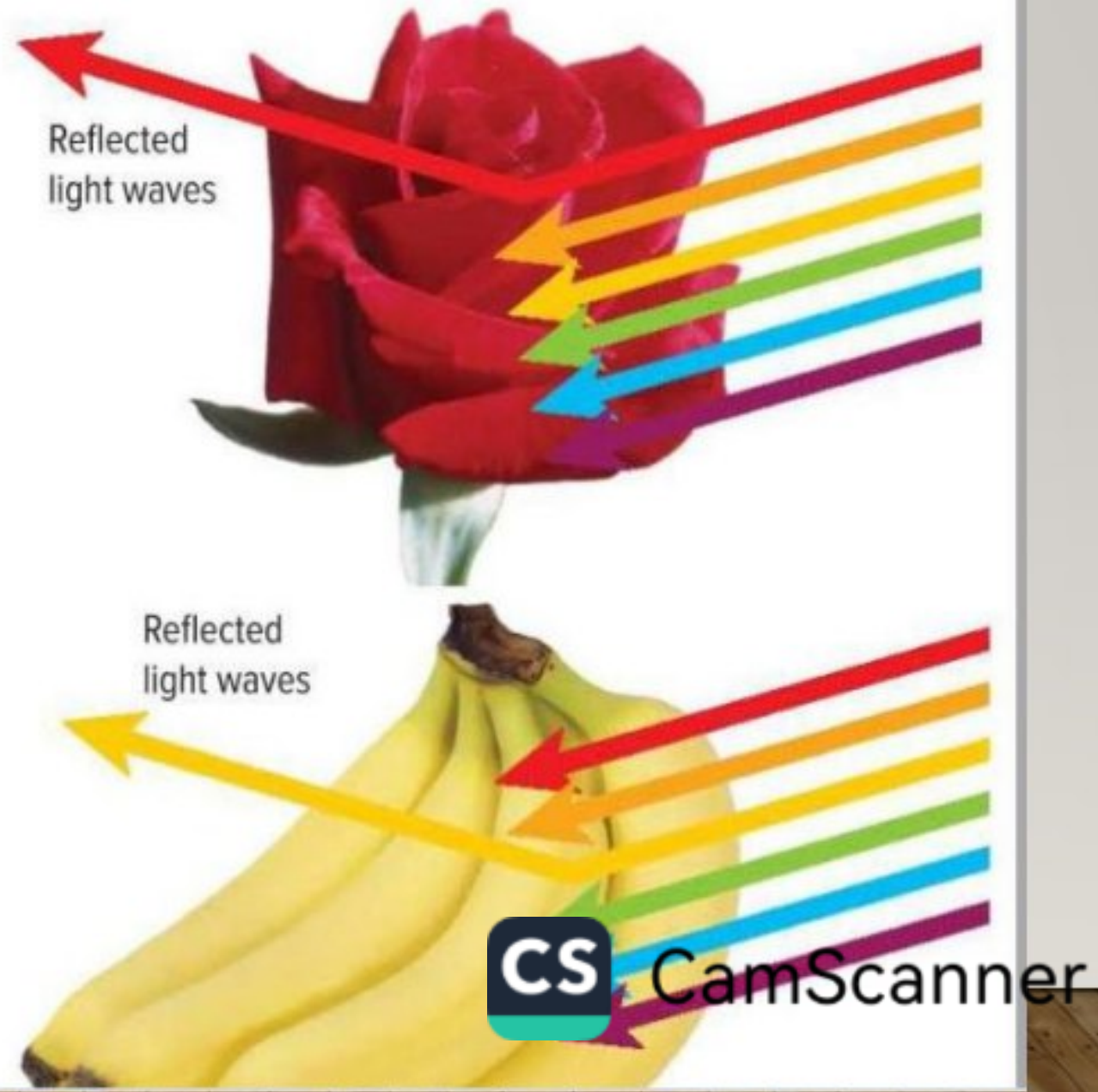
4. What colors of light make up ray 1?

- A the primary colors of light—red, blue, and green
- B the secondary colors of light—cyan, magenta, and yellow
- C No colors. The ray is black.
- ☒ D All of the colors. The ray represents white light.

When light waves of different wavelengths interact with an object, the object absorbs some light waves and reflects others. The wavelengths of light waves absorbed and reflected are determined by the particles that make up the object. Different particles absorb different wavelengths of light.

For example, the figure on the right shows that the rose is red because the petals of the rose reflect light waves with certain wavelengths. When these light waves enter your eye, they cause the cone cells in your retina to send certain nerve signals to your brain. These signals cause you to see the rose as red. A banana reflects different wavelengths of light than a rose. These different wavelengths cause cone cells in the retina to send different signals to your brain. These signals cause you to see the banana as yellow instead of red.

Recall that white light is a combination of all the wavelengths of light. To see a white object, all light



Describe how light waves interact with the clothes you are wearing.

The clothes absorb all the light colors and reflect only its own color

Why does a white surface appear white?

It reflects all the light colors

Why does a black surface appear Black?

It absorbs all the light colors

In what way does energy affect a wave?

High energy means high frequency and short wavelength



CamScanner

Type	Describe the wave's wavelength, frequency, and energy	Example use or characteristic of the wave
Radio Waves	low frequency and energy, wavelength between 30 cm to a kilometer or more	communication
Microwaves	low frequency and energy, wavelength between 1 mm and 30 cm	cooking
Infrared Waves	shorter than a microwave but longer than visible light	TV remote control
Light	the range of wavelengths between infrared and ultraviolet	perception of all colors
Ultraviolet Waves	shorter wavelength, higher frequency and energy than visible light	can cause chemical reactions
X-rays	high frequency and energy, short wavelength	medical imaging
Gamma Rays	highest frequency and energy, shortest wavelength	causing cell damage



CamScanner

Students will explore the structure of electromagnetic waves. this will lead them to understand the similarities and differences between electromagnetic waves and other waves.

Microwaves

Electromagnetic waves that have wavelengths between 0.1 mm and 30 cm are called **microwaves**. Microwaves with wavelengths of about 1 cm to 20 cm are widely used for communication, such as for cellular telephones and satellite signals. However, you are probably most familiar with microwaves because of their use in microwave ovens.



Get It?

Describe the steps by which a microwave oven heats food.



Get It?

The vibrating electric field in the microwave oven makes water molecules rotate back and forth. Friction between the molecules generates thermal energy, which heats the food.



Get It?

Describe the differences between microwaves and radio waves.



Get It?

Microwaves have shorter wavelengths and higher frequencies than radio waves have, and the photons of microwaves have more energy than the photons of radio waves.



Get It?

Compare the effects on matter caused by the absorption of electromagnetic radiation of different wavelengths.



Get It?

Light or longer wavelength radiation is generally converted to thermal energy. Shorter wavelengths can ionize atoms and cause damage to living cells.



CamScanner

7. **Compare and contrast** the properties and uses of radio waves, infrared waves, and ultraviolet waves.

7. All are electromagnetic waves. radio waves: long wavelengths, low frequencies, used for communications, MRI, radar; infrared waves: long wavelengths, low frequencies, used for thermal imaging; ultraviolet waves: short wavelengths, high frequencies, used in forensics, purification

12. **MATH Connection** Use scientific notation to express the range of wavelengths corresponding to visible light, ultraviolet waves, and X-rays.

12. visible light: 4.0×10^{-7} to 7.0×10^{-7} m; ultraviolet: 1.0×10^{-8} to 4.0×10^{-7} m; X-rays: 1.0×10^{-11} to 1.0×10^{-8} m

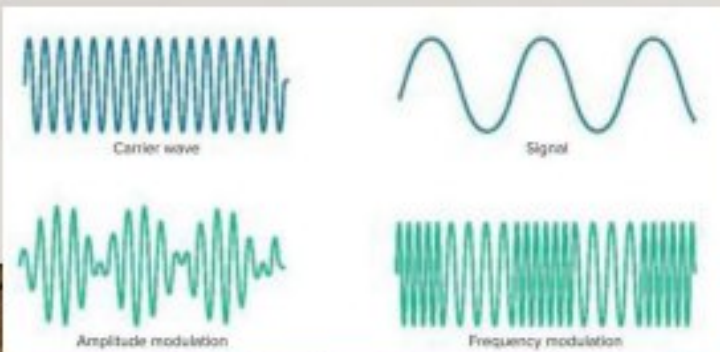


CamScanner

14. Identify and describe the steps that a radio station uses to broadcast sounds to your radio receiver.

14. Sounds at the radio station are converted into an electrical signal. This signal causes electrons in the broadcast antenna to vibrate. The vibrating electrons produce electromagnetic waves, which travel outward. The electromagnetic wave encounters a radio receiver antenna. The electric and magnetic fields of the wave cause the electrons in the receiver antenna to vibrate. The vibrating electrons provide the electrical signal that the radio converts back into sound.

15. Explain the difference between AM and FM radio. Make a sketch of how a carrier wave is modulated in AM and FM radio signals.



For AM, amplitude is modulated. For FM, frequency is modulated.

Students will explore the structure of electromagnetic waves. this will lead them to understand the similarities and differences between electromagnetic waves and other waves.

Radio Waves

Even though you cannot see them, radio waves are all around you. Radio waves are electromagnetic waves with wavelengths longer than 10 cm. Radio waves have long wavelengths and low frequencies, and their photons have low energies. Radio waves have many uses, including communications and medical imaging.

Another use for radio waves is to find the position and movement of objects by a method called radar. Radar stands for **RA**dio **D**etecting **A**nd **R**anging. With radar, radio waves are transmitted toward an object. By measuring the time required for the waves to bounce off the object and return to a receiving antenna, the location of the object can be found. Radar is used for tracking the movement of aircraft, watercraft, and spacecraft, as shown in

Audio transmission

Some radio waves carry an audio signal from a radio station to a radio. However, even though these radio waves carry information that a radio uses to create sound, you cannot hear radio waves. You hear sound when your radio changes the radio wave into a sound wave.



CamScanner

18

Students will explore the structure of electromagnetic waves. this will lead them to understand the similarities and differences between electromagnetic waves and other waves.

Get It?

Compare the effects on matter caused by the absorption of electromagnetic radiation of different wavelengths.

Color is the brain's interpretation of the wavelengths of the light absorbed by substances in the eye. These colors range from short-wavelength violet to long-wavelength red, as illustrated in **Figure 12**. If all colors of light are present in the same place, you see the light as white.

Red (7.00×10^{-7} m) Violet (4.00×10^{-7} m)



How do the different colors of light affect how you see color?

When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). As you will see, shorter wavelength electromagnetic radiation (ultraviolet waves, X-rays, gamma rays) can ionize atoms and cause damage to living cells.



CamScanner

19

Students will explore the structure and creation of sound waves. This will lead them to understand how sound is made, travels, and is heard.

Electromagnetic waves and the Doppler effect

The Doppler effect also occurs for other waves besides sound waves. For example, the frequency of electromagnetic waves changes if an observer and wave source are moving relative to each other. Astronomers use the Doppler effect to help measure the motions of stars and other objects.

In addition, police radar guns, such as the one shown in **Figure 11**, use the Doppler effect to measure the speeds of cars. The radar gun sends radar waves toward a moving car. The waves are reflected from the car and their frequency is shifted, depending on the speed and direction of the car. From the Doppler shift of the reflected waves, the radar gun determines the car's speed.



CamScanner

Students will explore the electromagnetic spectrum. This will lead them to understand how the properties of electromagnetic waves change as they become more energetic.

Students will explore the uses of radio and microwaves in communication. This will lead them to understand the technology we use to send messages around the world.

Electromagnetic waves with wavelengths between about ten-billionths of a meter and ten-trillionths of a meter are called X-rays. X-rays have shorter wavelengths than UV waves, and their photons have larger energies. X-rays penetrate skin and soft tissue but not denser materials, such as teeth and bones. Doctors and dentists use low doses of X-rays to form images, like the one in **Figure 16**, of bones and teeth. X-rays are also used in airport screening devices to examine the contents of luggage.

The Global Positioning System

Getting lost while hiking is not uncommon, but if you are carrying a Global Positioning System receiver, it is much less likely to happen. The Global Positioning System (GPS) is a system of satellites, ground monitoring stations, and receivers that determine your exact location on or above Earth's surface. The 24 satellites necessary for 24-hour, around-the-world coverage became fully operational in 1995. **Figure 26** illustrates how these satellites are arranged in orbit. Signals from four satellites are used to determine the location of an object using a GPS receiver.

16. **Describe** what happens to your signal when you are talking on a cell phone and you travel from one cell to another cell.

16. A central controller transmits your signal to the base station in the new cell.



CamScanner

20

Students will explore the electromagnetic spectrum. This will lead them to understand how the properties of electromagnetic waves change as they become more energetic.

Students will explore the uses of radio and microwaves in communication. This will lead them to understand the technology we use to send messages around the world.

GPS satellites are owned and operated by the United States Department of Defense, but the microwave signals they send out can be used by anyone. Several other countries are working to develop similar systems. Airplanes, ships, cars, and cell phones can use GPS for navigation. Some pet collars also contain GPS receivers. If the pet runs away or is lost, the GPS receiver in the collar can be used to locate the animal.



Figure 26 A GPS receiver uses signals from four of the 24 orbiting satellites to determine the receiver's location.



