Unit 2

Behaviours & Properties of Light

Transparent

"something clear or see-through that allows all light to pass through." If an object is transparent, you can clearly see things on the other side of it by looking through that object.

Examples) Clear glass window, water, cellophane

Translucent

"allowing light, but not detailed shapes, to pass through; semitransparent."

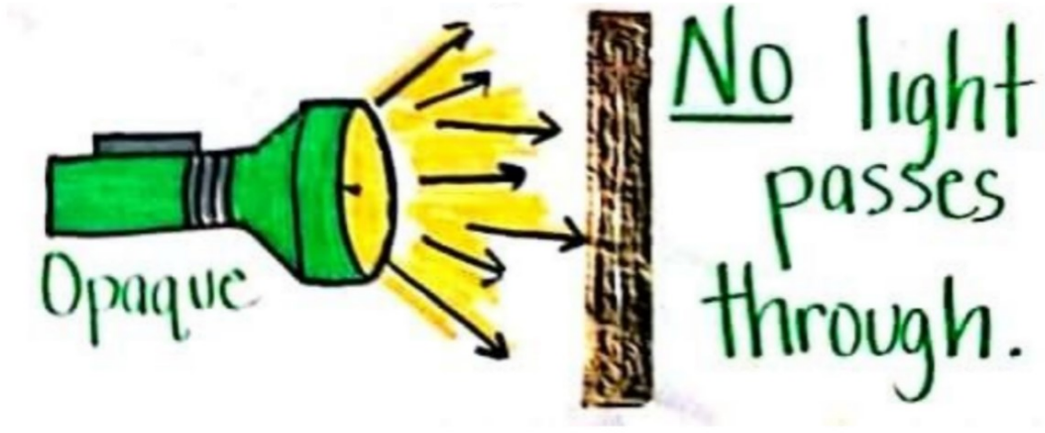
Examples: Sunglasses,

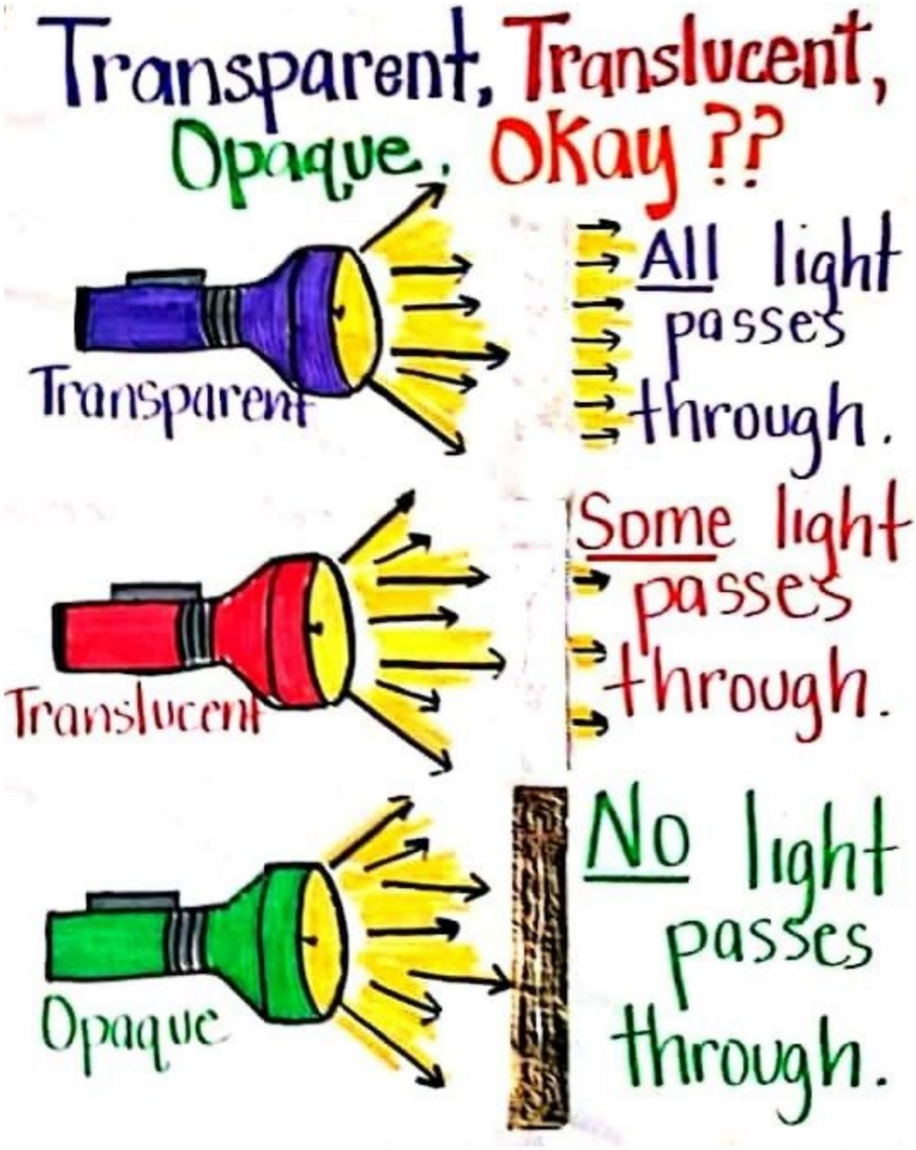
- Partially see through

Opaque

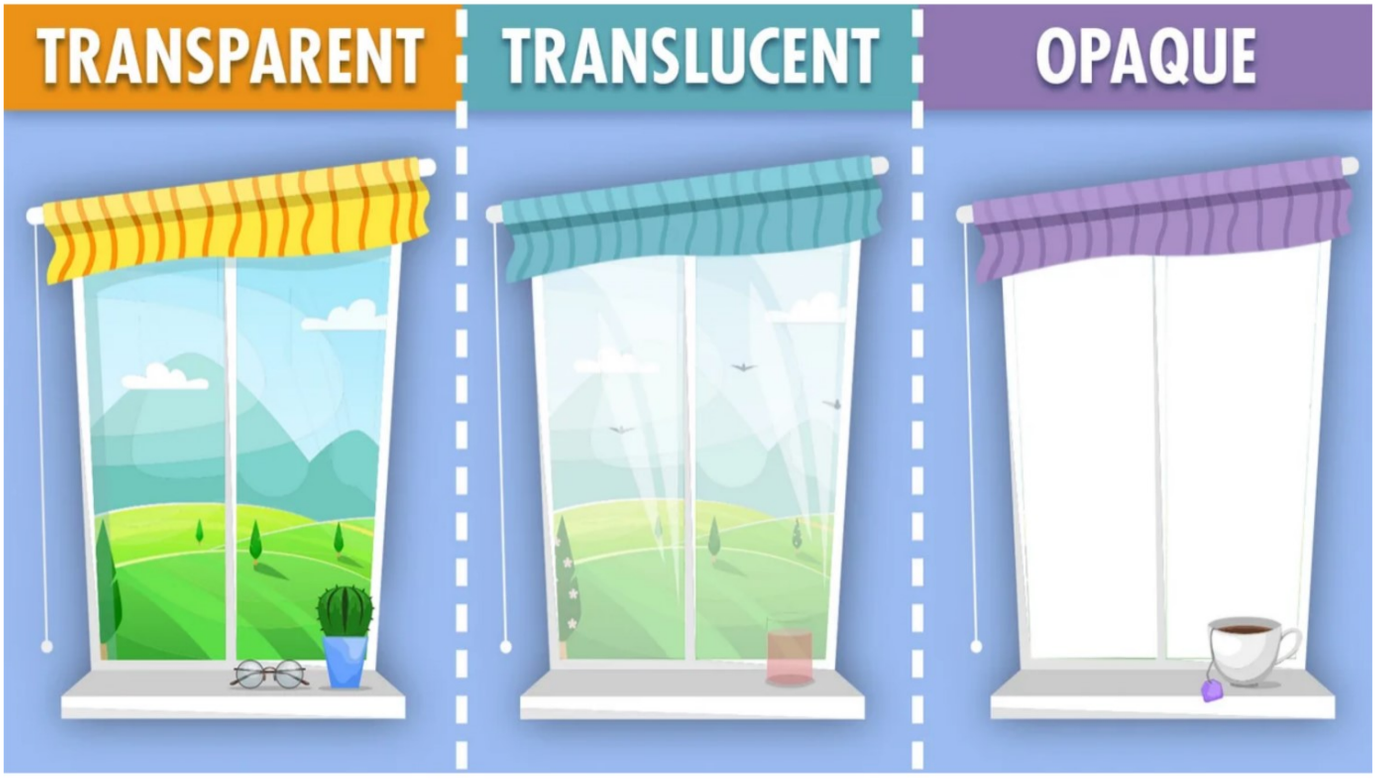
"does NOT allow light to pass through. Cannot see through"

Example) The brick wall

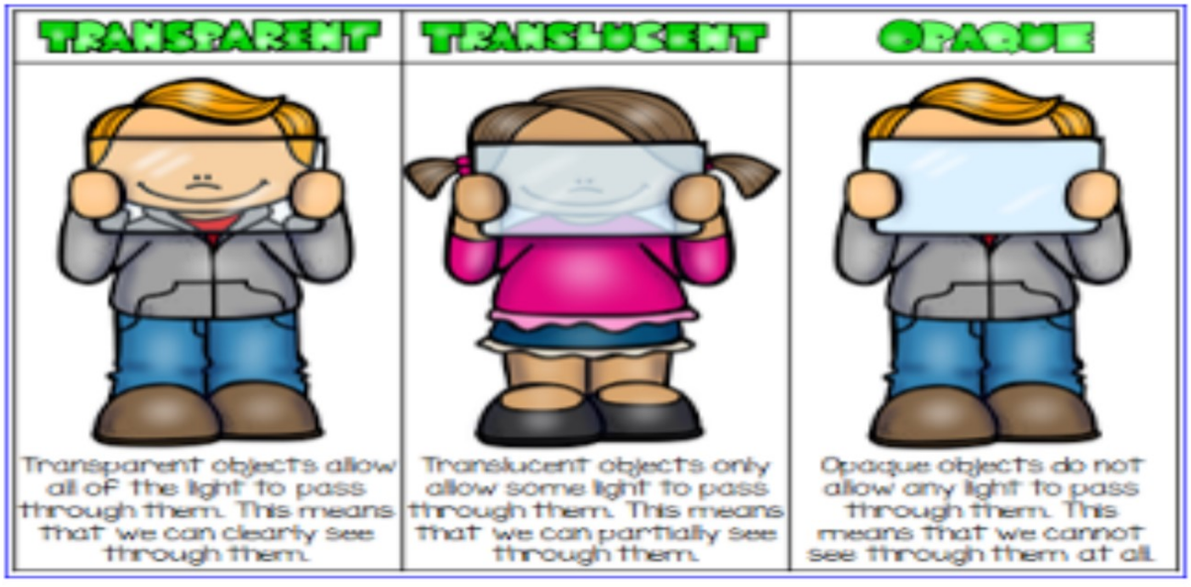



Transparent, Translucent, Opaque. OKay ??
Transparent
All light passes through.
Translucent
Some light passes through.
Opaque
No light passes through.

Transparent Translucent Opaque (WITH EXAMPLES) (youtube.com)



ADLC - Elementary Science: Translucent, Transparent, Opaque (youtube.com)



What Is the Electromagnetic Spectrum?

Have you ever gone outside after a rain shower and noticed a rainbow in the sky? Maybe you have had an x-ray to see if you had broken a bone. More than likely you have at least watched the television or used a cell phone. What do these all have in common? Well they all involve the electromagnetic spectrum.

The electromagnetic spectrum is a diagram that charts electromagnetic waves.

Electromagnetic waves are waves that can travel through the emptiness of space, at the speed of light.

Seven types of electromagnetic waves are:

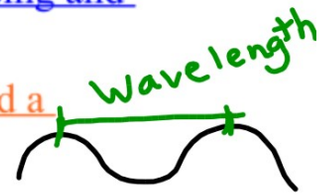
1) radio waves 2) microwaves 3) infrared waves, 4) visible light waves, 5) ultraviolet waves, 6) x-rays 7) gamma rays.

