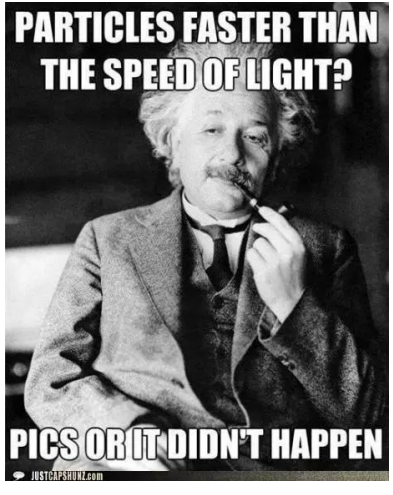
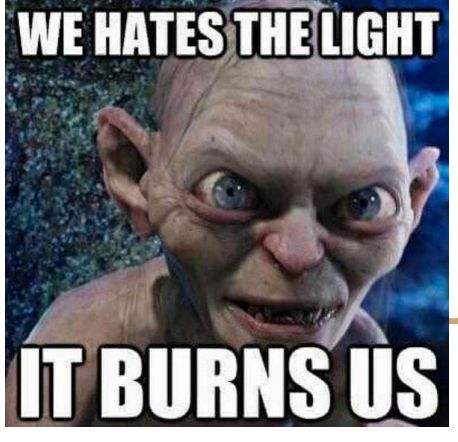
Unit 4
Light and Optics

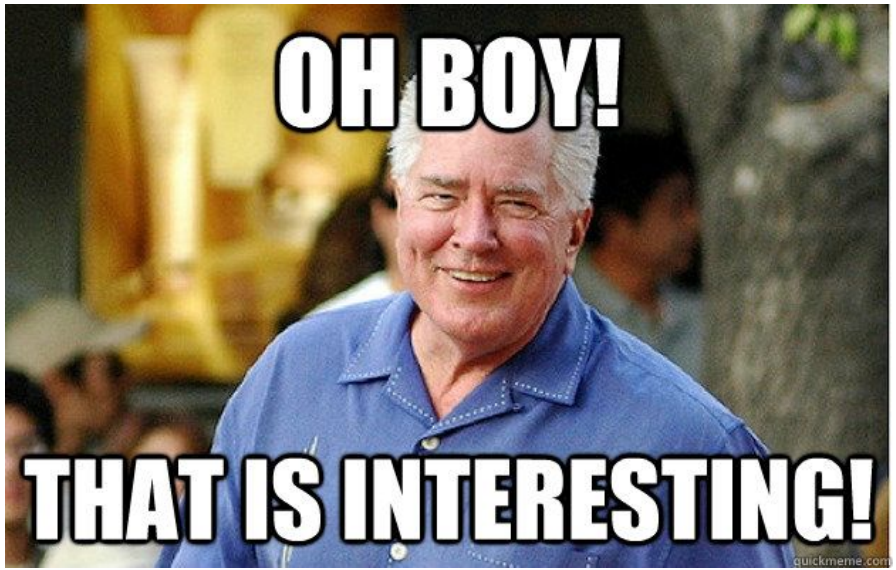




The four properties of light

Because of research through the years we now know that light has four main properties;

1. Light travels in straight lines
2. Light can be reflected
3. Light can bend
4. Light is a form of energy

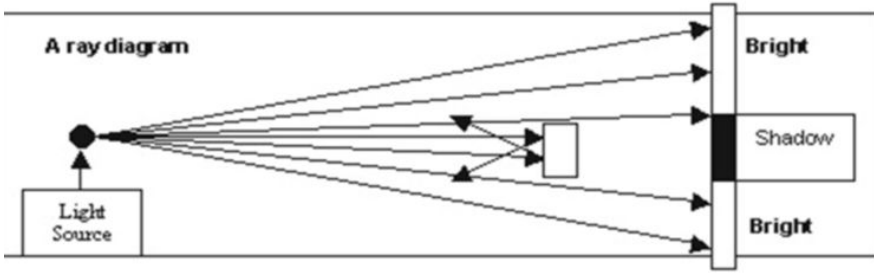


Light travels in straight lines

A ray is as a narrow beam of light that tends to travel in a straight line.

Because of this principle, the ray model of light can help to explain certain properties of light.

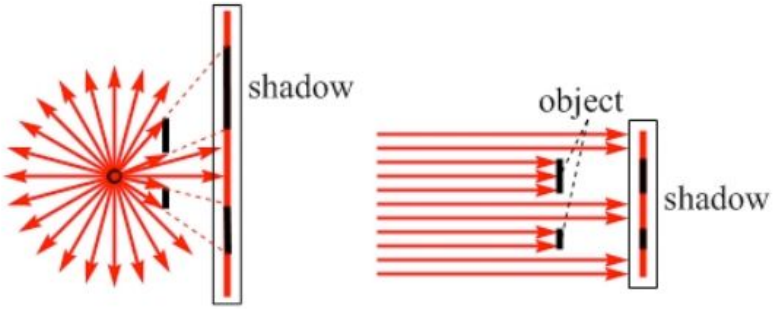
Ray diagrams can help to demonstrate brightness or intensity of light through changes in distance.



Shadows

The ray model helps to explain how shadows can be formed when an object blocks the ray of light.

When the light source is a point source, the shadow is generally larger than the object casting the shadow. When the light rays are all going in the same direction, however, the shadow is the same size of the object when the shadow is cast on a surface that is perpendicular to the light rays.



Properties of light

Light travels in straight lines until it strikes a surface. The type of surface the light hits will determine how the light continues. A surface may be;

1. Transparent
2. Translucent
3. Opaque

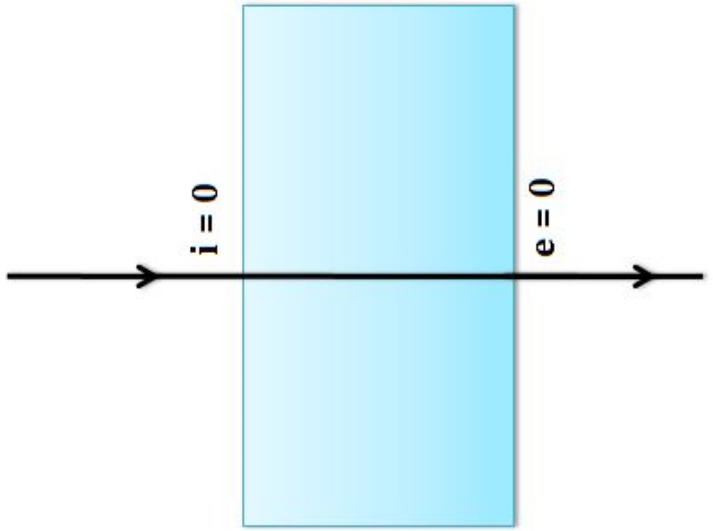
Paper Bag Activity

Groups of 2-3
Organize the contents of the bag in any way you choose.

Transparent

If a surface is transparent, light passes through it nearly or wholly undiffused, so that one can see clearly the details of whatever is on the other side.

Ordinary glass windows and clear plastic are transparent.



Translucent

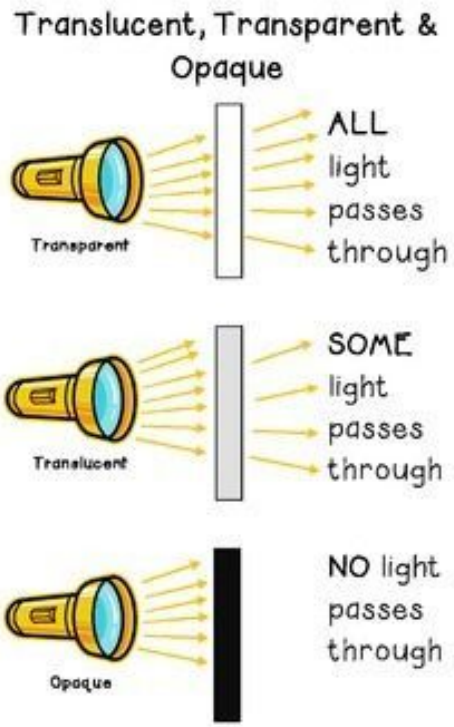
If a surface is translucent, light passes through but is diffused so that one cannot see clearly the details of whatever is on the other side.

Frosted glass, and wax paper are examples of translucent materials.

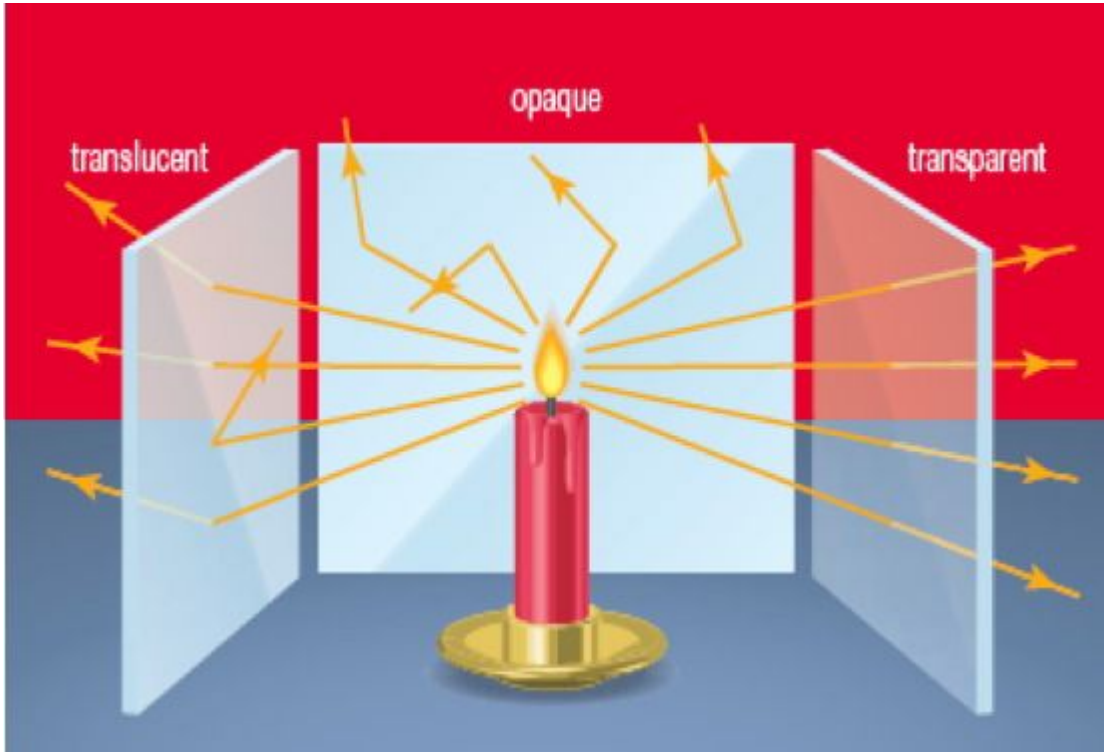
Opaque

A surface that permits no light to pass through it is opaque. You cannot see anything through an opaque object.