CamScanner

20

Students will explore the electromagnetic spectrum. This will lead them to understand how the properties of electromagnetic waves change as they become more energetic.
Students will explore the uses of radio and microwaves in communication. This will lead them to understand the technology we use to send messages around the world.



Get It?

Describe the differences between microwaves and radio waves.

Microwaves

Electromagnetic waves that have wavelengths between 0.1 mm and 30 cm are called **microwaves**. Microwaves with wavelengths of about 1 cm to 20 cm are widely used for communication, such as for cellular telephones and satellite signals. However, you are probably most familiar with microwaves

Microwave ovens

In a microwave oven, microwaves interact with the water molecules in food, as shown in **Figure 10**. Each water molecule has a slight positive charge on one side and a slight negative charge on the other side, so it will align in an electric field. The vibrating electric field inside a microwave oven causes water molecules in food to rotate back and forth billions of times each second. This rotation causes a type of friction between water molecules that generates thermal energy. The thermal energy produced by the water molecules' interactions causes food to cook.



CamScanner

20

Students will explore the electromagnetic spectrum. This will lead them to understand how the properties of electromagnetic waves change as they become more energetic.
Students will explore the uses of radio and microwaves in communication. This will lead them to understand the technology we use to send messages around the world.

Radio Waves

Even though you cannot see them, radio waves are all around you. Radio waves are electromagnetic waves with wavelengths longer than 10 cm. [Radio waves](#) have long wavelengths and low frequencies, and their photons have low energies. Radio waves have many uses, including communications and medical imaging.

Audio transmission

Some radio waves carry an audio signal from a radio station to a radio. However, even though these radio waves carry information that a radio uses to create sound, you cannot hear radio waves. You hear sound when your radio changes the radio wave into a sound wave.

Another use for radio waves is to find the position and movement of objects by a method called radar. Radar stands for **RA**dio **D**etecting **A**nd **R**anging. With radar, radio waves are transmitted toward an object. By measuring the time required for the waves to bounce off the object and return to a receiving antenna, the location of the object can be found. Radar is used for tracking the movement of aircraft, watercraft, and spacecraft, as shown in



CamScanner

Mechanical waves and sound



CamScanner

Define amplitude.

Define wavelength.

**Very
important**

Introduction to Waves	
Term	Definition
wave	a disturbance that transfers energy from one place to another without transferring matter.
mechanical wave	a wave that can travel only through matter.
medium	a material in which a wave travels.
transverse wave	a wave in which the disturbance is perpendicular to the direction the wave travels.
longitudinal wave	a wave in which the disturbance is parallel to the direction the wave travels.
sound wave	a longitudinal wave that can travel only through matter.
amplitude	the maximum extent of the repeating quantity from equilibrium.
loudness	how you perceive the energy of a sound wave.
intensity	the amount of energy that passes through a square meter of space in one second.
wavelength	the distance between one point on a wave and the nearest point just like it.
frequency	the number of times the pattern repeats in a given amount of time.
pitch	the perception of how high or low a sound is; related to the frequency of a sound wave.
reflection	the bouncing of a wave off a surface.
absorption	the transfer of energy from a wave to the medium through which it travels.
transmission	the passage of a wave through a medium.
diffraction	the change in direction of a wave when it travels by the edge of an object or through an opening.

Introduction to Waves

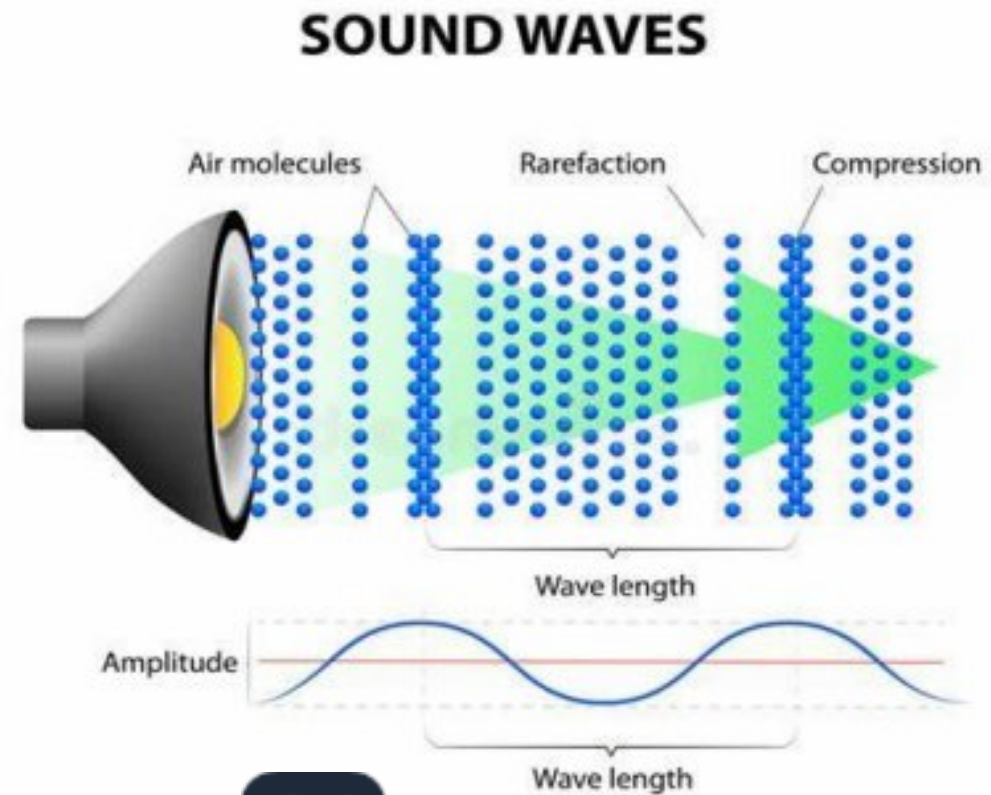
Learning Objective:
Illustrate the type of sound waves and relate it with the medium that transfer through

step 1

When the speaker cone moves out it forces particles in the air closer together this will form a compression

step 2

When the speaker cone moves back it leaves the area with fewer particles which calls rarefaction



CamScanner

8. **Determine** which will change if you turn up a radio's volume: *wave velocity, intensity, pitch, frequency, wavelength, loudness*. Explain.

8. Loudness and intensity will change when you turn up a radio's volume. Loudness is the human perception of volume. Loudness is primarily affected by sound intensity.



CamScanner

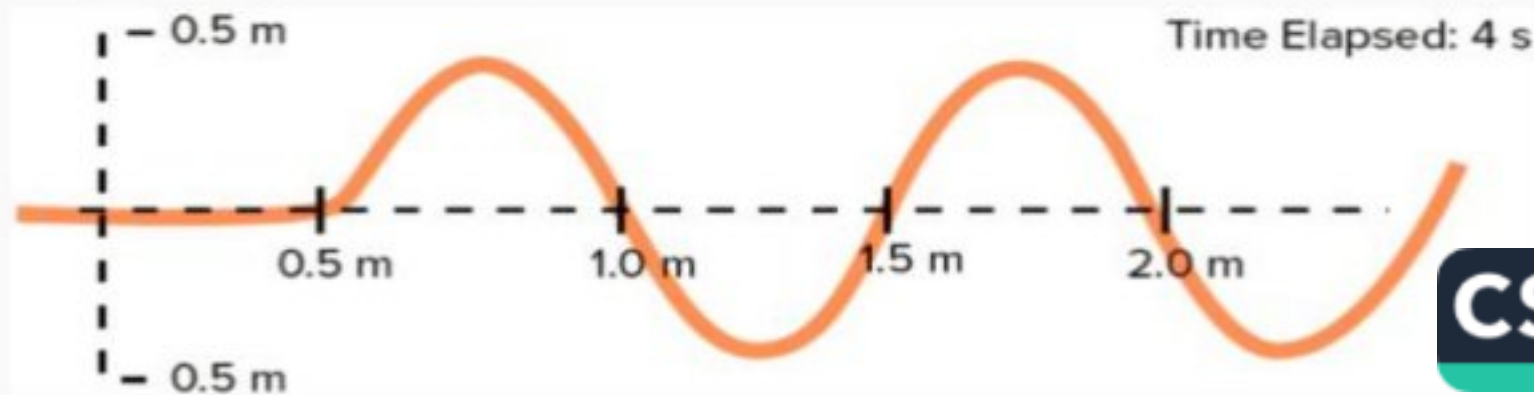
- To calculate the frequency of waves, divide the number of wavelengths by the time.

- $$\text{Frequency} = \frac{\text{number of Wavelength}}{\text{Time}}$$

Question 1:

Difficulty level: Unset

1. Determine the wavelength, frequency, and amplitude for each wave.



CamScanner

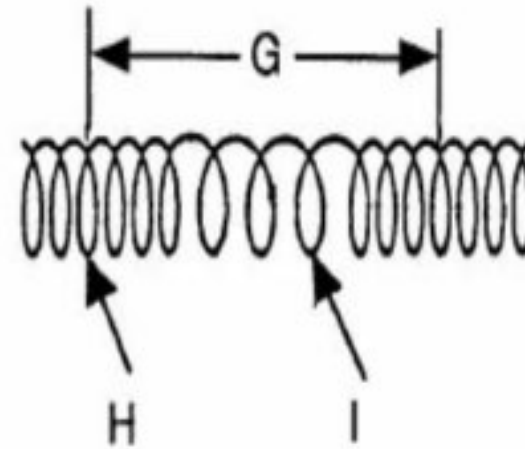
2. The following questions refer to the diagram to the right:

(a) Is this wave transverse or longitudinal?