The Electromagnetic Spectrum (youtube.com)

Wavelengths

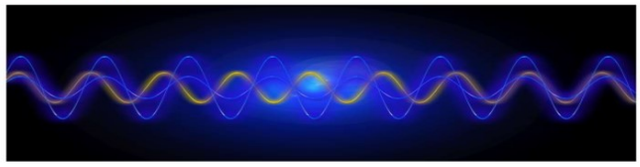
The electromagnetic spectrum takes all the electromagnetic waves and lines them up based on their wavelengths. So what is a wavelength? If you have ever been to the beach and watched the water move, you have seen a wavelength. Electromagnetic waves move similarly to the rising and falling of water waves.

From the top of one wave to the top of the next wave is called a **wavelength.**



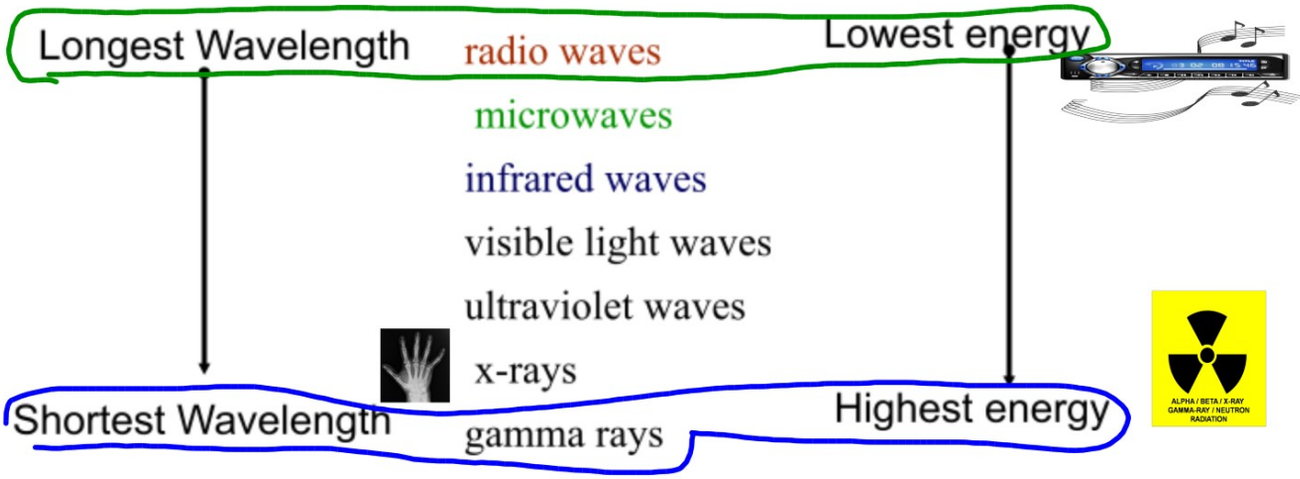
If the wavelength is long, you will experience less waves.

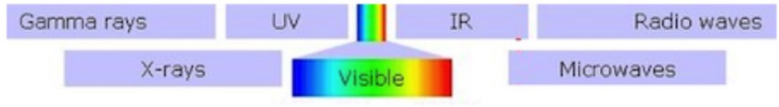
If the wavelength is short or closer together, you will experience more waves. ✗