A door, or brick wall are example of opaque objects



Transparent, Translucent and Opaque



Transparent, translucent or opaque?

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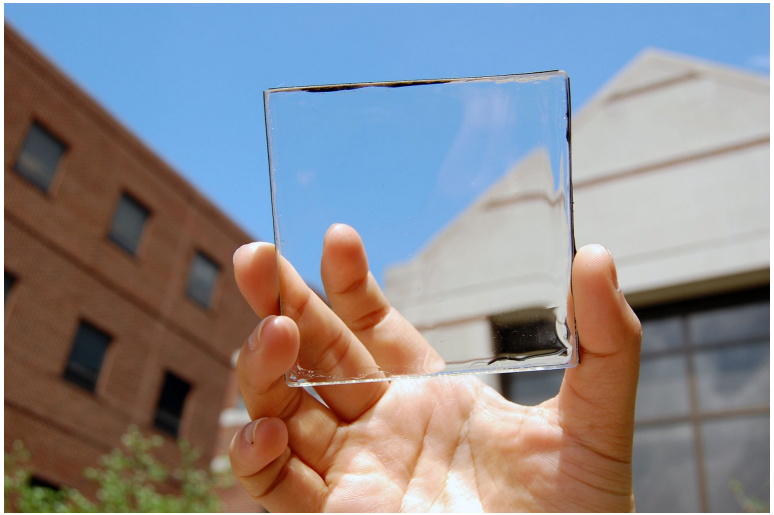


Transparent, translucent or opaque?

Transparent, translucent or opaque?

Why is glass transparent?

Review

a) What is an example of a transparent object?

b) What does the ray diagram look like for an opaque object?

c) How does a ray of light travel?

Light can be reflected

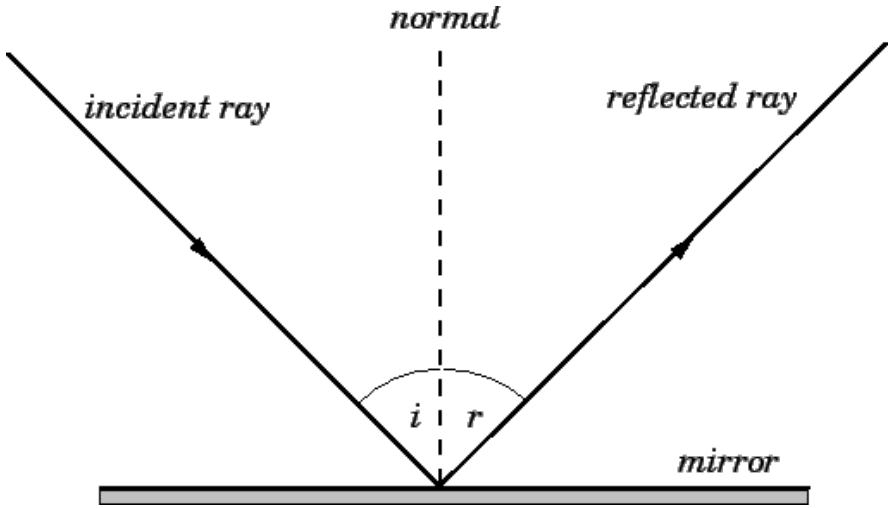
Reflection is the process in which light strikes a surface and bounces back off that surface. How it bounces off the surface depends on the Law of Reflection and the type of surface it hits.

Light coming from a light source is called an incident ray and the light that bounces off the surface is called a reflected ray.

Law of reflection

The law of reflection states that when the incident ray, the normal line and the reflected ray all lie in the same plane;

The angle of incidence equals the angle of reflection.



Types of reflection

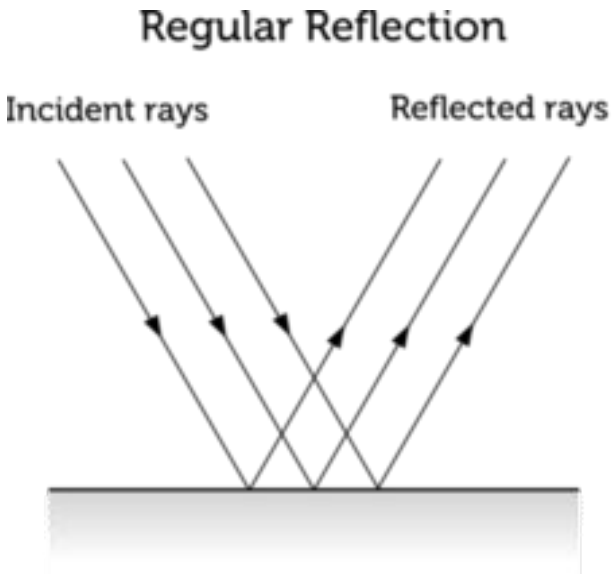
The law of reflection holds true for both types of reflection. The two types of reflection are;

1) Regular reflection
2) Diffuse reflection

Regular reflection

Regular reflection occurs when light hits a smooth surface.

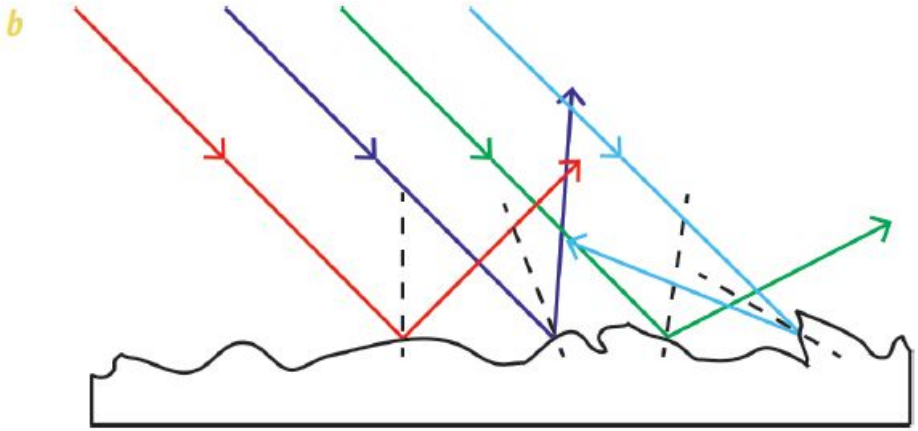
In regular reflection beams are reflected at the same angle. When your eye detects the reflected beams, you can see a reflection on the surface.



Diffuse reflection

Diffuse reflection occurs when light hits a rough or uneven surface. Because of the rough surface, each of the rays of light are reflected at a different angle and the light is scattered in many directions.

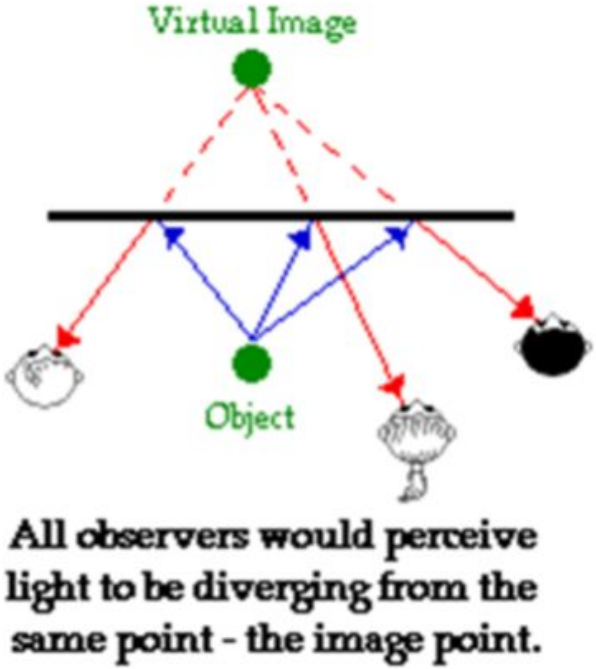
In diffuse reflection you can see the object from any position.