(b) Letter H represents a **compression** and

letter I represents a **Rarefaction**

(c) Letter G represents a **wavelength**



3. A kid on a playground swing makes 6 complete to-and-fro swings each 30 seconds.

The frequency of the swinging is **$6/30 = 0.2 \text{ Hz}$**

4. In what type of wave is the vibration perpendicular to the direction of travel of the wave? **Transverse**

5. What type of wave vibrates parallel to the direction of travel?

Longitudinal

6. What type of wave contains compressions and rarefactions? **Longitudinal**

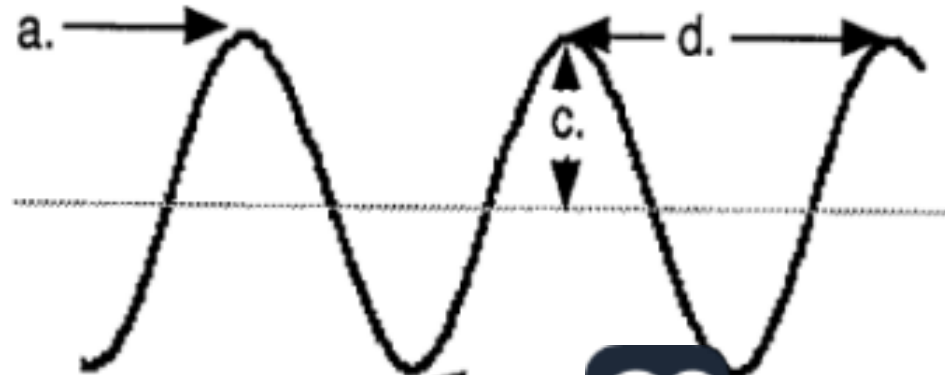


CamScanner

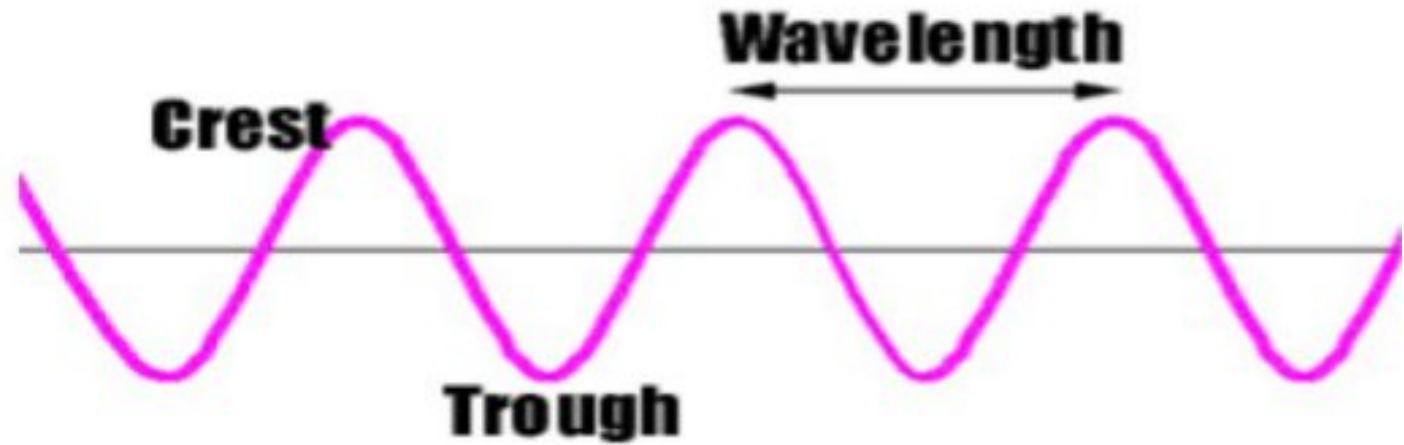
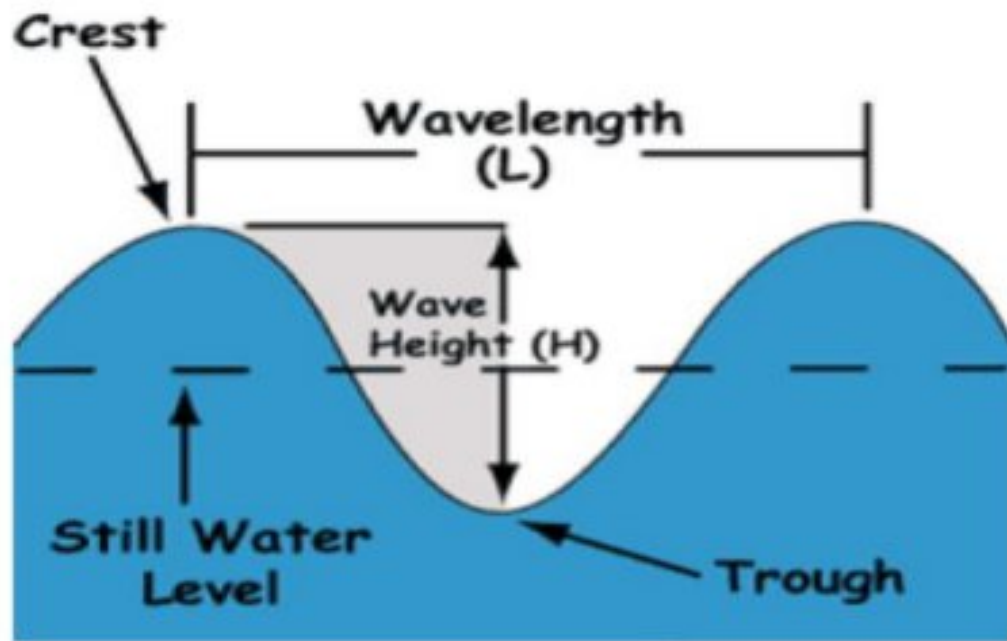
WORKSHEET - LABELING WAVES

1. The highest point on a wave is the Crest, while the lowest point is the trough.
2. Amplitude of a wave is a measure of the amount of energy it carries.
3. The distance from one crest to the next crest is the Wavelength.
4. frequency is a measure of the number of waves that pass a point in a given amount of time.
5. The illustration to the right shows a wave.
Label each part in the space below:

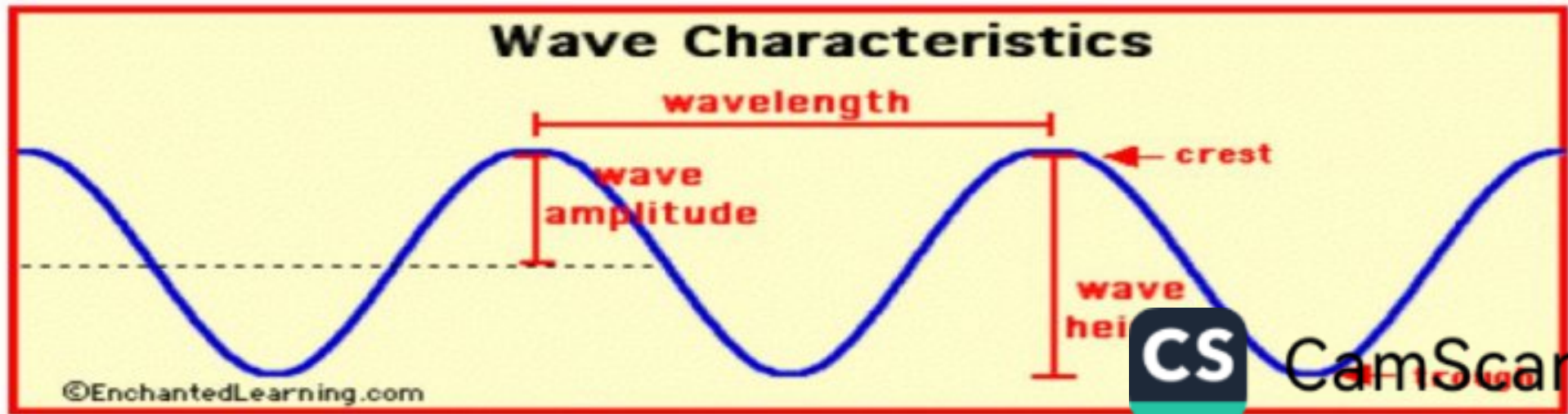
- a. crest
- b. trough
- c. amplitude
- d. wavelength



CamScanner

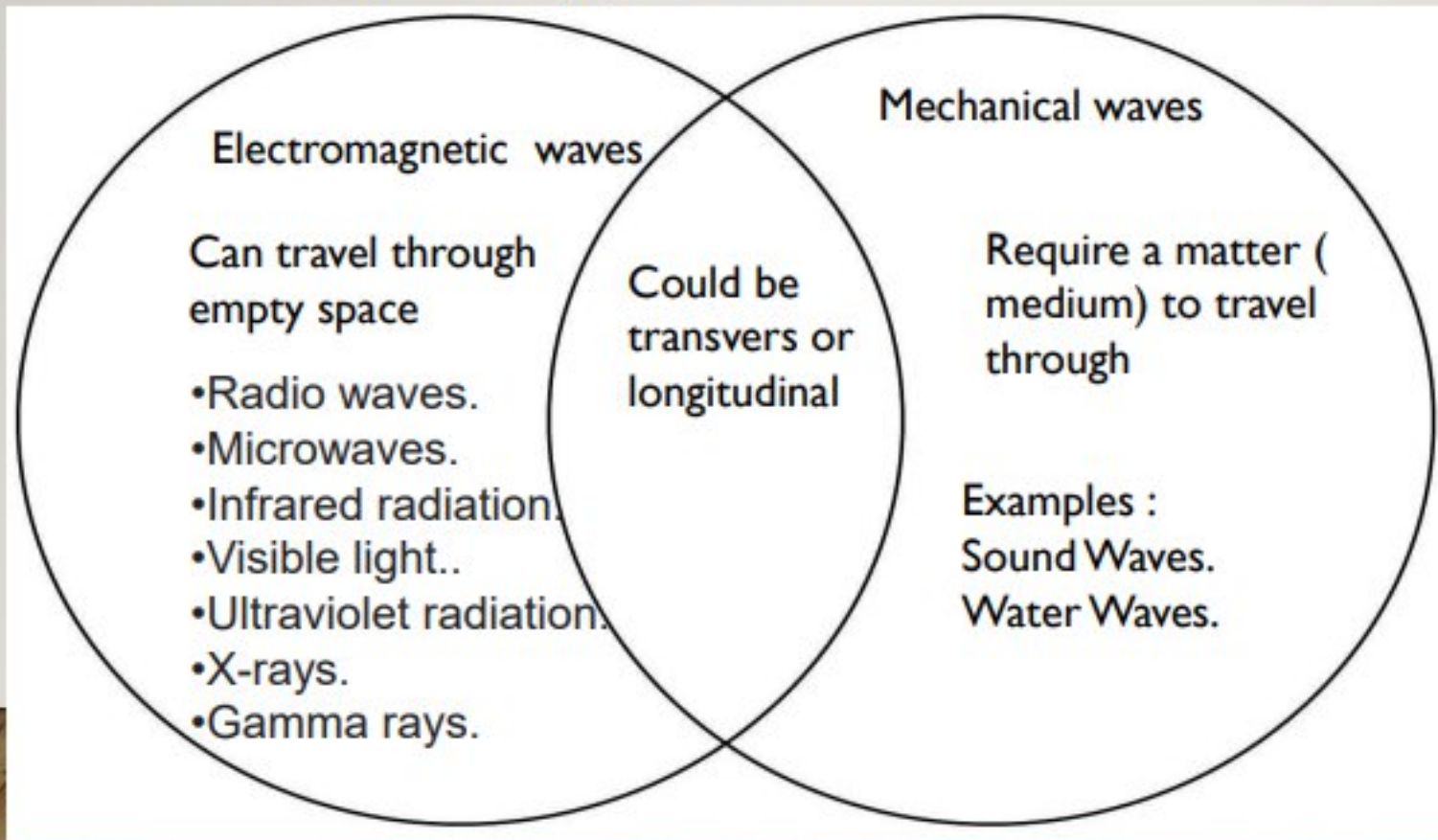


Slide content



CamScanner

- What are the types of waves?

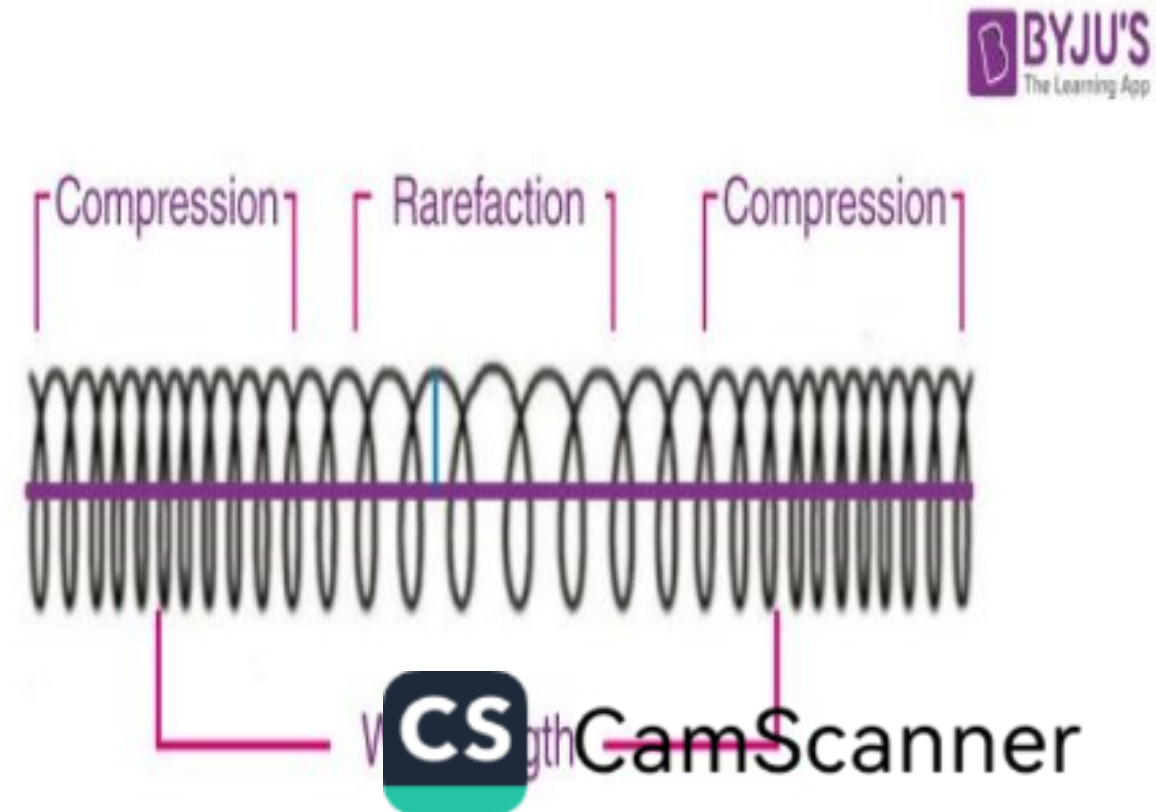
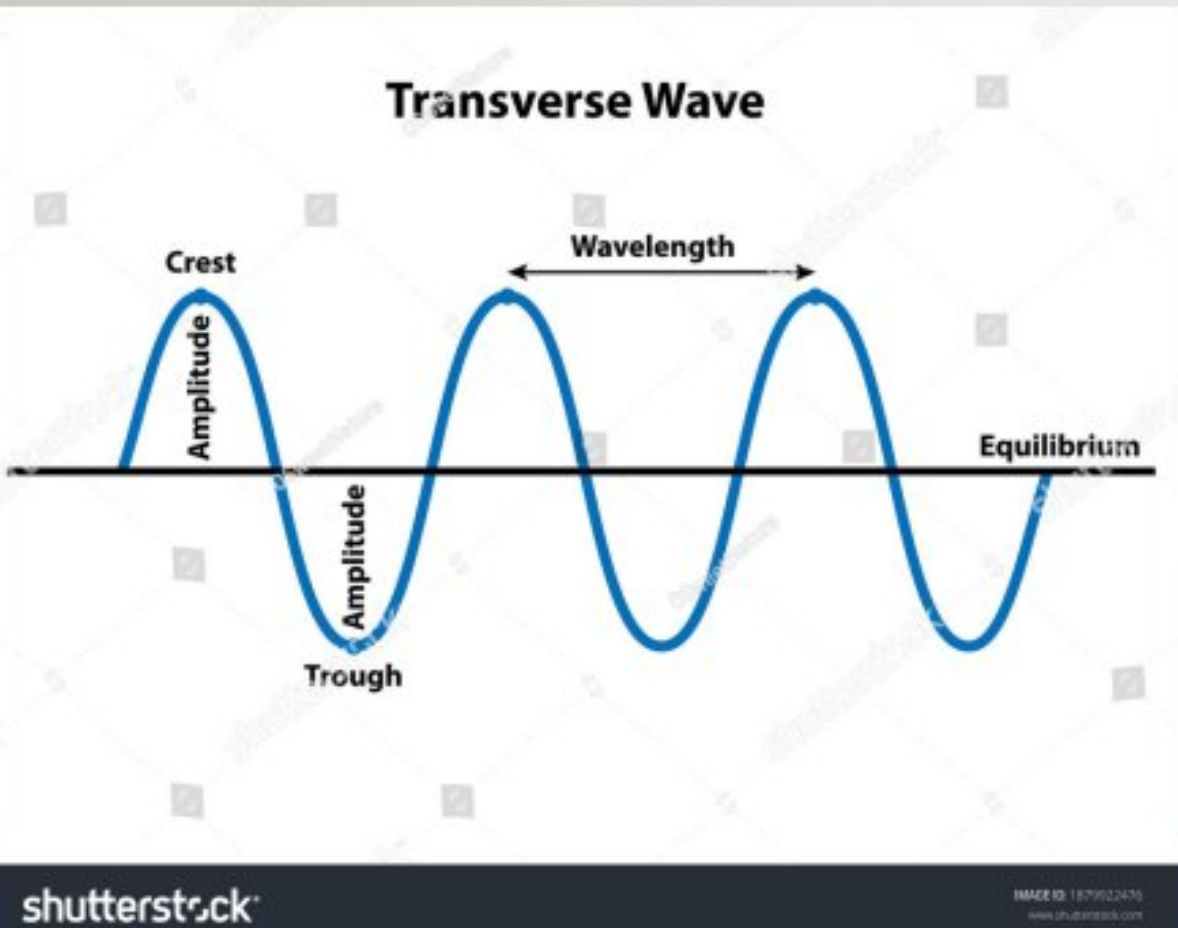