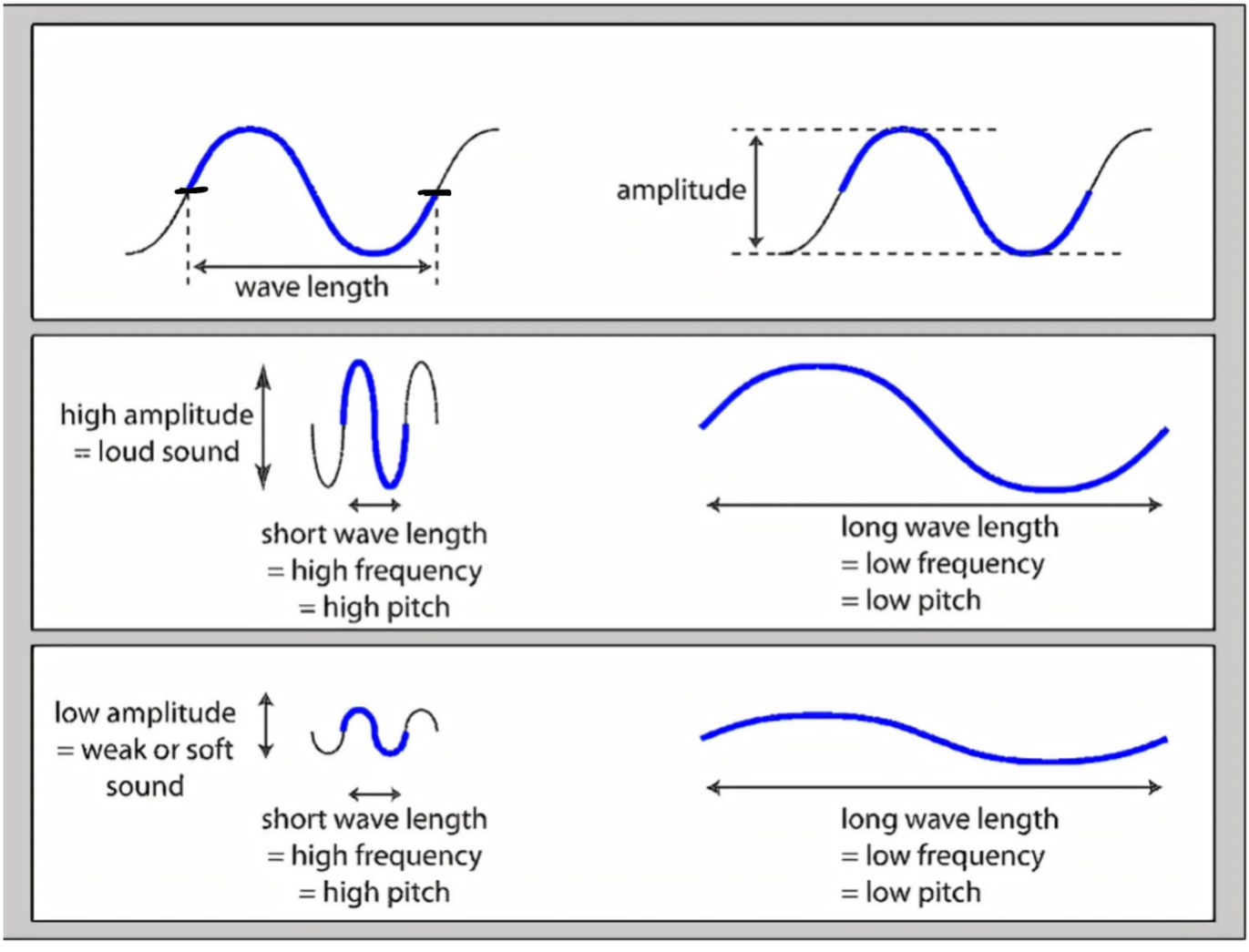


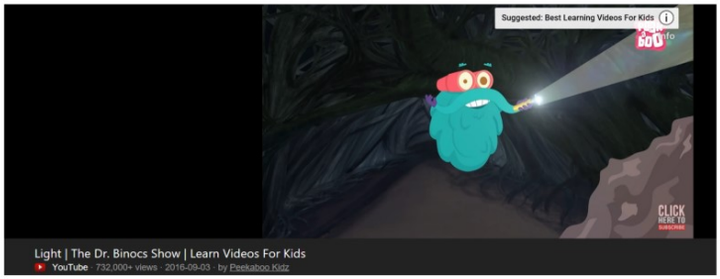
The electromagnetic spectrum is set up based on wavelengths.

The order is:






wave length
amplitude
high amplitude
= loud sound
short wave length
= high frequency
= high pitch
long wave length
= low frequency
= low pitch
low amplitude
= weak or soft
sound
short wave length
= high frequency
= high pitch
long wave length
= low frequency
= low pitch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Light | The Dr. Binocs Show | Learn Videos For Kids
YouTube · 732,000+ views · 2016-09-03 · by Peekaboo Kidz

Light - is the form of energy that you can see and the reason why we can see objects around us. Light travels in straight lines.

Natural light sources are:

1) The Sun is a star with the most abundant and the least expensive in the world

2) Flames or Sparks from Fire

emit means "gives off"

The sun and other stars emit light in all directions using waves or rays (similar to spokes on a bicycle). This is known as **radiation**. The sun produces its energy using a process called Nuclear Fusion Energy such as light that travels by radiation, like the sun, is known as **radiant energy.**

Since we do not always have the light from the sun, we have developed **artificial light sources** Examples: light bulb, flashlight

Interesting fact - less than 0.0000001% of the suns energy actually reaches the earth

Light: Crash Course Astronomy #24 - YouTube

Properties of Light

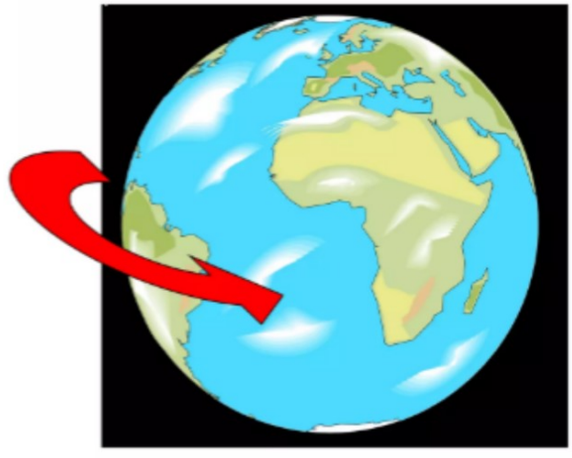
1) Light travels in straight lines:

2) • Light travels VERY FAST – around 300,000 kilometres per second.

1. the speed of light = 299,792,458 meters / second

How to measure the speed of light - with CHOCOLATE! | Do Try This At Home | We The Curious - YouTube

At this speed it can go around the world 7.5 times in one second.



still under 2

- Light travels much faster than sound. For example:

Visualizing the Speed of Light and Speed of Sound (youtube.com)

Thunder and lightning start at the same time, but we will see the lightning first.

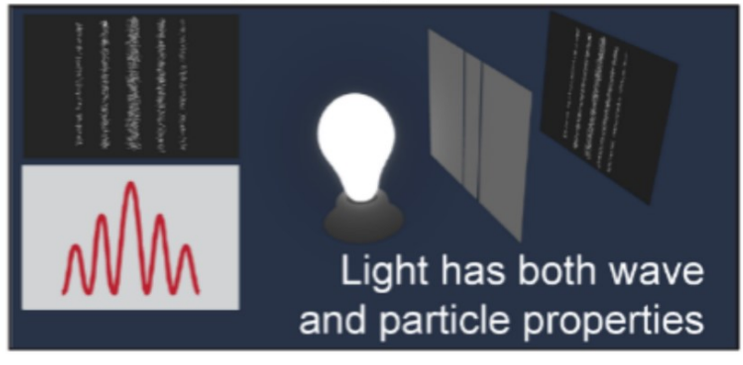
2\ When a starting pistol is fired we see the smoke first and then hear the bang.

3. Light Has a Dual Nature

NOTES

https://www.youtube.com/watch?v=J1yIApZtLos

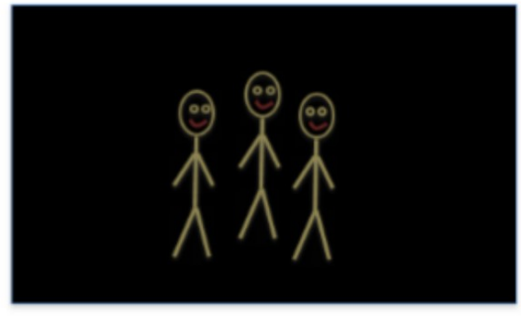
Light can behave as waves, or as particles called photons.