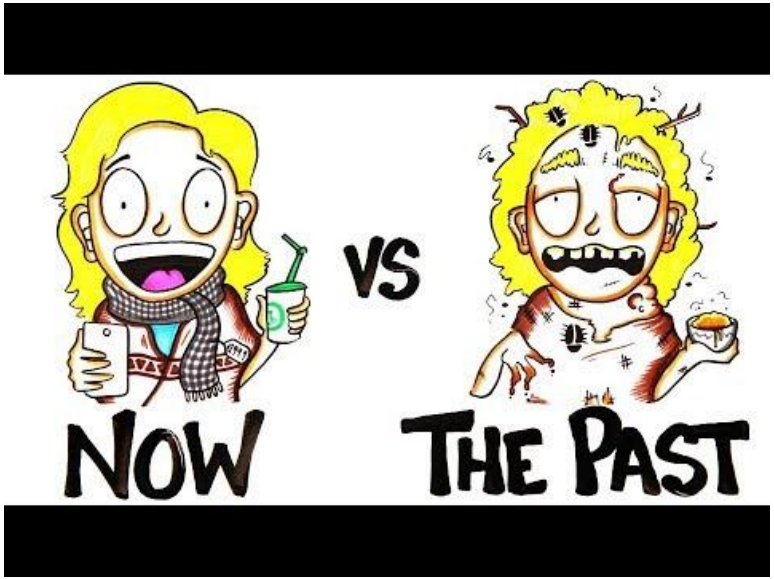
Reflections

An image is formed in a mirror because light reflects off of all points on the object being observed, in all directions.

The rays that reach your eye appear to be coming from a point behind the mirror. Because your brain knows that light travels in a straight line, it interprets the pattern of light that reaches your eye as an image of an object you are looking at.



Would your life have been better in the past?

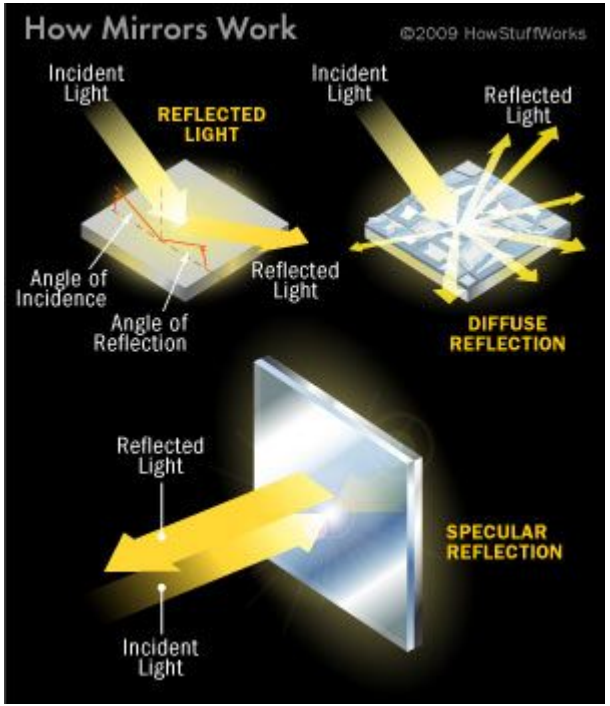


Review!

a) What are the two types of reflections?

b) What do we know about the angles of incidence and reflection?

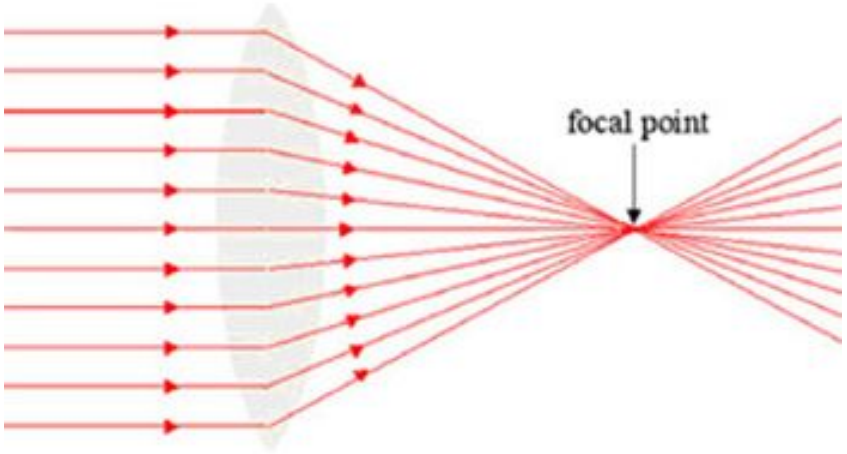
c) What is a ray?



Focal Point

A focal point is the point at which rays or waves meet after reflection or refraction, or the point from which diverging rays or waves appear to proceed.

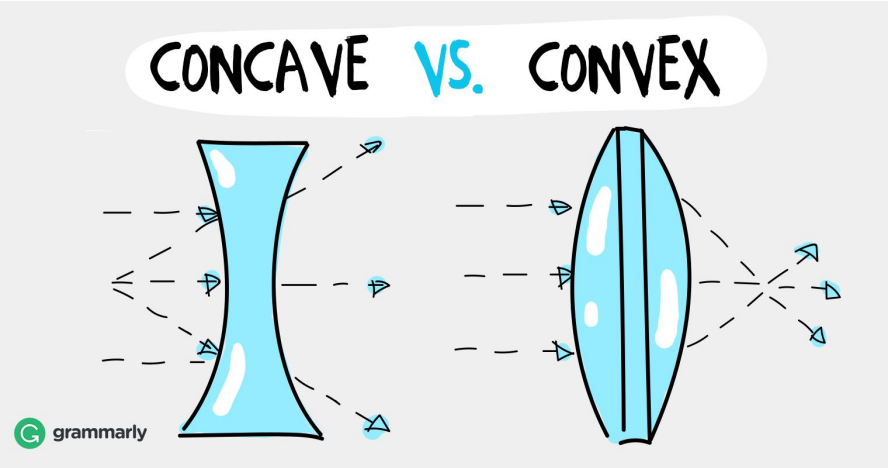
In other terms the focal point is the point that all rays head to.



Concave and Convex

A mirror or lens that is curved inwards, is referred to as concave.

A mirror or lens that is curved outwards, so that it bows outwards is referred to as convex.

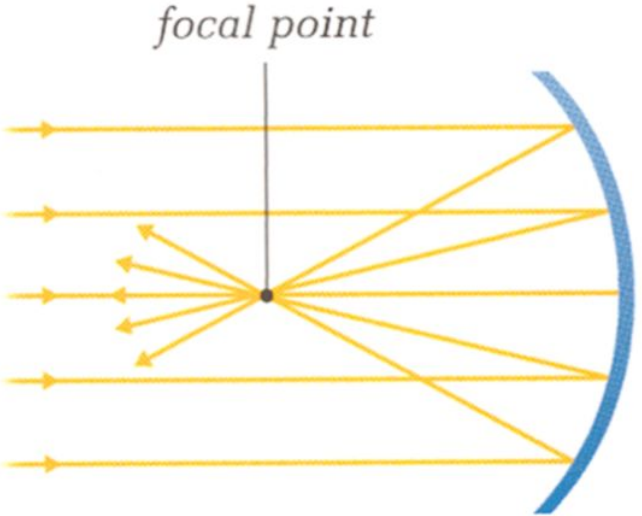


Concave Mirrors

Because concave mirrors are indented, reflected light rays travel towards each other or converge.

The distance from a concave mirror and how curved it is determines how light is reflected.

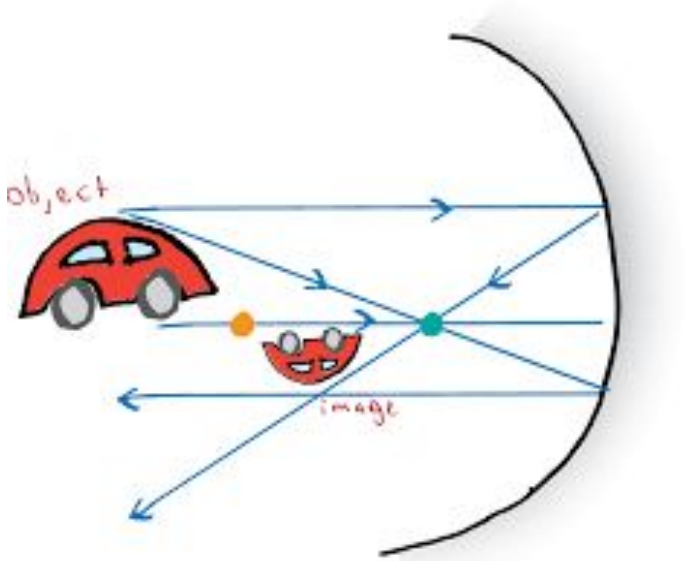
If an object is placed exactly on the focal point it will appear to have no image.



Concave Reflections

If an object's image is being reflected and the object itself is outside of the focal point, the image appears to be upside down and smaller.

If the object is between the mirror and the focal point, the image will appear to be right side up and bigger.

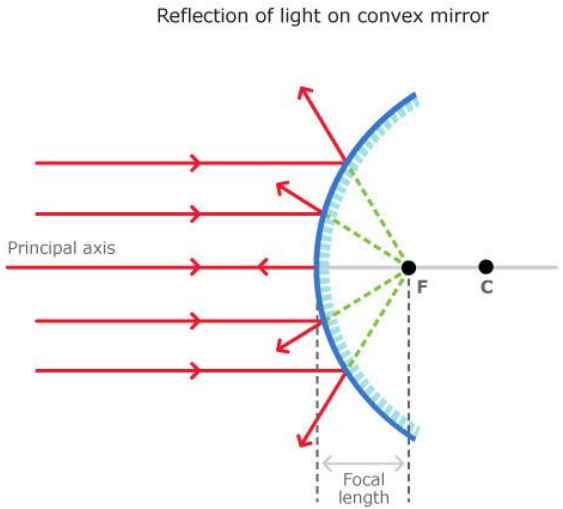


Convex Mirrors

Convex mirrors are bowed outward and spread light out when it is reflected.

Light reflected off of a convex mirror will never reach a focal point.