Use Venn diagram
to compare
between types of
waves with
examples



CamScanner

- a Transverse Wave which moves the medium perpendicular to the wave motion,
Longitudinal Wave, which moves the medium parallel to the wave motion



A wave is a disturbance in a medium that transports energy without causing net particle movement

The amplitude of a wave is its height, which is commonly measured in meters. It is proportional to the quantity of energy transported by a wave.

Wavelength – A wavelength is a distance between identical locations in adjacent cycles of crests of a wave

Crest: the maximum height up from the equilibrium

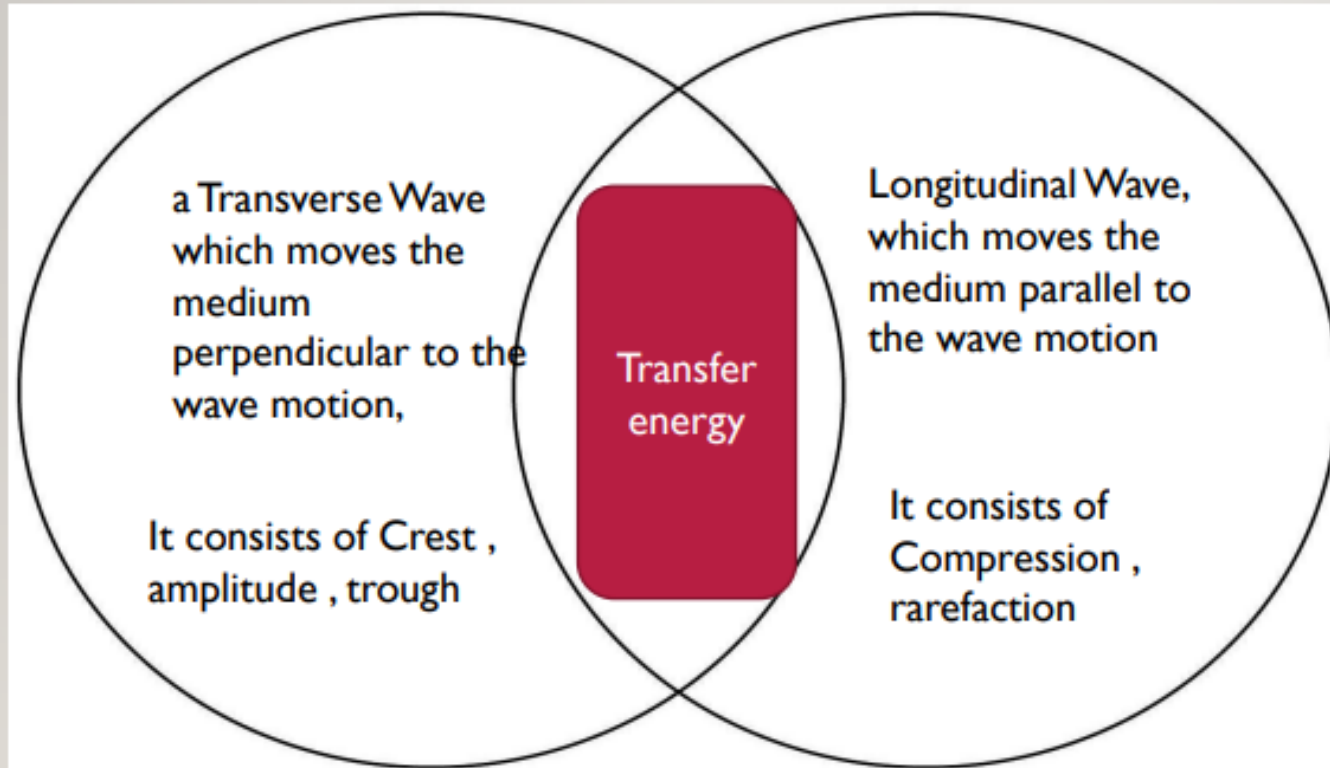
Trough : the maximum height down from equilibrium

Compression : Compression is a region in a longitudinal wave where the particles are closest together. (high pressure)

Rarefaction : the region where the medium is spread out (low pressure)

Describe the movement of the longitudinal wave.?

Identify the different types of mechanical waves and their properties



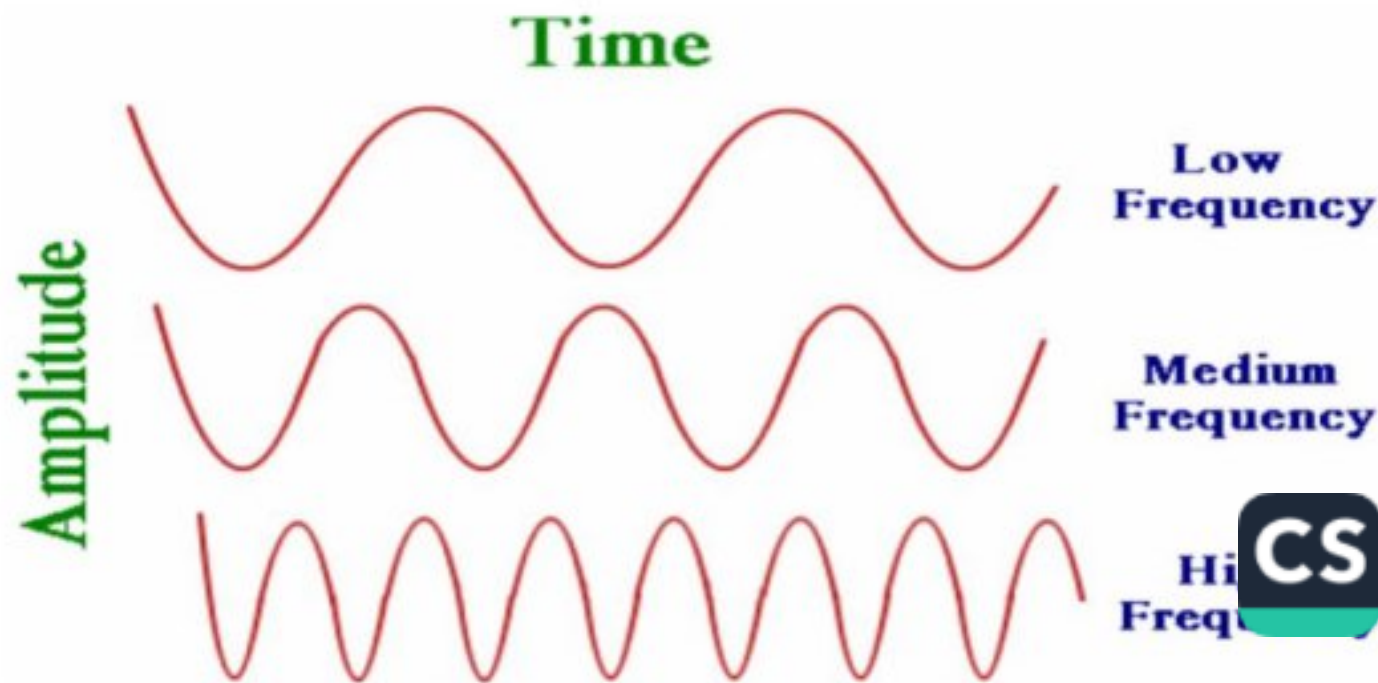
Use Venn diagram
to compare
between
Transverse and
longitudinal



CamScanner

Relation between frequency , speed and wavelength

- **The frequency (f)** of a wave is the number of complete cycles in a given time. Measured in hertz (Hz) (Unit : HZ)

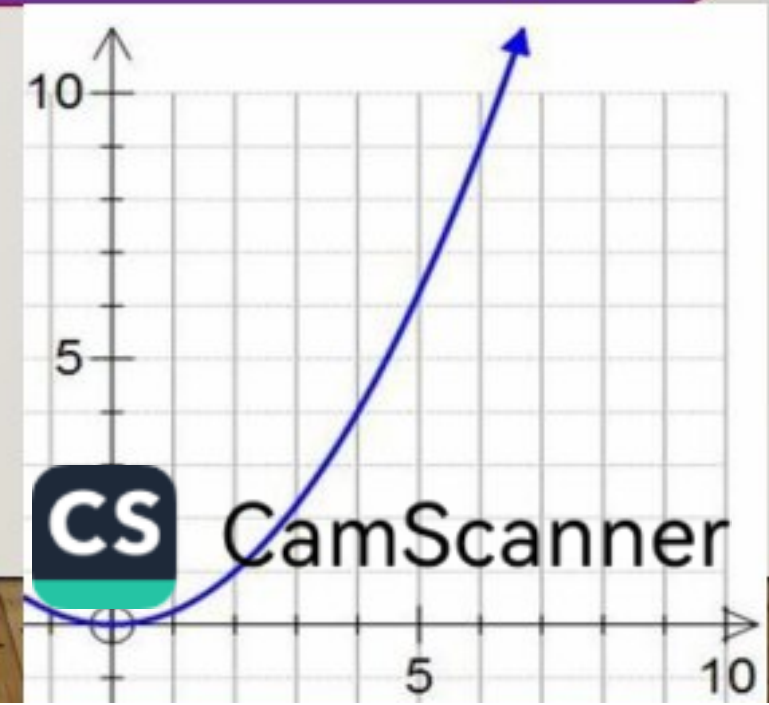
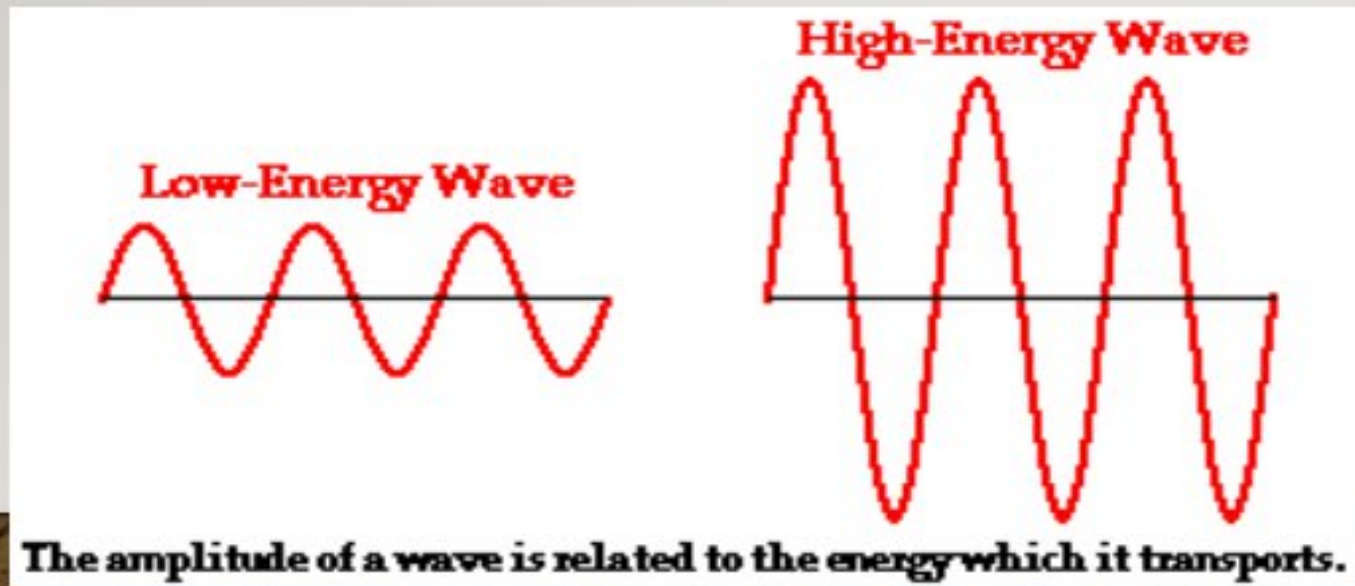


CamScanner

How does the amplitude of the wave relate to its energy?