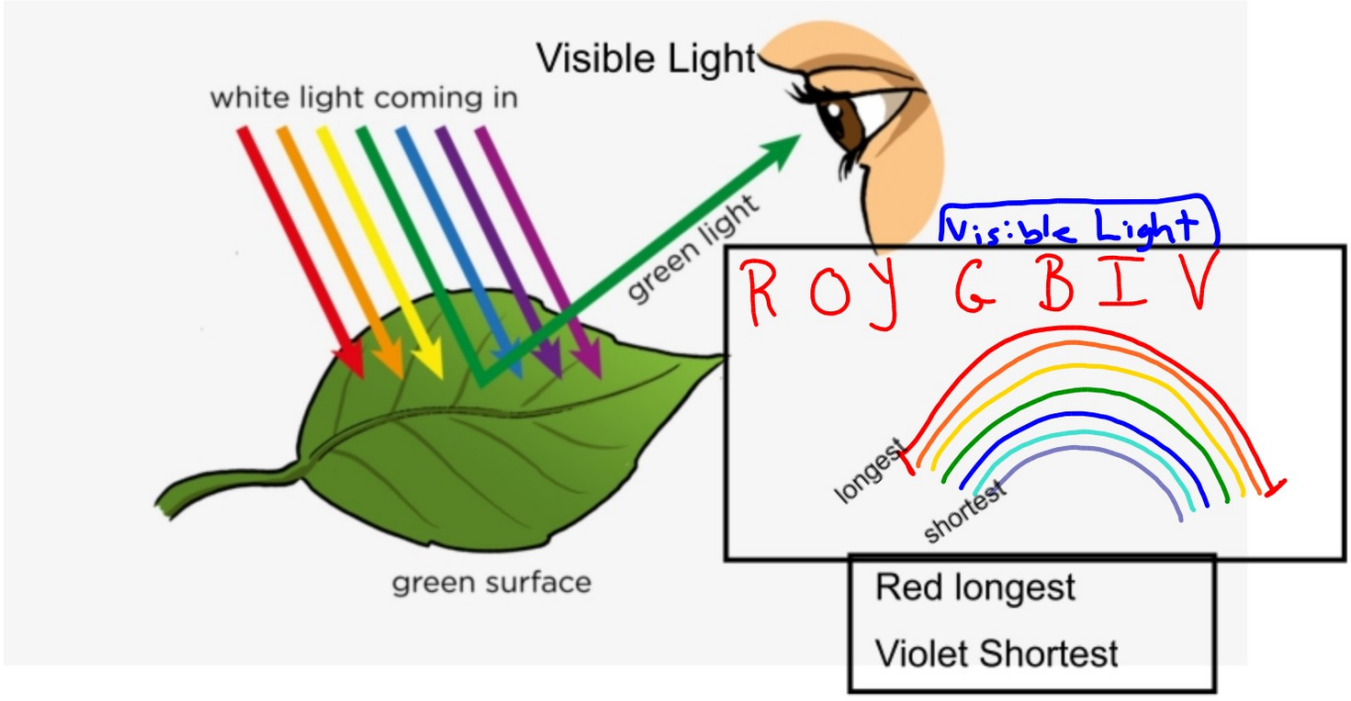


https://www.youtube.com/watch?v=IRBfpBPELmE&t=52s

If you were in a *perfectly dark* room with your best friends, could you see them?

What if you stayed in there for a *really* long time?




Visible Light
white light coming in
green light
green surface
Visible Light
R O Y G B I V
longest
shortest
Red longest
Violet Shortest

All sources of light require energy. A light bulb uses electricity, flash light uses batteries and a match used chemicals. Light from the Sun is formed through a process called **nuclear fusion**.

How Does Fusion Power the Sun? - YouTube

Testing Space Lasers for Deep Space Optical Communications (Mission Overview) (youtube.com)

emember light is a form of energy. When light is absorbed by a rface, it can be transformed into one of the following:

1) **Thermal Energy**- energy that comes from heat

ex) black sweater absorbing the sun

2) **Chemical Energy** - energy stored in the bonds of chemical compounds (atoms and molecules)

ex) trees absorbing sunlight to make sugars

ex) glow sticks

3) **Electrical Energy** - uses electrons and conductors to produce the electricity we use in our houses

4) **Solar Energy** - Solar cells change light to electricity

Intensity is the brightness of a light. This indicate how much energy a surface will receive.

Ex) Pavement on a bright sunny day will be hotter than pavement on cloudy day.

Hot Clear day

Cloudy Day

Ex) Compare reading a book right next to a lamp at night time, to trying to read it 3 m away from it. How does increasing the distance from the lamp affect the intensity of the light striking the book's pages?

4. Light Varies in Intensity

NOTES

The intensity of light is a measure of its brightness.

$$I = \frac{P}{A}$$

Intensity is defined as power P per unit area A.

Its units are watts per square meter (W/m^2).

The intensity of light from a source depends on how close you are to it.

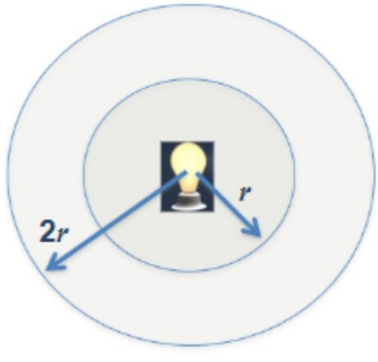
- When you are close to the source, the light is more intense.
- When you are far from the source, the light is less intense.

Light from this bulb spreads out in every direction.

•At radius r, it passes through surface area $A_1 = 4\pi r^2$.

•At radius $2r$, it passes through surface area $A_2 = 4\pi (2r)^2 = 16\ \pi r^2$

The same amount of light is spread over 4 times the surface area.



5. Light Interacts with Matter

NOTES

Light can change speed and direction when it interacts with matter.

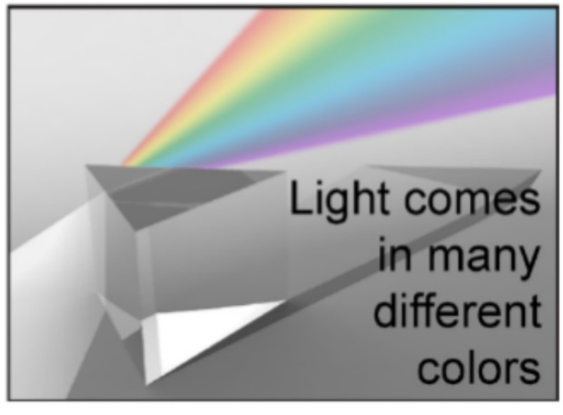
Light reflects off shinny mirrors BUT

refracts if passes through water

6. Light is Comprised of Many Colors

NOTES

White light is composed of many colors. It can be *dispersed* (separated) using a prism.



Sources of Light

There are many different sources of light:

1) **Incandescent sources** - is when an object can be heated to such a high temperature that it gives off visible light.