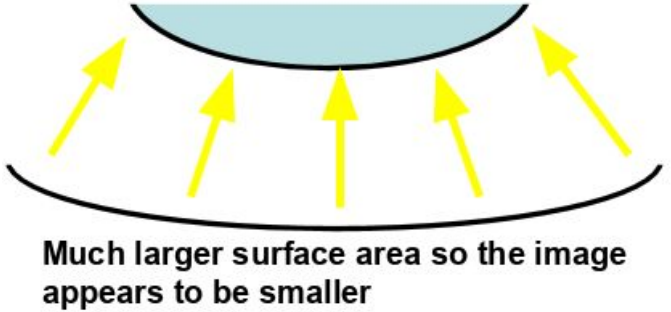
An imaginary focal point behind the convex mirror will determine how spread out the light is when it is reflected. This is all based on how flat or fat the mirror is.

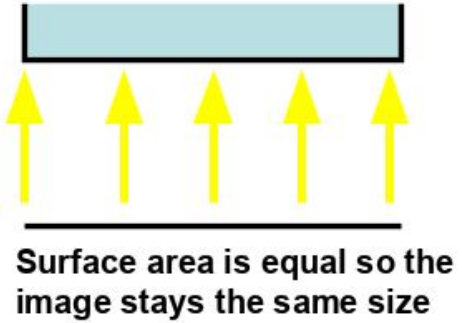


Convex Reflections

The images in convex mirrors always appear to be smaller than they actually are. This is because a convex mirror gathers light from an area much larger than the mirror itself.

In a flat mirror with a same sized reflection the surface area is equal so the image stays the same size.

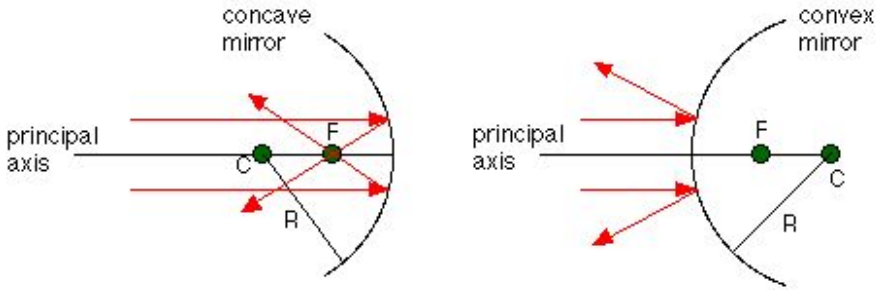




The Law of Reflection

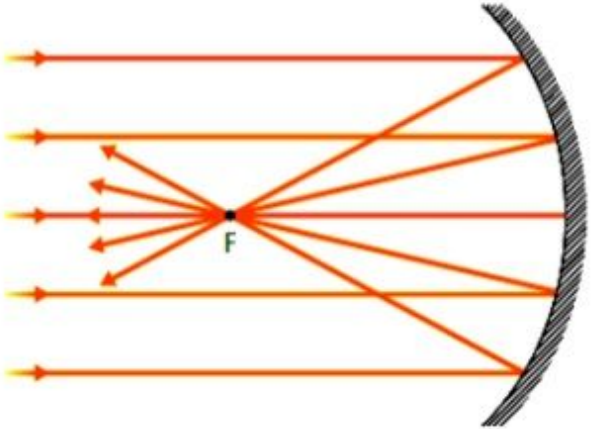
Concave and convex mirrors still obey the law of reflection because the angle of reflection is still equal to the angle of incidence.

Due to the bend in the mirror the angle of incidence for one ray of light will be different from the angle of incidence for the next.



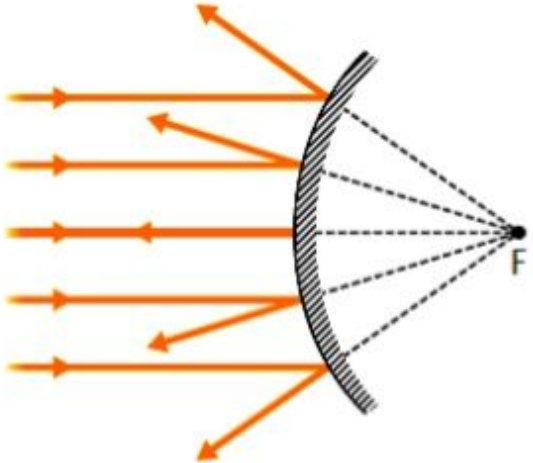
Curved Mirrors

Concave



"converging" mirror

Convex



"diverging" mirror

Should we build a Mars Base?

Review!

a) What is the difference between concave and convex?

b) What is a focal point?

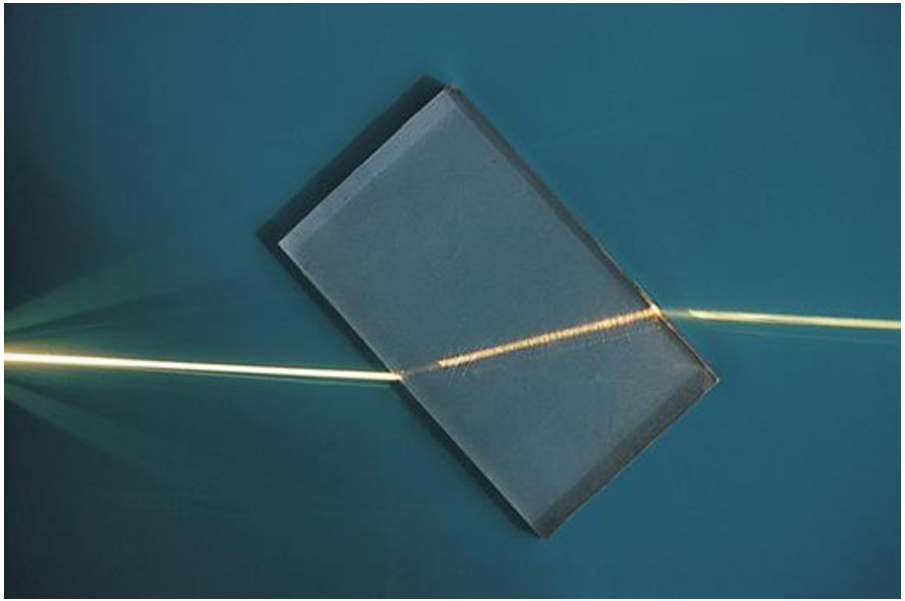
c) Do concave and convex mirrors follow the law of reflection?

Refraction

Refraction is the bending of a wave of light when it travels from one medium to another.

Refraction occurs when light is slowed down within a denser material.

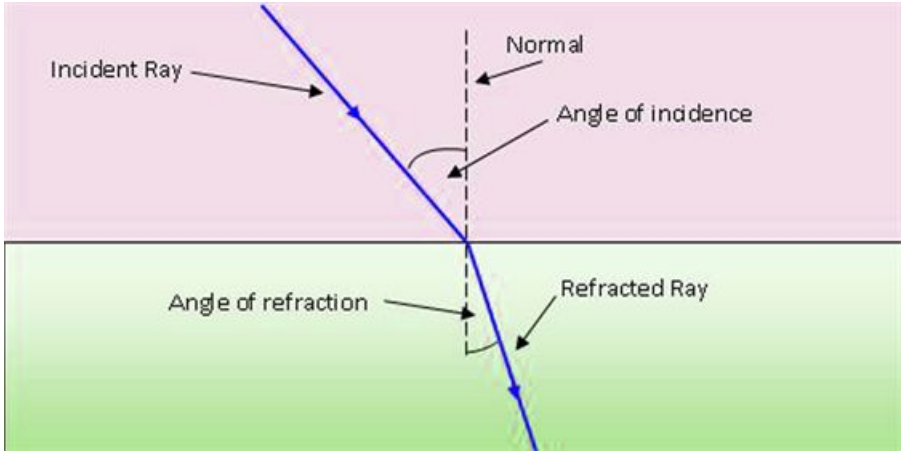
For example, when light travels from air into water, it slows down, causing it to continue to travel at a different angle or direction.



Refraction

A refracted ray is the second ray that travels in a different direction than the incident ray.

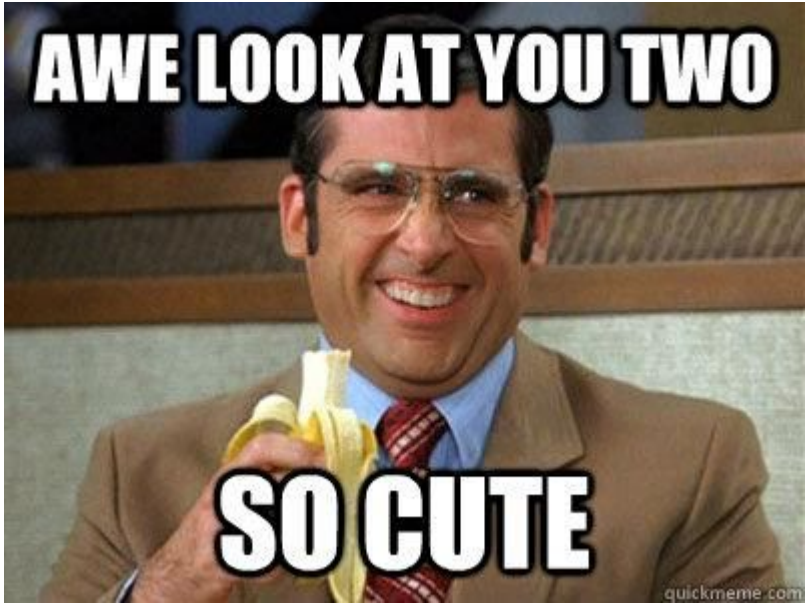
The angle of refraction is the angle between the normal and the refracted ray.