Relation between frequency , speed and wavelength

- The wave that has higher Amplitude , has higher energy (Directly proportional)



Pitch

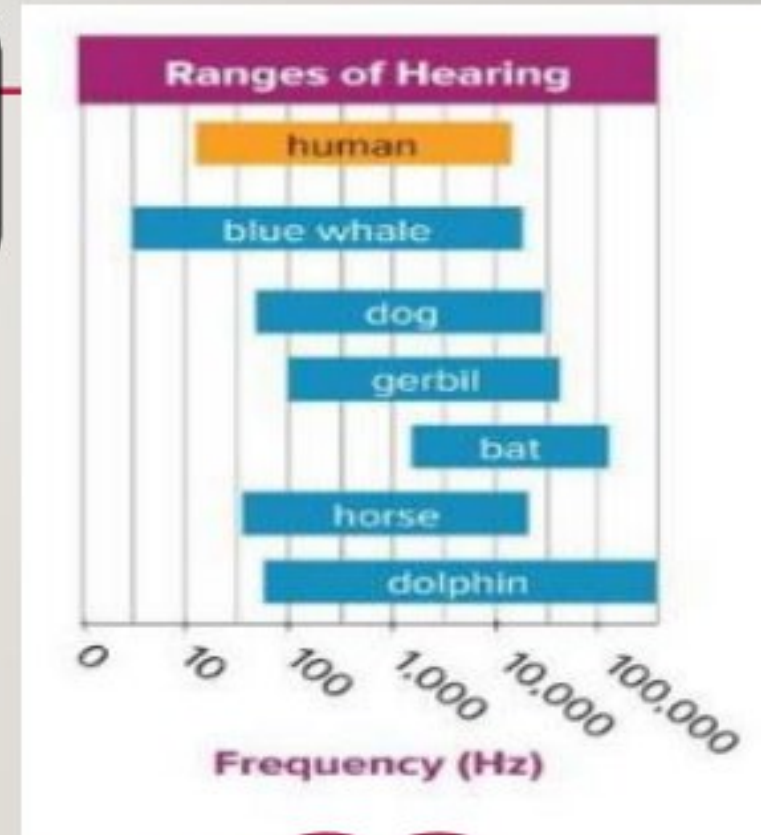
The understanding of how high or low a sound seems

- The relation between Pitch and Frequency is proportional
- Higher frequency means higher Pitch

An adult male voice is 85 HZ and an adult female voice is 165 HZ. Which one has higher Pitch ? Justify your answer

The adult female has higher Pitch as the relation between pitch and frequency is proportional

Human Ears can detect sounds in range 20 -20,000 HZ



Frequencies above 20,000 Hz are called



ultrasound

CamScanner



Piece
of cake

All relations

How does the wavelength change if the frequency of a wave decrease ?

As frequency of wave a wave decrease the wavelength increase and vice versa

How does the frequency change if the energy of a wave decrease ?

the frequency decreases if the energy of a wave decrease

How does the Frequency change if the Amplitude of a wave decrease ?

the Frequency decreases if the Amplitude of a wave decrease

How does the wavelength change if the energy of a wave decrease ?

As energy of wave a wave decrease the wavelength increase and vice versa

How does the loudness change if the energy of a wave decrease ?

the loudness decreases if the energy of a wave decrease

How does the loudness change if the Amplitude of a wave decrease ?

the loudness decreases if the Amplitude of a wave decrease ?

CS

CamScanner

Describe the behavior of sound as it travels from one room to another

Mechanical waves interactions

- Echo is an example of sound wave reflecting
- When a wave reflected from a surface the angle of the reflection is equal to the angle the wave strikes the barrier and change the direction

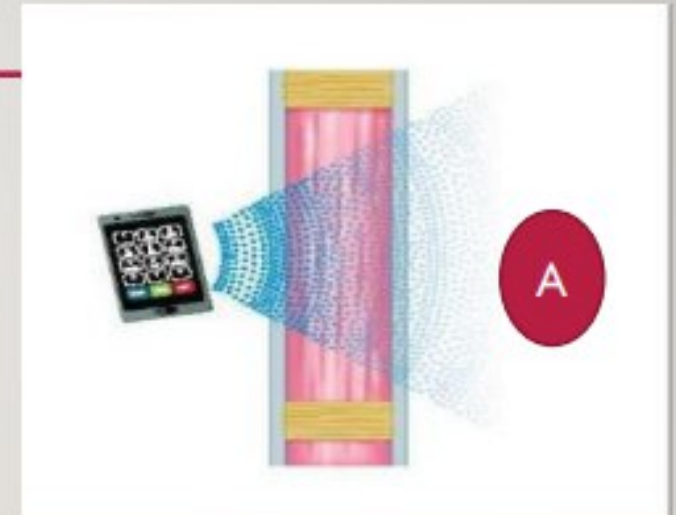
- Absorption** :The transfer of energy by a wave to the medium through which it travels
 - The amount of energy absorbed depends on the **type of wave** and the **material which it moves**

- **Transmission** : the passage of a wave through a medium
- Sometimes the matter doesn't absorb all the wave energy but could transmit some of the energy to the other side

Ex :Wooden floor can improve the vibration to increase the sound

Curved surfaces can reflect the sound waves in different directions

- **Diffraction** : the change in wave direction when it travels by the edge of an object or through an opening



CS CamScanner

MUSIC Connection Acoustical engineers must take into account the type of materials they are working with. If they are designing a concert hall, these engineers carefully choose the shapes and materials to control sound waves. The stage has a wooden floor to improve vibrations. The curved panels on the ceiling reflect sound waves in different directions to fill the space.

Highway sound barriers are another example of controlling sound waves. The barriers are often made from wood, concrete, or metal, like the one shown on the right. The barriers' purpose is to keep the highway noise away from residential areas. The higher the wall, the more sound will be reflected from the hard surface.



How does sound change when traveling through different mediums?

Nature of sound

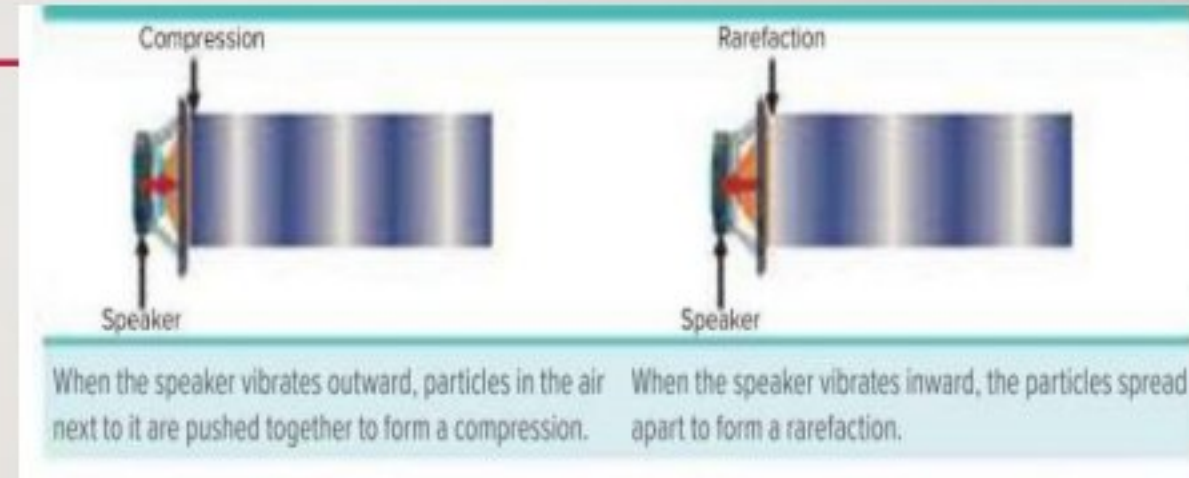
- Sound waves is produced by the vibration of medium particles
- Sound is a kind of mechanical longitudinal waves consists of compressions and rarefactions

speed of sound

Which affected by the density and the temperature of the medium

Ex: solids transfer the sounds very quickly because the particles are very close to each other

Gases transfer the energy less than any other matter because the particles are further apart so it takes longer to transfer the energy



- Depends on temperature & mass of particles & elasticity
 - $\uparrow$ temperature = $\uparrow$ speed ~ 0.6 m/s per 1°C
 - Lighter particles move faster
 - The faster the material can change back to original shape (its elasticity) – the faster sound travels

Nature of sound

Provide evidences which one of these sound would travel more slowly in cork or the water ? Justify your answer



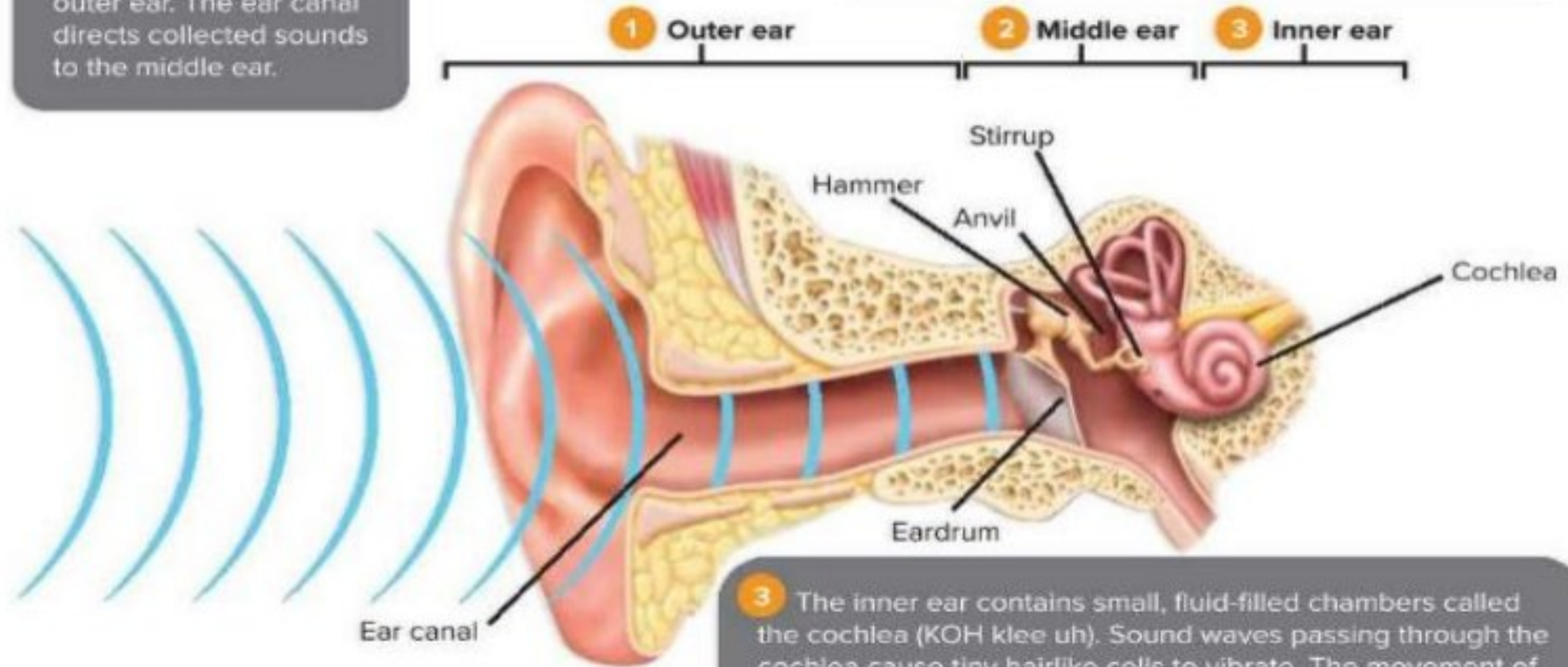
It would be slower in cork because it contains gaps of air inside it.

CS

GamScanner

1 The outer ear collects sounds. Cupping your hand around your ear makes the collector bigger, so it gathers more sounds. The ear canal also is part of the outer ear. The ear canal directs collected sounds to the middle ear.

2 The middle ear amplifies sound. The eardrum, a structure like a drumhead, lies between the outer and the middle ear. Sound waves entering the outer ear cause the eardrum to vibrate. The vibrations transfer to three tiny bones called the hammer, the anvil, and the stirrup. The vibrations of these bones conduct the sound toward the inner ear.



3 The inner ear contains small, fluid-filled chambers called the cochlea (KOH klee uh). Sound waves passing through the cochlea cause tiny hairlike cells to vibrate. The movement of the hair cells produces nerve impulses that travel to the brain. The brain interprets these signals as sound.

1. **Explain** how sound travels from your vocal cords to your friend's ears when you talk.

CS

CamScanner



Get It?

Identify what makes the eardrum vibrate.



Get It?

energy from sound waves

EAR LABELING



CamScanner

The inner ear

When the membrane in the oval window vibrates, the sound vibrations are transmitted into the inner ear.