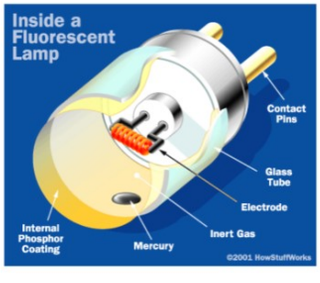
Pathway: Electrical → Thermal → visible

Ex) A regular Light bulb, candle flames

2) **Fluorescent Sources** - High energy,driven through a tube and the mercury inside will give off ultraviolet (UV) light **immediately**.

Pathway: Ultraviolet → Energy absorbed by particles → visible

Ex) Black Light, Lights in classroom (long tubes)



Example) Fluorescent light in school. An electrical current from the lead in wires and electrodes cause the mercury vapor inside the tube to give off ultraviolet radiation. A phosphor coating on the inside of the tube absorbs the UV energy.This causes the coating to glow, thus producing light that you can see.

Fluorescent Advantage over Incandescent

- no thermal energy involved so less heat/ energy lost (Energy efficient)

- bulbs are cool to touch

Fluorescent Disadvantage over Incandescent

- expensive

- mercury & phosphorus are toxic thus making them harder to dispose of

Sources of Light continued

3) **Phosphorescent sources** - is when light particles are absorbed then released later as light.

Pathway: Ultraviolet → Energy absorbed by particles → visible

Ex) glow in the dark stickers

4) **Chemiluminescent sources** - chemical reactions that release energy

Pathway: Chemical → visible

How Do Glowsticks Work?

Ex) glow sticks

In a glow stick you have breakable barrier that separates two liquid. Bending the stick causes the barrier to break thus mixing the two liquids to cause a chemical reaction that relaes light.

5) **Bioluminescent sources** - unusual source but it is used by sea animals that usual live deep in the ocean where the sunlight does not reach. Jelly fish use this source of light energy.

Pathway: Chemical → visible

Why Is (Almost) All Bioluminescence in the Ocean? (youtube.com)

Ex) Jelly Fish

Énergie NB Power

Lighting Measurement

Watt - is a measure of electrical power

- equivalent to 1 Joule per second

1 W = 1 J/s

- Kilowatt is 1000 W

NB Power Charges about
14 cents/KW h

Rates (nbpower.com)

actual $0.1385 /KWh

Reflecting on Reflection

Luminous - are objects that emit their own light

Ex) Sun

Non-Luminous - are objects that do not produce their own light.

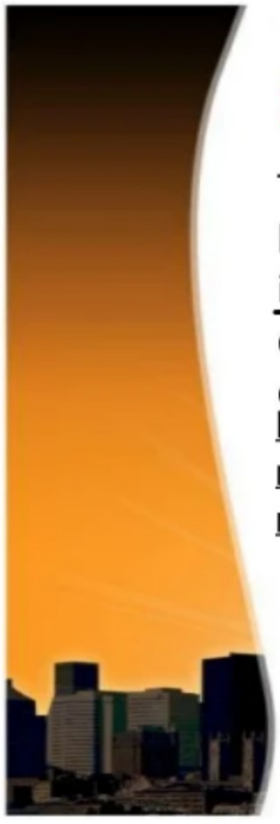
- Can only be seen when light from a luminous source strikes the object and then reflect off the object into your eyes.

Ex) Moon, Books How Does The Moon Shine? | How Moon Shines ? (youtube.com)

Reflection - occurs when light bounces off an object

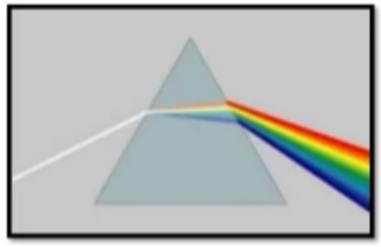
When a room is poorly lit, you see less because less light is reflecting

All the light that hits an object is not all reflected, some is absorbed by the object. Dark objects tend to absorb most of the light, where as light objects reflect the more light. Ex) Dark clothes in the summer VS. Light color clothes



Dispersion

The process in which light is separated into its colors due to the differences in degrees of refraction.



Dispersion is how rainbows are made.

How are rainbows formed?

The Magic School Bus - Makes a Rainbow - Ep. 33

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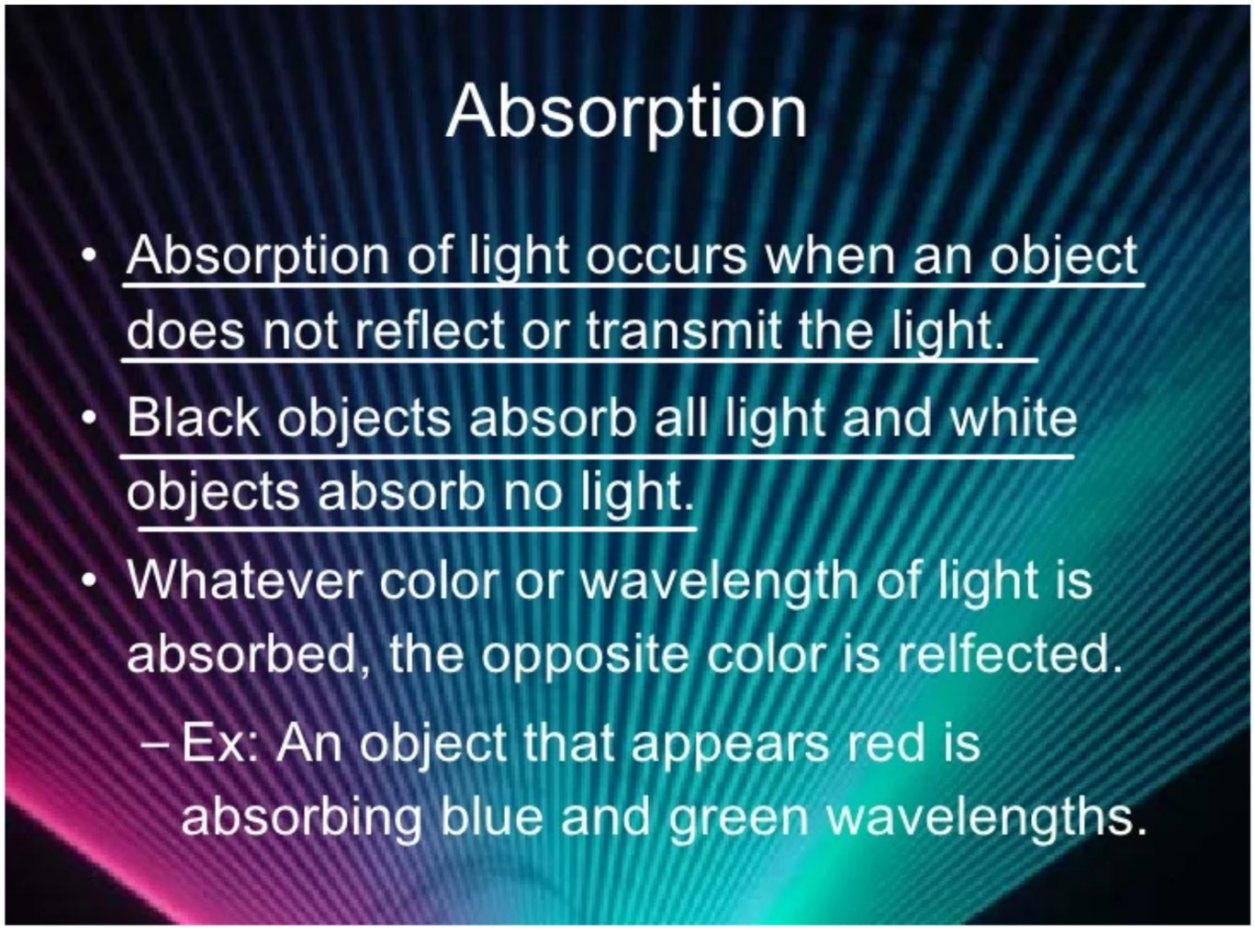
When Light is TRANSMITTED