Refraction

When refracting the amount of bending depends on two things;

1) Change in speed
2) Angle of incident ray

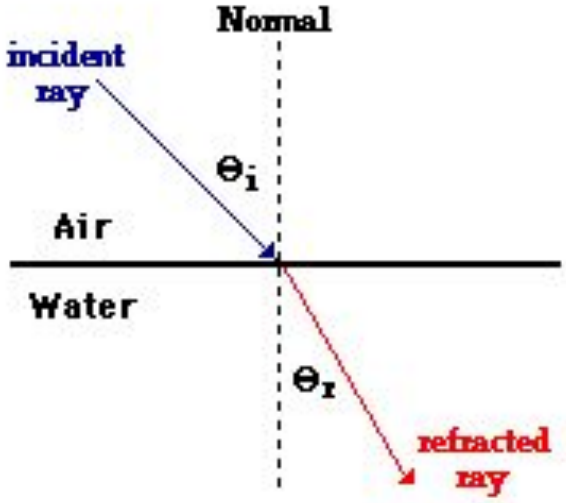


Change in Speed

If a substance causes the light to speed up or slow down more, it will refract or bend more.

If light enters any substance with a higher refractive index it slows down. The light then bends toward the normal line.

If light enters into a substance with a lower refractive index it speeds up. The light then bends away from the normal line.



Angle of Incidence

If light is entering a substance at a greater angle, the amount of refraction will be more noticeable.

If light is entering a new substance from a straight line, the light will still slow down, but will not change direction at all.

Refraction Constants

Substance	Refractive index	Speed of light in substance (x 1,000,000 m/s)	Angle of refraction if incident ray enters substance at 20°
Air	1.00	300	20
Water	1.33	226	14.9
Glass	1.5	200	13.2
Diamond	2.4	125	8.2

Is Makeup Bad for You?

Review!

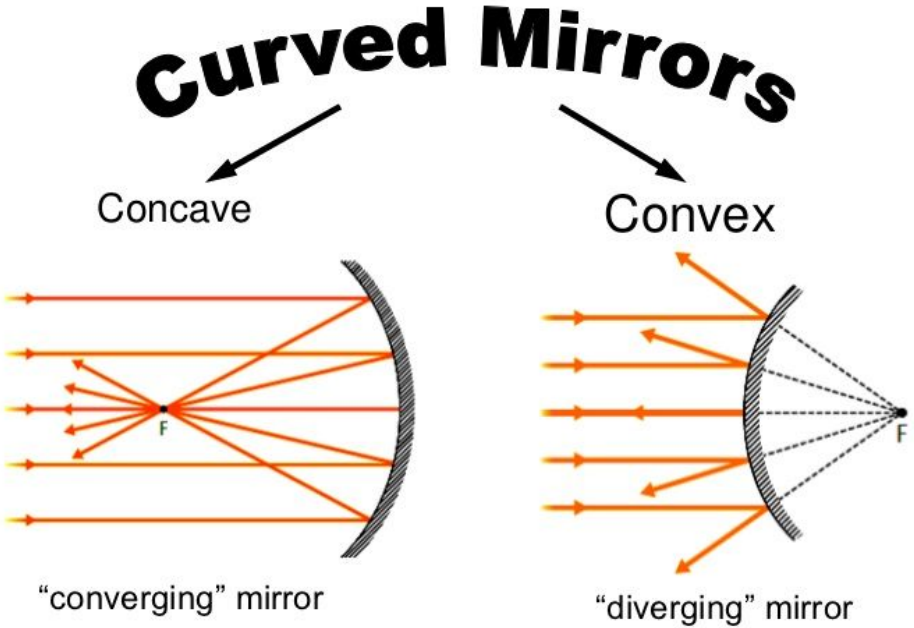
a) What is refraction?

b) What is the law of reflection?

c) What is the difference between concave and convex?

#CatCanHelp

Remember!


Curved Mirrors
Concave
Convex
F
F
“converging” mirror
“diverging” mirror

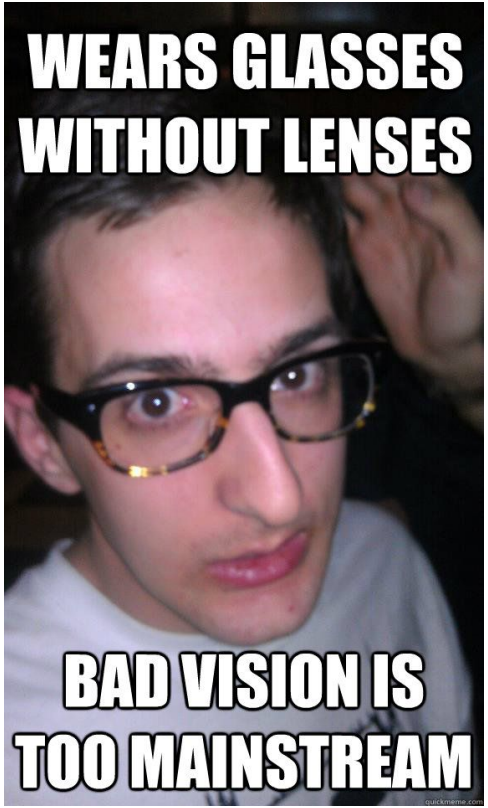
Lenses

Lenses are curved pieces of transparent material that refract light in a predictable way.

Lenses are generally made from glass or plastic.

There are two types of lenses;

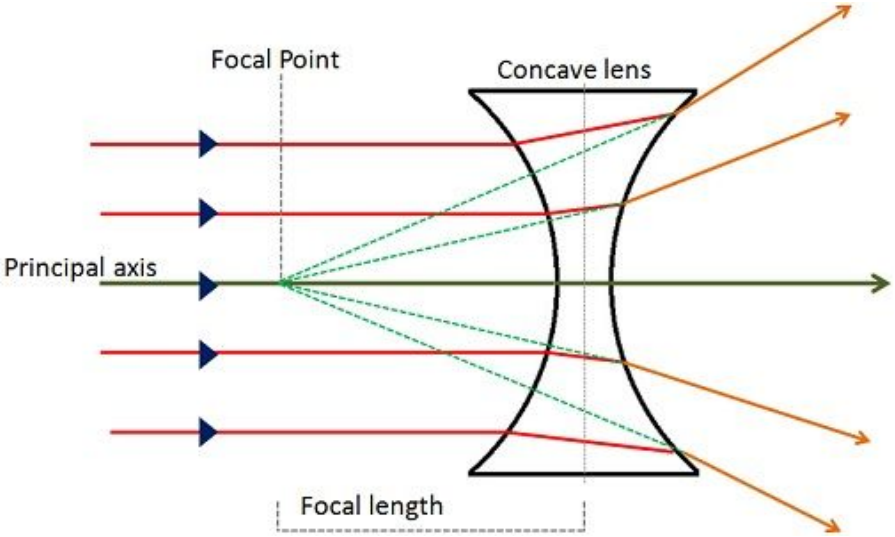
Concave and convex.



Concave Lenses

Concave lenses are indented lenses that refract parallel rays away from each other.

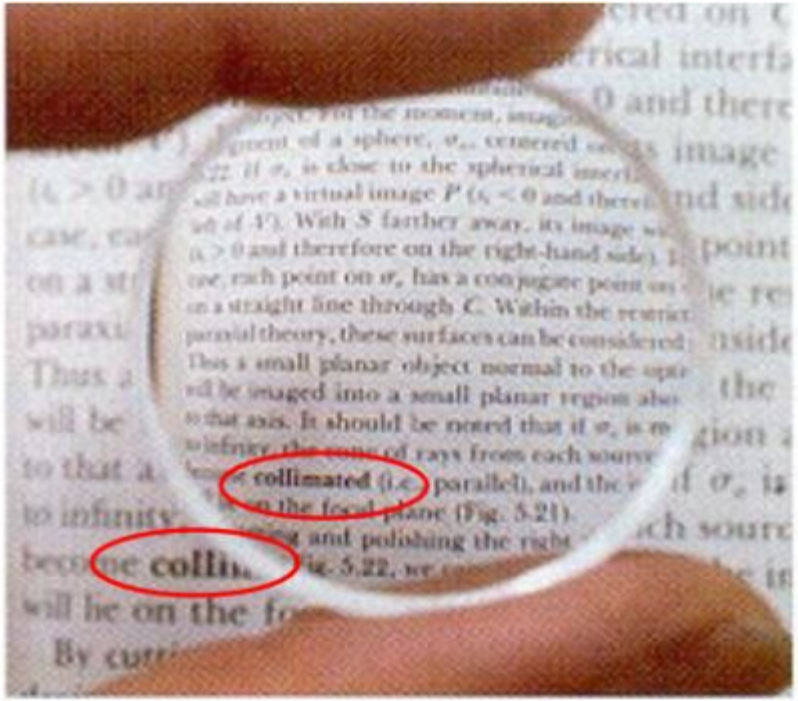
The stronger the curve on the lens the more spread out the beams of light will become.



Fun Fact!

Concave lenses can be used to de-magnify objects.

Because of this concave lenses are used in glasses that correct nearsightedness.

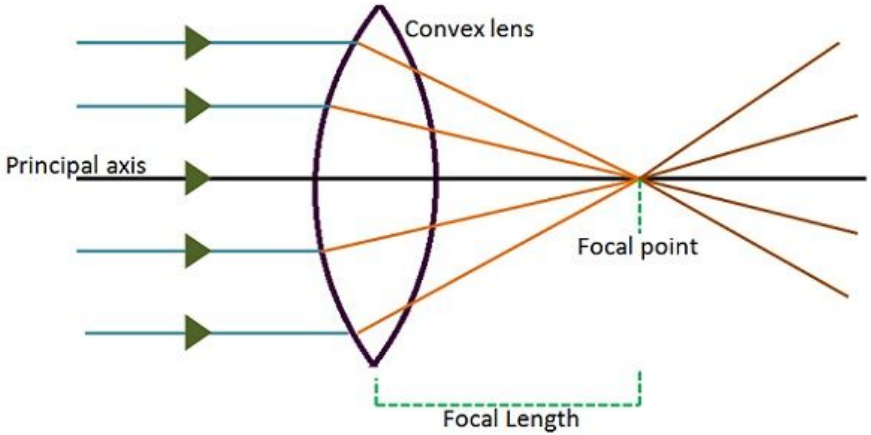


Convex Lenses

Convex lenses are bowed outward and concentrate light to a focal point.