The inner ear contains the cochlea (KOH klee uh). The cochlea is a spiral-shaped structure that is filled with liquid and contains tiny hair cells. These hair cells are shown in **Figure 5**. When the hair cells in the cochlea begin to vibrate, nerve impulses are sent through the auditory nerve and to the brain. It is the cochlea that converts sound waves to nerve impulses.



Density and sound speed Sound usually travels fastest in solids and slowest in gases. One reason for this is that the individual particles that make up liquids and solids are usually closer together than the particles that make up gases. **Figure 3** helps to illustrate why sound travels quickly in solids and liquids. Imagine that you are going door to door to raise money for a charity. In a city, it doesn't take very long to walk from house to house. In a rural area, it takes longer to walk from house to house. Similarly, when the particles that make up a medium are farther apart, sound travels more slowly through that medium.

Elasticity and sound speed Elasticity is the tendency of an object to rebound to its original state when it is deformed. A rubber ball is elastic. It tends to spring back to its original shape after someone squeezes it. A ball of clay is much less elastic.

Elastic objects also rebound more quickly when sound waves travel through them. Therefore, sound waves travel more quickly through elastic objects. Usually, solids are more elastic than liquids, and liquids are more elastic than gases. This is another reason why sound waves typically travel fastest through solids, faster through liquids, and slowest through gases.

Intensity

For sound waves, the amplitude of the waves is related to intensity. Intensity is the amount of energy that passes through a certain area in a specific amount of time. Picture sound waves traveling from a computer speaker, through an imaginary rectangle, and to your ears, as shown in **Figure 7**. If you could measure how much energy passed through such a rectangle in one second, you would measure intensity.

When you turn up the volume on your computer, the speaker cone moves in and out through a greater distance. In turn, greater energy is transferred through the medium, resulting in greater intensity. When you turn down the volume, you reduce the energy carried by the sound waves, so you also reduce the intensity.



Distance and intensity Intensity influences how far away a sound can be heard. If you and a friend whisper a conversation, the sound waves you produce have low intensity and are not heard at a far distance. However, when you shout, the sound waves have high intensity and can be heard farther away.

Sound intensity decreases with distance for two reasons. First, the energy that a sound wave carries spreads out as the sound wave spreads out. Second, some of a sound wave's energy converts to other forms of energy, usually thermal energy, as the sound travels through matter. As the sound wave travels farther, more of its energy converts into other forms. Some materials, such as soft, thick curtains, are very effective at converting sound energy to other forms of energy.

Loudness

Some sounds are so loud that they can be painful to hear. Loudness is the human perception of sound volume and primarily depends on sound intensity. When sound waves of high intensity reach your ear, they cause your eardrum to move back and forth a greater distance than when sound waves of low intensity reach your ear. As a result, you hear a loud sound.



Get It?

Relate intensity and loudness.

CS

CamScanner

Vibrations and Sound

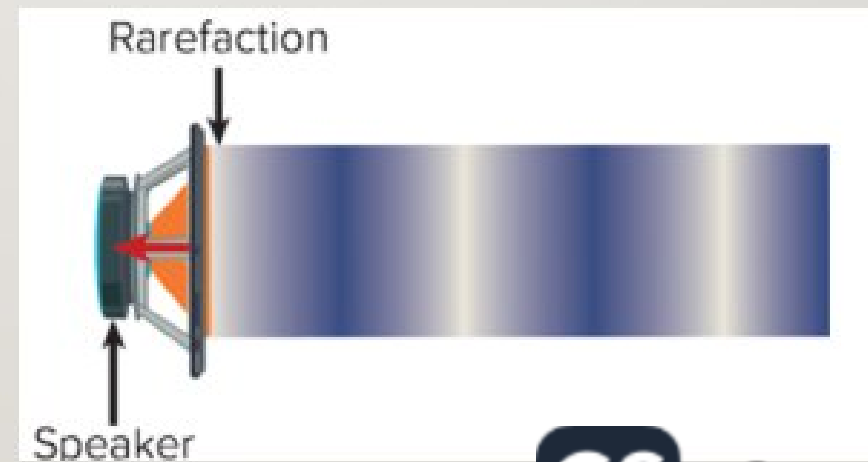
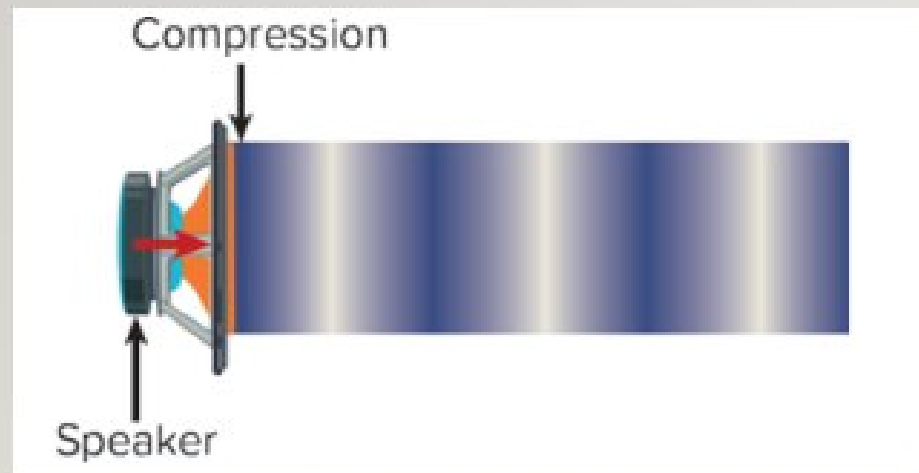
An amusement park can be a noisy place. The sounds from the rides and games can make it hard to hear what your friends say. All of these sounds have something in common: a vibrating object produces each one. For example, your friends' vibrating vocal cords produce their voices. Vibrating speakers produce the music from a carousel.



Students will develop and use models to describe light's path as straight lines and to describe how objects function to interact with light waves through reflection, absorption, and transmission.

Students will use structures to investigate how mechanical waves are reflected, absorbed, or transmitted through various materials, and develop models to describe the phenomena they observe.

Sound waves are longitudinal waves. Remember that a longitudinal wave is composed of two types of regions—compressions and rarefactions. If you look at **Figure 1**, you will see that when a radio speaker vibrates outward, the particles near the speaker are pushed together, forming a compression. When the speaker moves inward, the particles near the speaker are spread apart, and a rarefaction forms. As long as the speaker continues to vibrate back and forth, sound waves are produced.



Students will develop and use models to describe light's path as straight lines and to describe how objects function to interact with light waves through reflection, absorption, and transmission.

Students will use structures to investigate how mechanical waves are reflected, absorbed, or transmitted through various materials, and develop models to describe the phenomena they observe.

Sound in liquids and solids

If you have been underwater and heard garbled voices, you know that sound travels through water. If you have put your ear to your desk and heard sounds, you know that sound travels through solids. Sound waves travel through any type of matter—solid, liquid, or gas. **The matter through which a wave travels is called the medium. A sound wave produces compressions and rarefactions in a medium as it travels through that medium.**

What happens when there is no matter through which sound can travel? Could sound be transmitted without matter to compress, expand, and collide? **In order for astronauts, such as the ones in Figure 2, to talk to each other, they must use electronic communication equipment because there is no atmosphere to transmit sound waves. Sound waves cannot travel through the vacuum of outer space.**



Students will develop and use models to describe light's path as straight lines and to describe how objects function to interact with light waves through reflection, absorption, and transmission. Students will use structures to investigate how mechanical waves are reflected, absorbed, or transmitted through various materials, and develop models to describe the phenomena they observe.

The speed of sound

The speed of a sound wave through a medium depends on that medium's composition and whether that medium is solid, liquid, or gas. **Table 1** shows the speed of sound through some common mediums. The temperature, density, and elasticity of the medium also affect the speed of sound.

Air (0°C)	330
Air (20°C)	340
Cork	500
Water (0°C)	1400
Water (20°C)	1500
Copper	3600
Bone	4000
Steel	5800

Temperature and sound speed The speed of sound through a fluid depends on the temperature of that fluid. This relationship is particularly pronounced for gases but also exists for liquids, such as water. As the temperature of a fluid increases, the particles that make up that fluid move faster. This makes them more likely to collide with each other. If the particles that make up a medium collide more often, more energy can be transferred in a shorter amount of time. As a result, the sound waves travel faster.



Get It?

Identify two reasons why sounds usually travel faster through solids than through gases.



Get It?

Sound usually travels faster through solids than through gases because solids are usually denser and more elastic than gases.



CamScanner

2. **Summarize** the physical reasons that sound waves travel at different speeds through different mediums.

2. Sound waves travel at different speeds through different mediums due to differences in temperature, density, and elasticity.

3. **Explain** why sound speeds up when temperature increases.

3. Particle speed increases when temperature increases.

Explain why the astronauts need radios in order to talk to each other.

Caption Question Fig. 2: The astronauts are in outer space where sound waves cannot travel. Unlike sound waves, radio waves can travel through space.



CamScanner

14. Compare and contrast music and noise.

Making Music

To someone else, your favorite music might sound like a jumble of noise. A sound wave from noise and a sound wave from music are both shown in **Figure 12**. Noise has random patterns and pitches. Music is any collection of sounds that are deliberately used in a regular pattern.

What is a beat?

page 268

Beats

Have you ever heard two flutes play the same note when they were not properly tuned? You might have heard a pulsing variation in loudness. This variation in loudness is called beats and can be unpleasant to the ear. As shown in **Figure 18**, when compressions and rarefactions overlap each other, loudness decreases. When compressions overlap compressions, loudness increases.

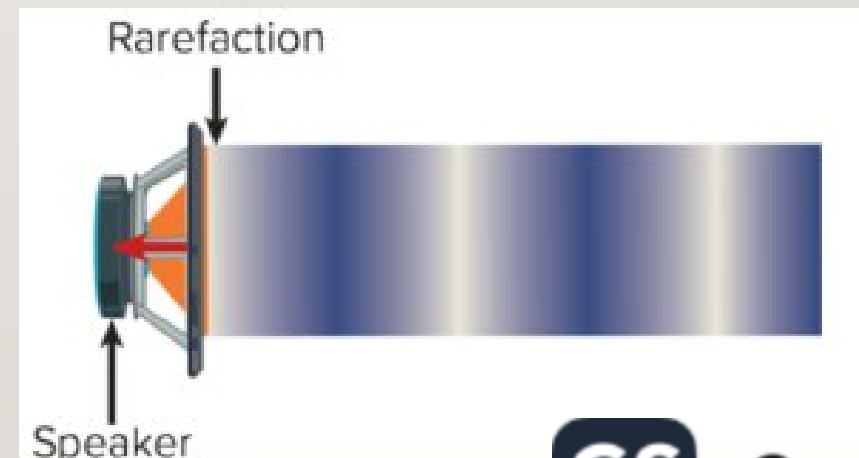
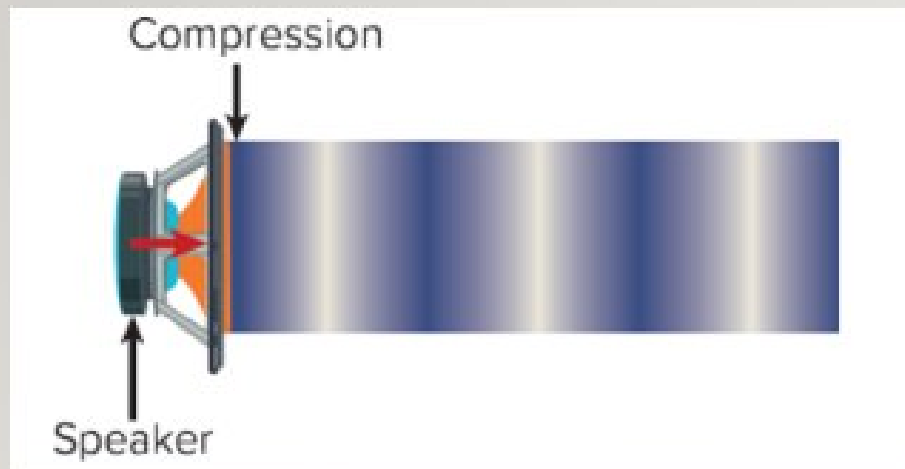


CamScanner

Students will develop and use models to describe light's path as straight lines and to describe how objects function to interact with light waves through reflection, absorption, and transmission.

Students will use structures to investigate how mechanical waves are reflected, absorbed, or transmitted through various materials, and develop models to describe the phenomena they observe.

Sound waves are longitudinal waves. Remember that a longitudinal wave is composed of two types of regions—compressions and rarefactions. If you look at **Figure 1**, you will see that when a radio speaker vibrates outward, the particles near the speaker are pushed together, forming a compression. When the speaker moves inward, the particles near the speaker are spread apart, and a rarefaction forms. As long as the speaker continues to vibrate back and forth, sound waves are produced.



17. **Explain** how two musical notes that have the same pitch and volume could sound very different from each other.

17. The two notes have different sound qualities.

How does the source of a wave change the shape of the wave?

Frequency and the amplitude of the source would affect the shape of the wave

What do different sound pitches have in common?

They all travel by the same speed at the given medium

What is the relationship between frequency and sound pitch?

Directly proportional (high frequency leads to high pitch)



CamScanner

Students will explore the structure of electromagnetic waves. this will lead them to understand the similarities and differences between electromagnetic waves and other waves.



Get It?

Identify What produces waves, and what do waves carry?