- Reflection occurs because there is no transmission of light (light is not able to pass through to the new material)
- However, when light is transmitted different things can happen. Light can be:
  - Refracted
  - Polarized
  - Scattered

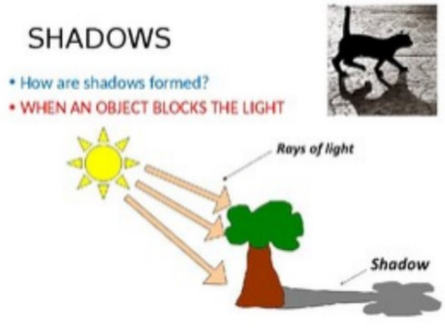

Absorption
• Absorption of light occurs when an object does not reflect or transmit the light.
• Black objects absorb all light and white objects absorb no light.
• Whatever color or wavelength of light is absorbed, the opposite color is relfected.
– Ex: An object that appears red is absorbing blue and green wavelengths.

February 2nd is Groundhog Day! As the tradition goes, if a groundhog emerges from its burrow and sees its shadow, spring is still 6 weeks off; if the groundhog doesn't see his shadow, it means warmer weather is on its way.

Have you ever wondered what causes shadows? Or how a shadow might change shape depending on the time of day or time of year? Look around you now; If you are in a lighted space, chances are you will see a shadow because shadows are all around us.

Shadows -the absence of light. Light is a form of energy that travels in a straight line until it hits an object. If the object blocks the light from passing through it, that creates an area of darkness–a shadow–on the other side.

LEAKED! Hilarious Shadow Puppets - AGT 2023 Early Release (youtube.com)



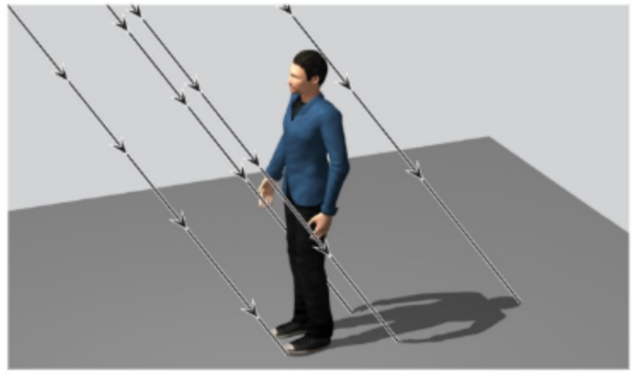
Shadow Ace Full Performance | America's Got Talent 2023 Semi Finals Week 4

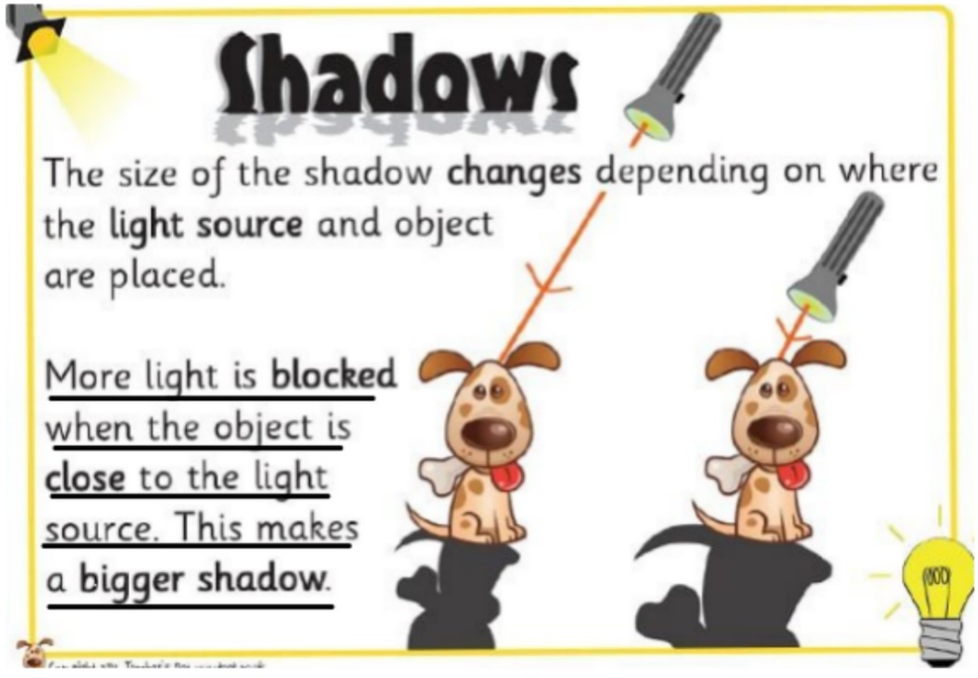
35 Cool Examples of Shadow Art || BiSmile - YouTube