The distance of the focal point from the lens depends on how fat or flat the lens is.

The greater the curvature of the lens the closer the focal point.



Fun Fact!

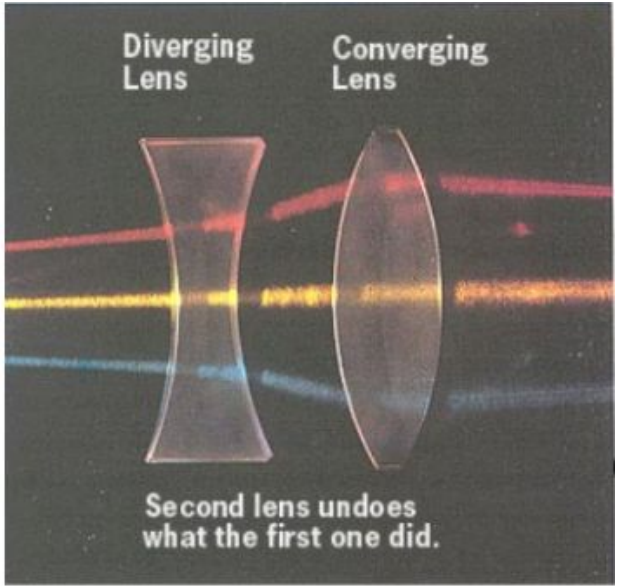
Convex lenses are used as magnifiers.

Because of the ability to focus light to a focal point, convex lenses are used in glasses that correct farsightedness.

Counter Productive

By doubling up the two different types of lenses, we can undo the refraction of light.

To do this however, the curvature for each lens has to be precisely the same in order for the light to be straightened back out.



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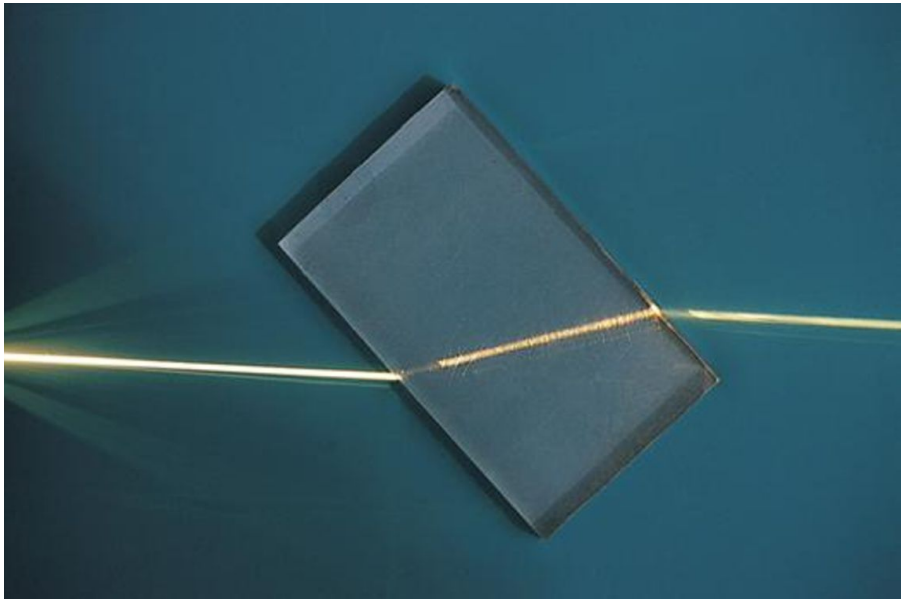

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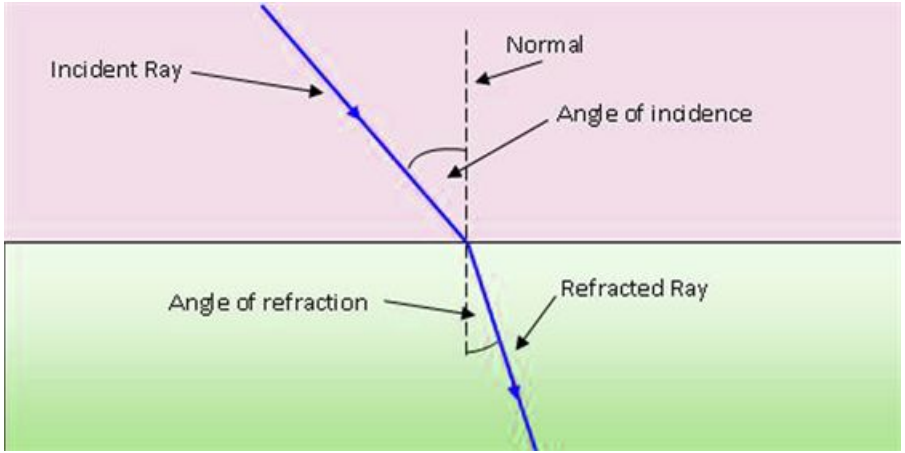

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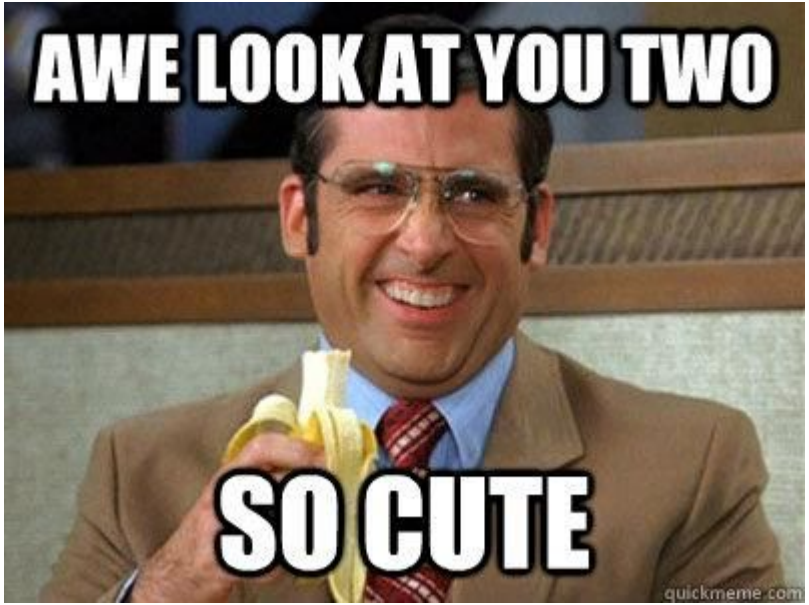

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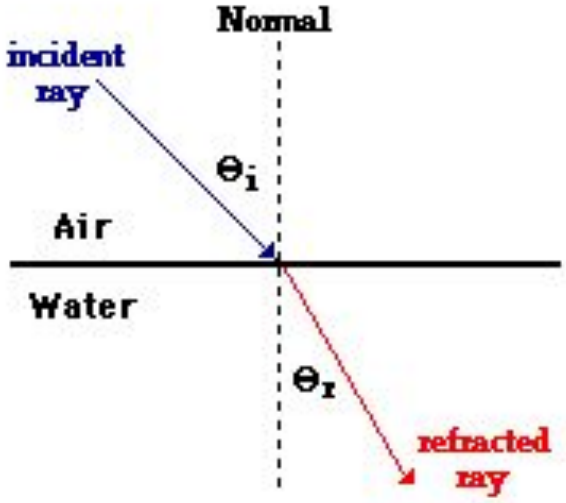

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b) What is the law of reflection?

c) What is the difference between concave and convex?

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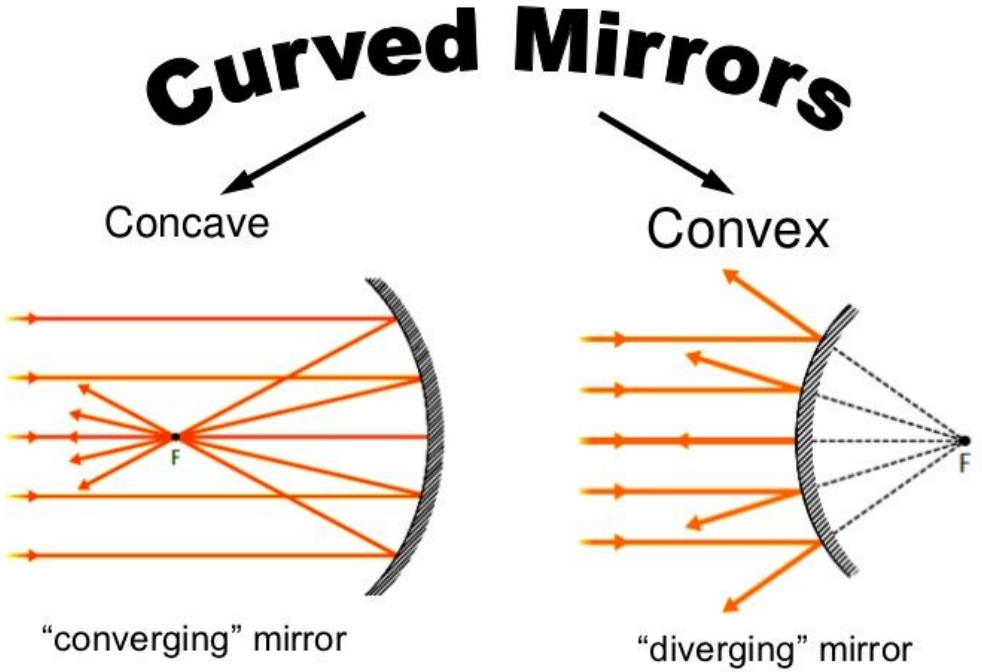
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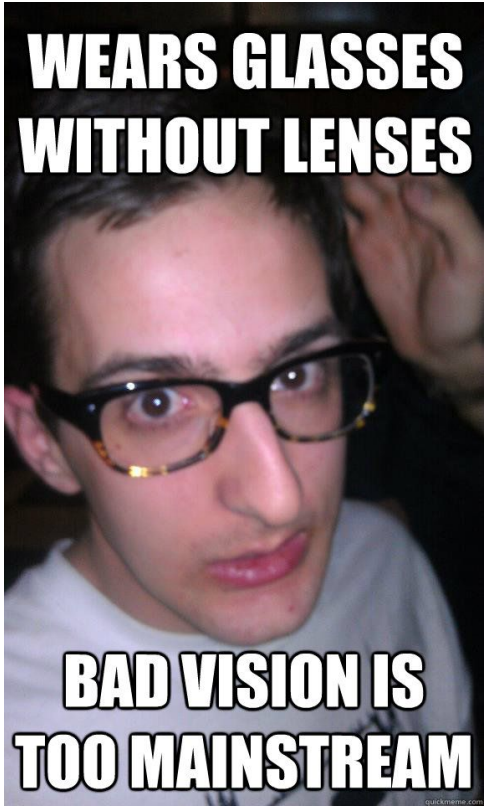