Waves in Matter

Waves are produced by something that vibrates. By moving an inflatable float up and down in a pool, you can create a wave in the water. When you speak, the vibrations of your vocal cords create a sound wave.

Waves carry energy from one place to another. Look at the water wave and the sound wave in **Figure 1**. Both waves are moving through matter. The water wave is moving through water, and the sound wave is moving through air.

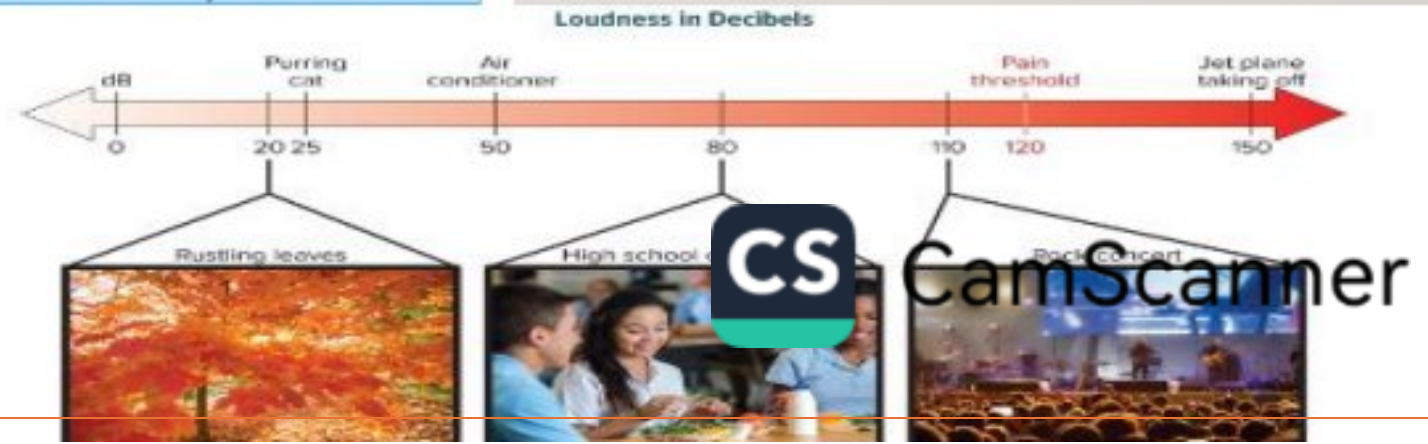


Students will explore the structure and creation of sound waves. This will lead them to understand how sound is made, travels, and is heard.

A **decibel**, abbreviated dB, is a unit of sound intensity. The loudest sounds that you hear are probably more than 10 billion times more intense than the softest sounds that you can hear. In order to handle this wide range of intensities, the decibel measurement scale is set up in a special way.

Every increase in 10 dB on the decibel scale represents a tenfold increase in intensity. This means that a 50-dB sound is 10 times more intense than a 40-dB sound. You might think that this means a 60-dB sound is 20 times more intense than a 40-dB sound. However, a 60-dB sound is 10×10 , or 100, times more intense than a 40-dB sound. A 100-dB sound is 10^7 , or 10 million times more intense than a 30-dB sound. A sound can also have an intensity of less than 0 dB. However, people generally cannot hear these sounds.

Sustained sounds above about 90 dB can cause permanent hearing loss. Even short, sudden sounds with intensity levels above 120 dB may cause pain and permanent hearing loss. During some rock concerts, sounds reach this damaging intensity level. Wearing ear protection, such as earplugs, around loud sounds can help protect against hearing loss. **Figure 8** shows some sounds and their intensity levels in decibels.



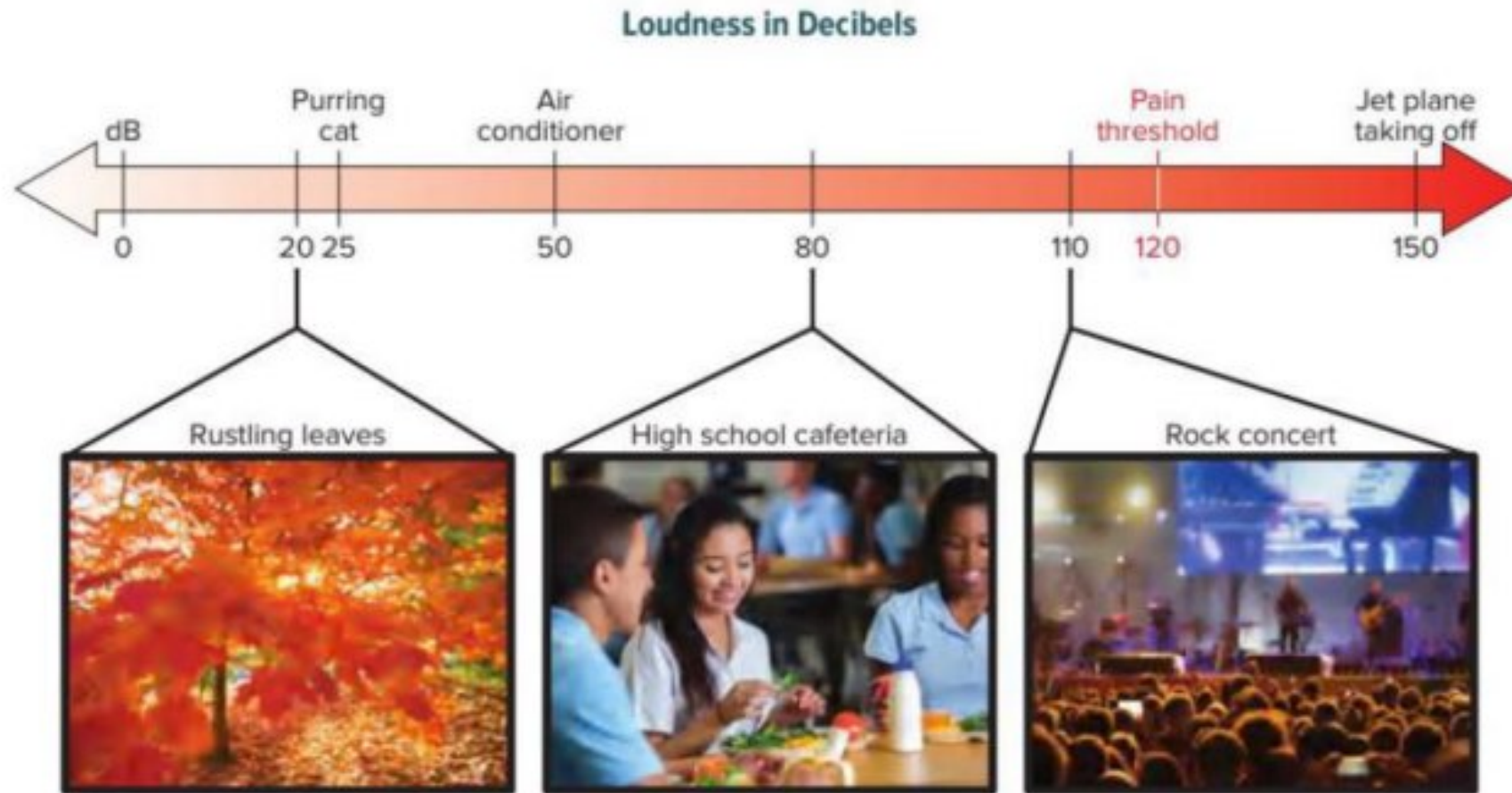


Figure 8 The volumes of different sounds are often measured in decibels.
Identify where a normal speaking voice would fall on the decibel scale.

19

Students will explore the structure and creation of sound waves. This will lead them to understand how sound is made, travels, and is heard.



Get It?

Describe the Doppler effect.

page 262

Moving observers

You can also observe the Doppler effect when you are moving past a sound source that is standing still.

Suppose you were riding in a school bus and you passed a building with a ringing bell. The pitch would sound higher as you approached the building and lower as you rode away from it.

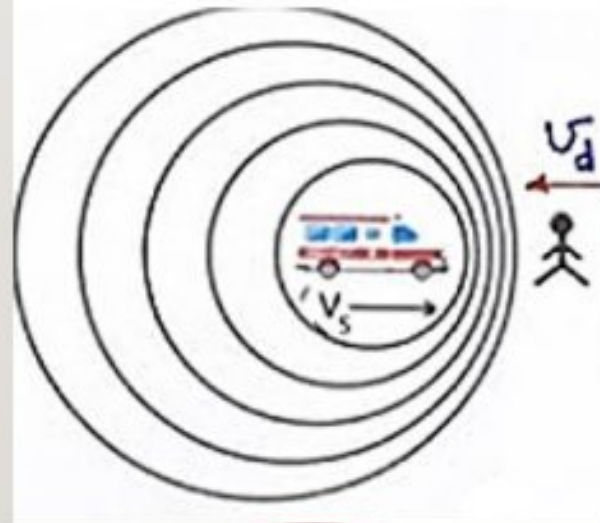
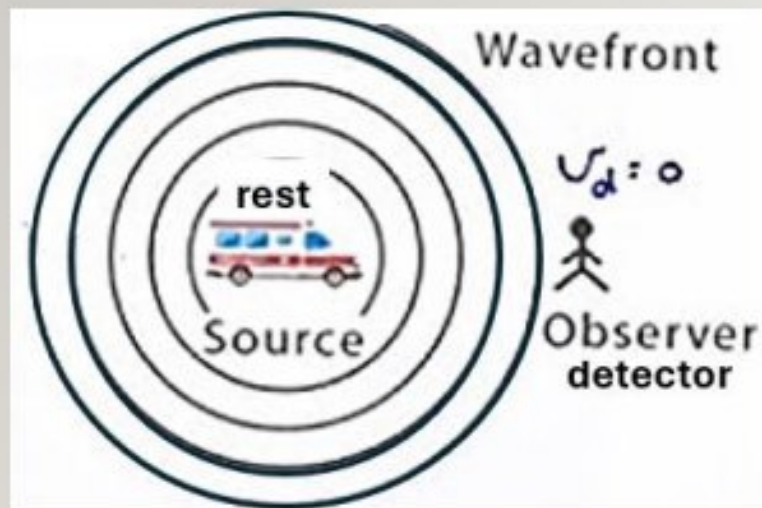
The Doppler effect happens any time a sound source is moving relative to an observer. It occurs whether the sound source or the observer is moving. The faster the change in position, the greater the change in frequency and pitch.



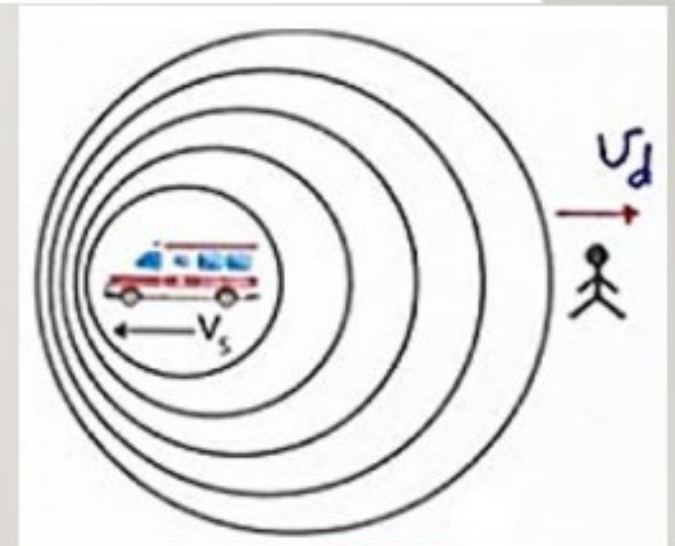
CamScanner

The Doppler Effect

Imagine that you are standing at the side of a racetrack with race cars zooming past. When the cars are moving toward you, the pitches of their engines are higher. When the cars are moving away from you, the pitches are lower. The **Doppler effect** is the change in wave frequency due to a wave source moving relative to an observer or an observer moving relative to a wave source. Figure 10 shows how the Doppler effect occurs.