Shadow Ace WOWS the judges with amazing hand shadows! | AGT: Fantasy League 2024 (youtube.com)

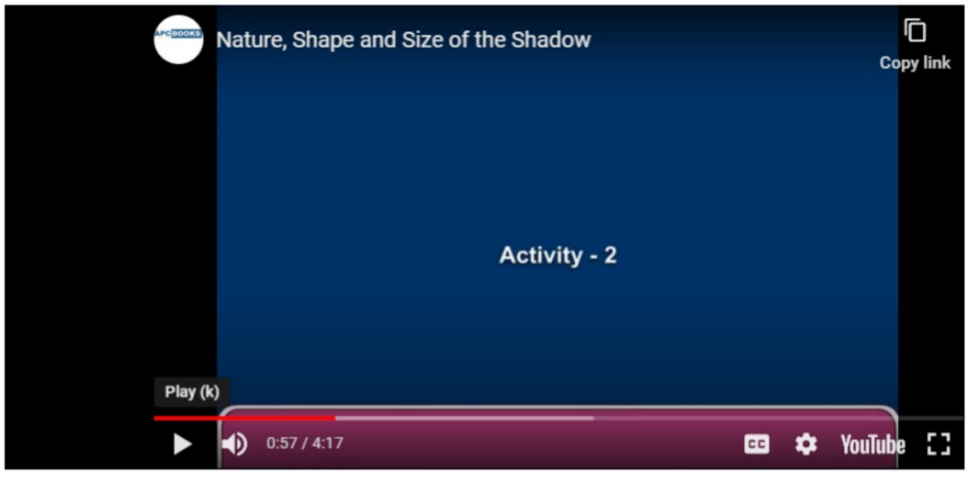
Light rays **are represented as straight paths.**

When they are blocked by solid objects, shadows are formed.




Shadows
The size of the shadow changes depending on where the light source and object are placed.
More light is blocked when the object is close to the light source. This makes a bigger shadow.

Shape and size of a shadow depends on the angle at which light falls on the object, distance between the source of light and the object and also on the distance between the object and the screen. Shape and size of a shadow does not depend on the colour of the object.



Nature, Shape and Size of the Shadow

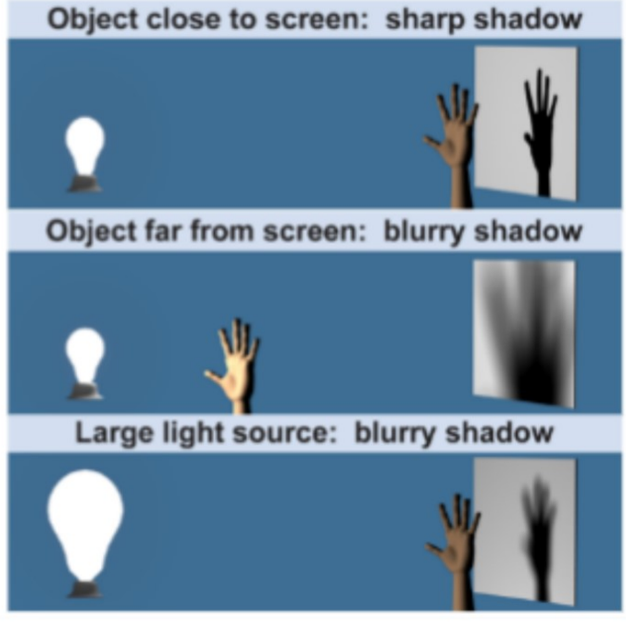
YouTube · 2.2K views · Jan. 16, 2017 · by APC BOOKS

Shadows vary

Objects close to the screen form sharp shadows.

Object far from the screen form blurry shadows.

Objects in front of large light sources form blurry shadows.



Light sources and shadows

There are many sources of light but the biggest one is our SUN! Have you noticed how easy it is to see shadows outdoors on a bright sunny day? And how in contrast, shadows tend to be soft and harder to see on cloudy days? This is because shadows are sharper when the light source is intense and focussed.

The angle at which a light strikes an object also affects the size and shape of its shadow.

An object blocks more light when the light is at a lower angle (side on) making longer shadows;

when the light source is at a higher angle (overhead) the shadows are shorter.

You can see this for yourself if you stand outside at mid-day when the sun is high in the sky. Notice the size and shape of your shadow. Now stand outside in the same place in the late afternoon when the sun appears on the horizon.

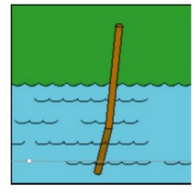
The lower the sun, the longer the shadow

Because the sun is lower in the sky during the winter, shadows at a given particular time of day are longer in the winter than in the summer. And contrarily, because the sun is higher in the summer, you have more short shadows during the day.

What happens when light shines in water?

When swimming in a pool you may have tried to dive down a grap a toy from the bottom. As you reach the object was not where you expected it to be.

Refraction - is the bending of light as it travels from one medium to another. Light bends because it changes speed when it moves between materials with different densities. Light usually travels more slowly in comparatively dense materials. The bending of light makes the objects image appear to be in a different position from where the object really is.



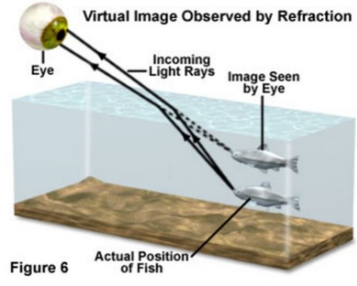
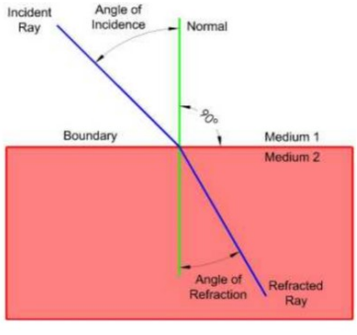


Figure 6



Angle of Refraction - in optics the angle between the normal and the refracted ray