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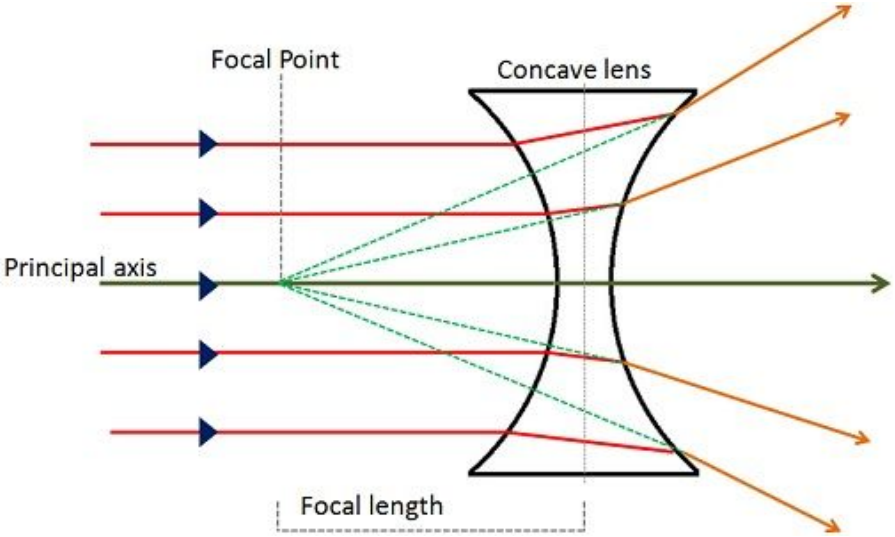
Concave lenses are indented lenses that refract parallel rays away from each other.

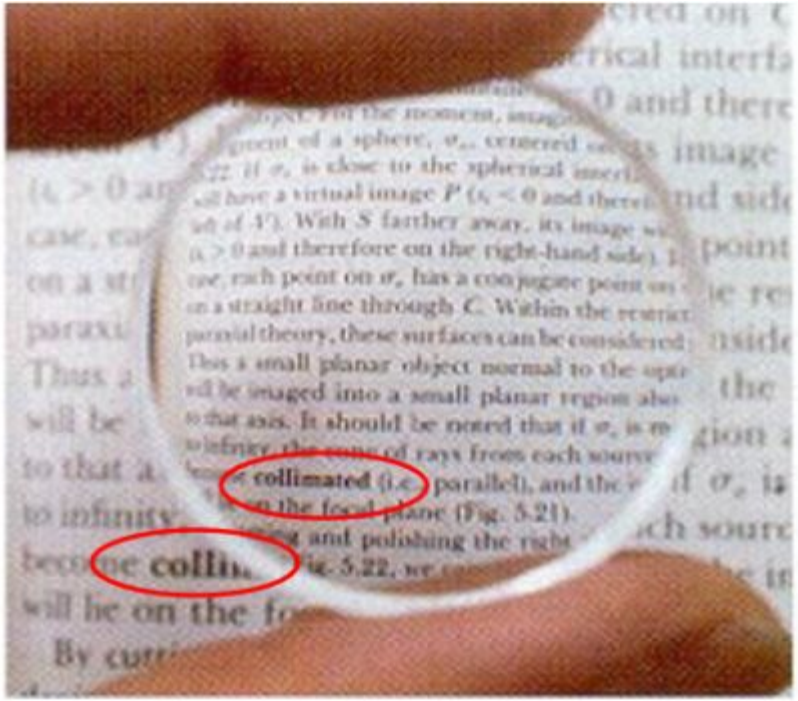
The stronger the curve on the lens the more spread out the beams of light will become.



Fun Fact!

Concave lenses can be used to de-magnify objects.

Because of this concave lenses are used in glasses that correct nearsightedness.

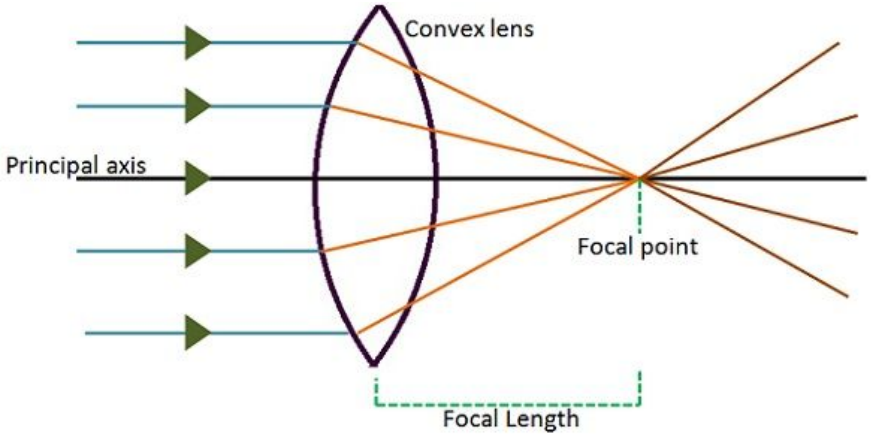


Convex Lenses

Convex lenses are bowed outward and concentrate light to a focal point.

The distance of the focal point from the lens depends on how fat or flat the lens is.

The greater the curvature of the lens the closer the focal point.



Fun Fact!

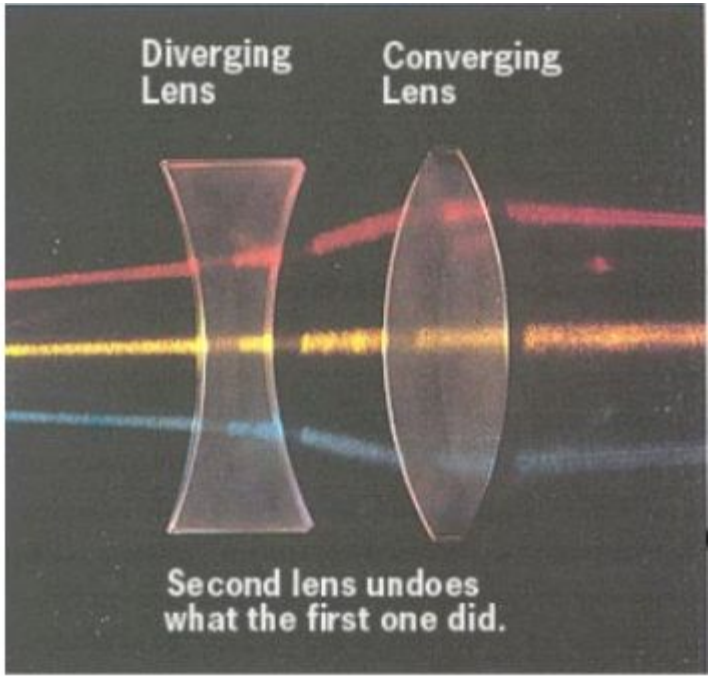
Convex lenses are used as magnifiers.

Because of the ability to focus light to a focal point, convex lenses are used in glasses that correct farsightedness.

Counter Productive

By doubling up the two different types of lenses, we can undo the refraction of light.

To do this however, the curvature for each lens has to be precisely the same in order for the light to be straightened back out.



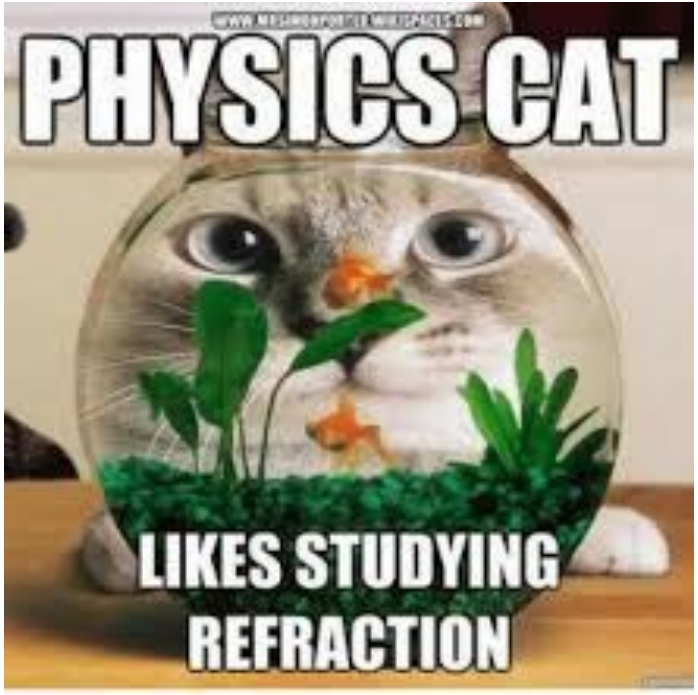
What is part of a balanced breakfast?