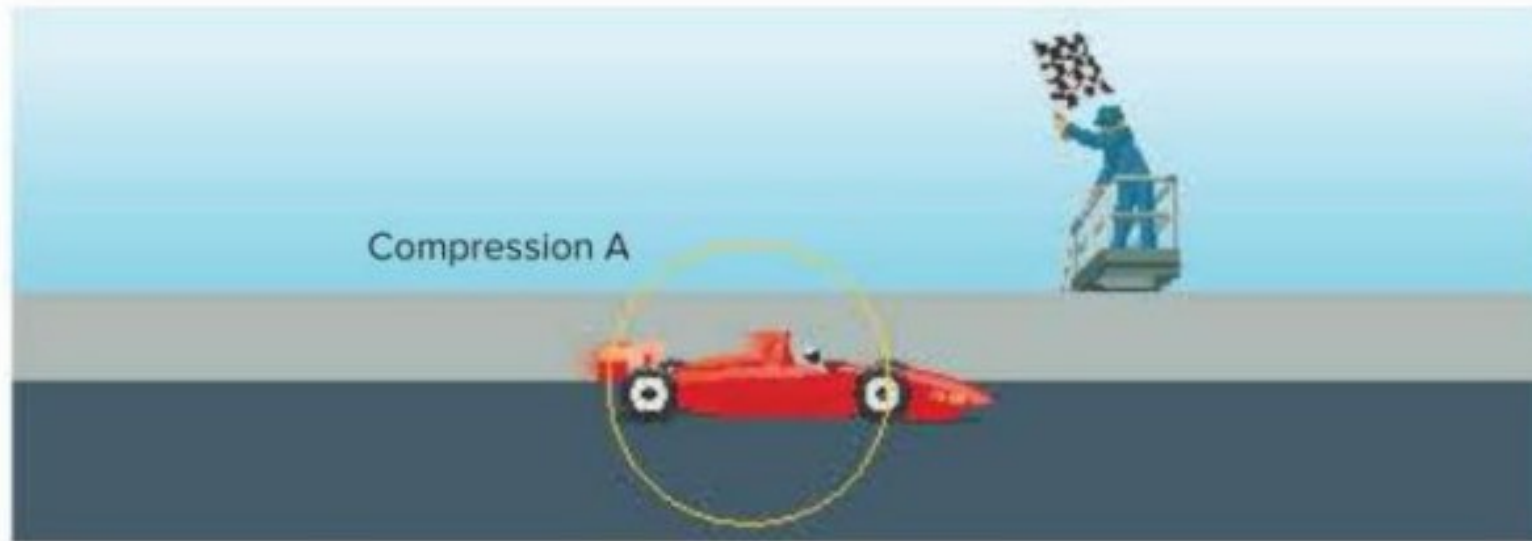
Get closer



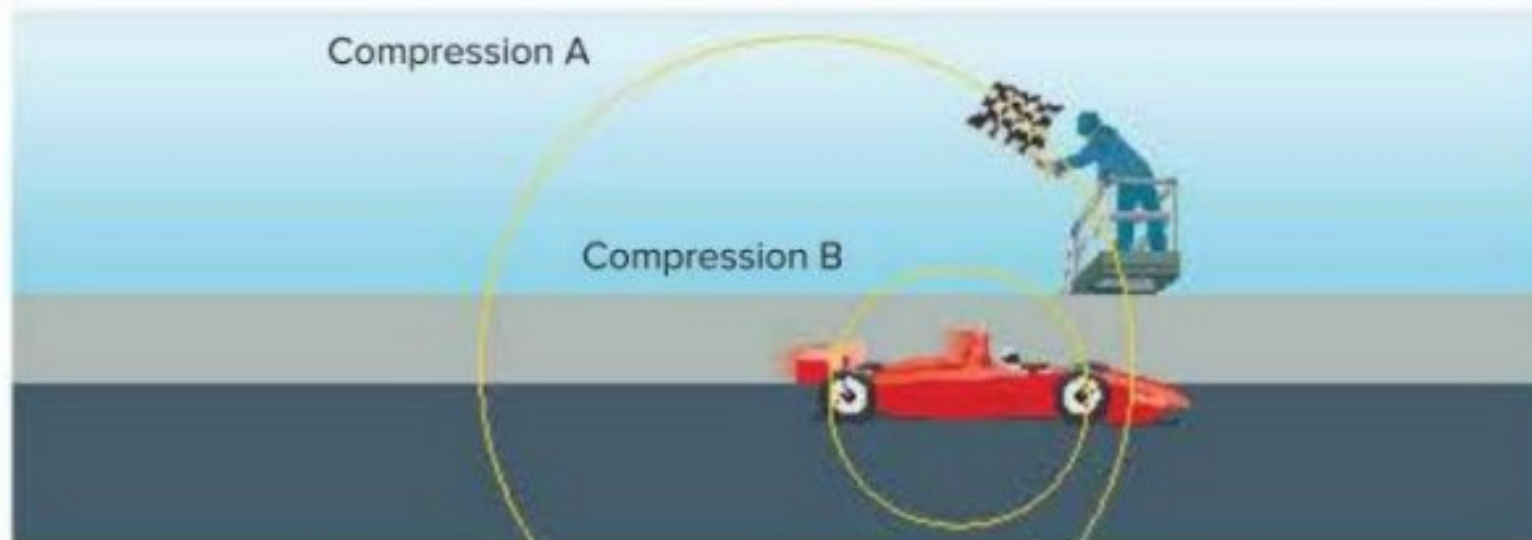
Get far away



CamScanner



The race car sends out a sound wave as it moves, producing compression A. Compression A continues to move outward, and the car continues to move forward.



The car is closer to the flagger when it creates compression B. Compressions A and B are closer together in front of the car, so the flagger hears a higher-pitched sound.



CamScanner

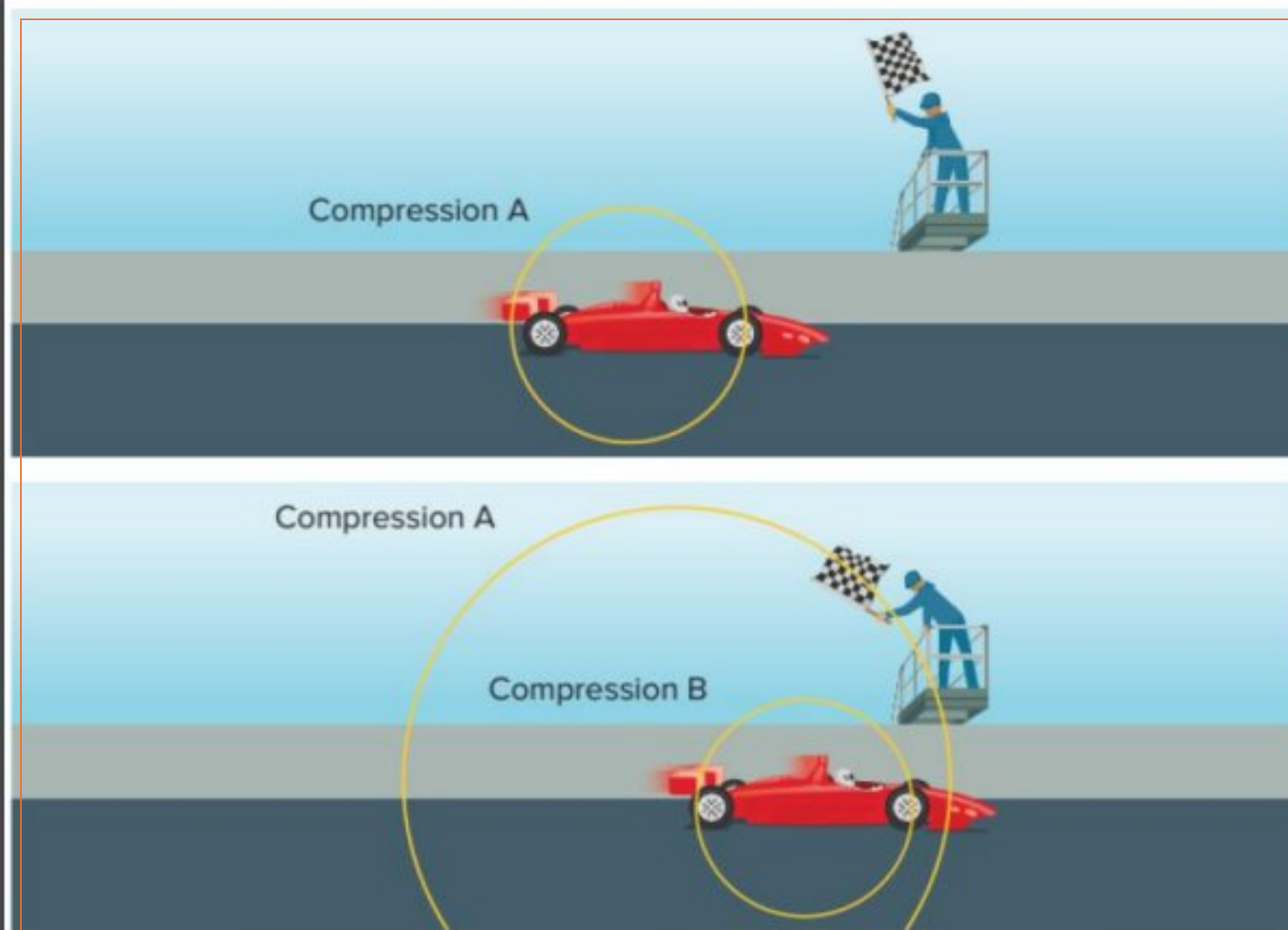
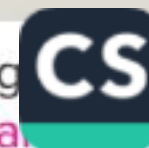


Figure 10 The Doppler effect occurs when the source of a sound wave is moving relative to a listener.

Explain why the flagger will hear a lower-pitched sound once the car passes him.

Caption Question Figure 10 shows the wave compressions that reach the flagger's ear. The wave compressions are more spread out once the car passes the flagger.



CamScanner

How could speed cameras in Abu Dhabi distinguish cars that exceed the speed limit ??

Electromagnetic waves and the Doppler effect

The Doppler effect also occurs for other waves besides sound waves. For example, the frequency of electromagnetic waves changes if an observer and wave source are moving relative to each other. Astronomers use the Doppler effect to help measure the motions of stars and other objects.

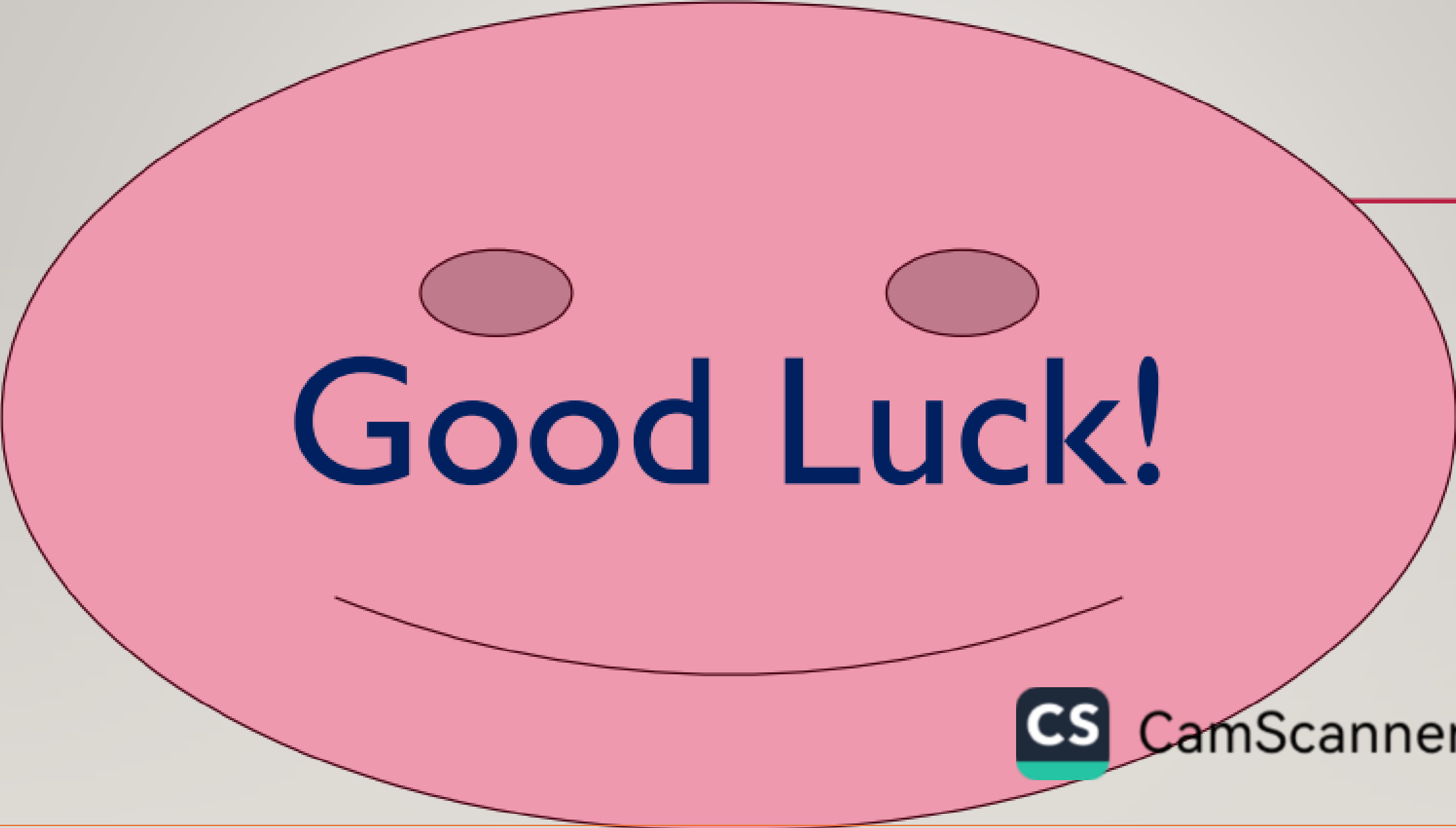
In addition, police radar guns, such as the one shown in **Figure 11**, use the Doppler effect to measure the speeds of cars. The radar gun sends radar waves toward a moving car. The waves are reflected from the car and their frequency is shifted, depending on the speed and direction of the car. From the Doppler shift of the reflected waves, the radar gun determines the car's speed.



Figure 11 Police use radar guns to measure the speeds of motorists on highways. Radar guns function based on the Doppler effect.



CamScanner



Good Luck!



CamScanner