Review!

a) What is the difference between concave and convex lenses?

b) What is refraction?

c) What are the four properties of light?



Light is a Form of Energy

Light is a form of electromagnetic radiation. Light consists of photons which are produced when an object's atoms heat up.

Because light is not a particle, it can travel through a vacuum. This fact was fundamental in discovering that light is a wave.

Fun Fact!

Unlike sound, light does not need a medium to travel through.

Light travels the fastest through a vacuum at a speed of 300,000,000 m/s.

Fun Fact part 2 - Electric Boogaloo

If the sun were to blow up, life on Earth would certainly end. But it would take approximately eight minutes and twenty seconds before we could theoretically see no light.

The Wave Model of Light

The wave model of light is used to explain the characteristics and behaviour of light energy; it describes light as energy in the form of waves.

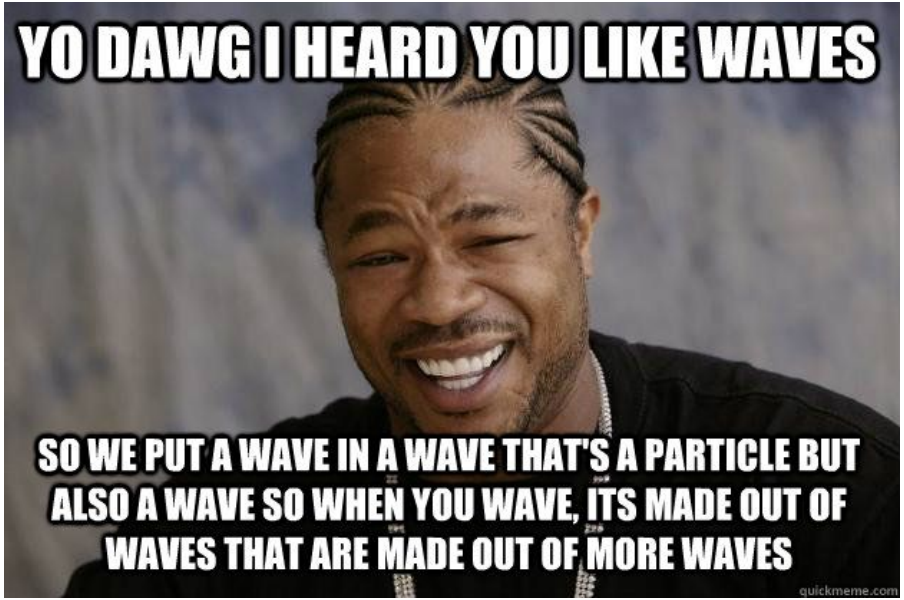
Since waves can describe light it is important to learn about the properties of waves.

Properties of Waves

A wave is a beam of energy.

There are three important properties of waves, that determine a wave type;

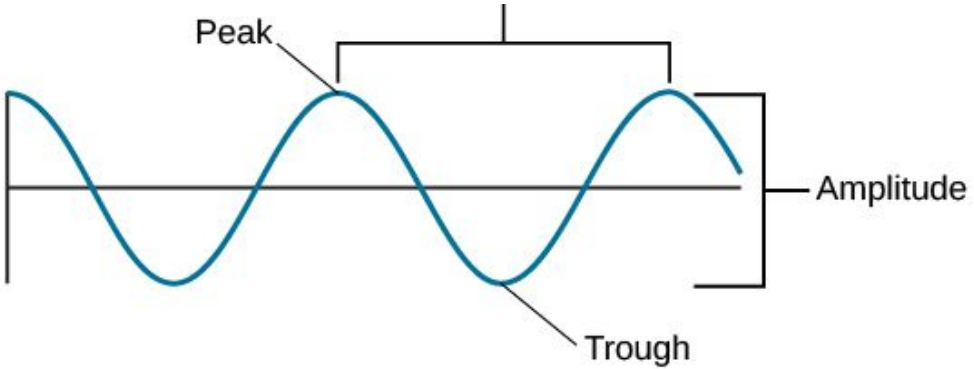
Wavelength, frequency and amplitude.



Amplitude

The lowest point of a wave is referred to as a trough, while the highest point of a wave is referred to as the peak.

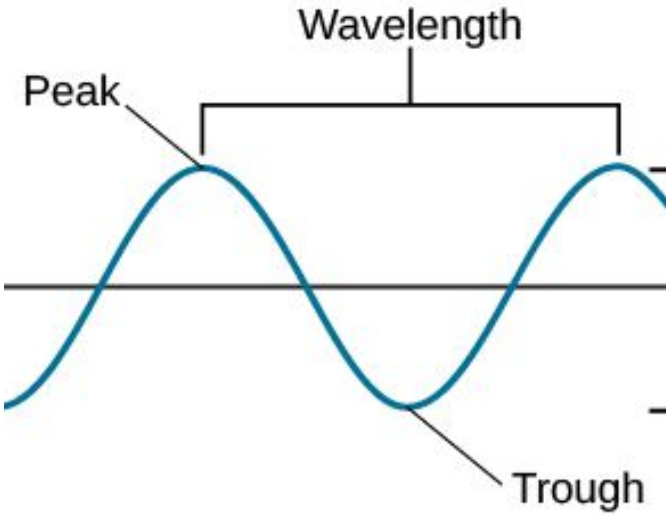
Amplitude is the height of a wave from the trough to the peak of the wave.



Wavelength

Wavelength refers to the length of a wave from one peak to the next.

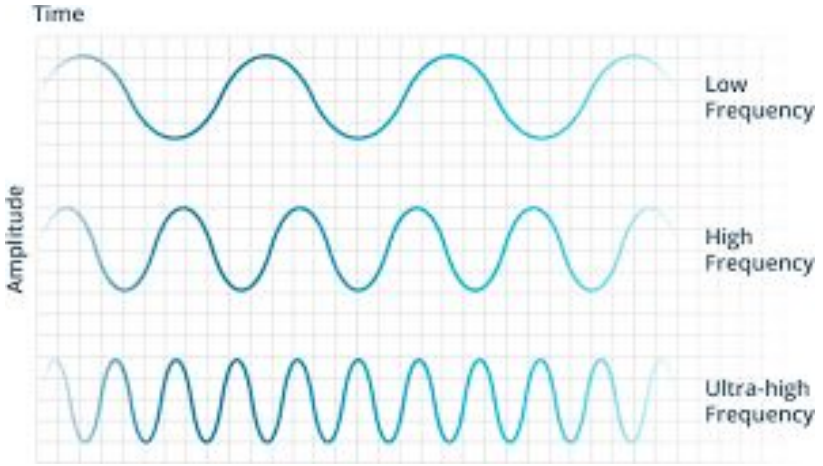
Wavelength is directly related to the frequency of a given wave.



Frequency

Frequency refers to the number of waves that pass a given point in a given time period.

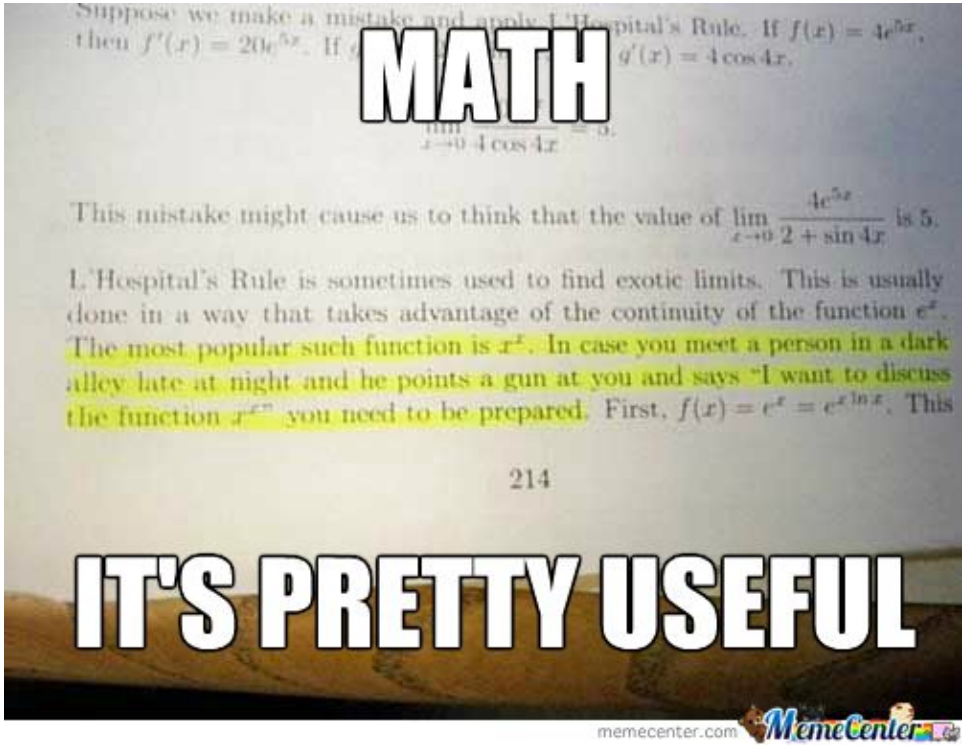
Frequency is often expressed in Hertz or cycles per second. Longer wavelengths will have lower frequencies, and shorter wavelengths will have higher frequencies.



Speed

The mathematical link between speed, wavelength, and frequency of a wave can be expressed as follows;

Speed = Wavelength x Frequency



waves?

second and has a wavelength of 1 meter. What is the frequency of the wave?

at a speed of 3.0 m/s and has a wavelength of 1.2 m

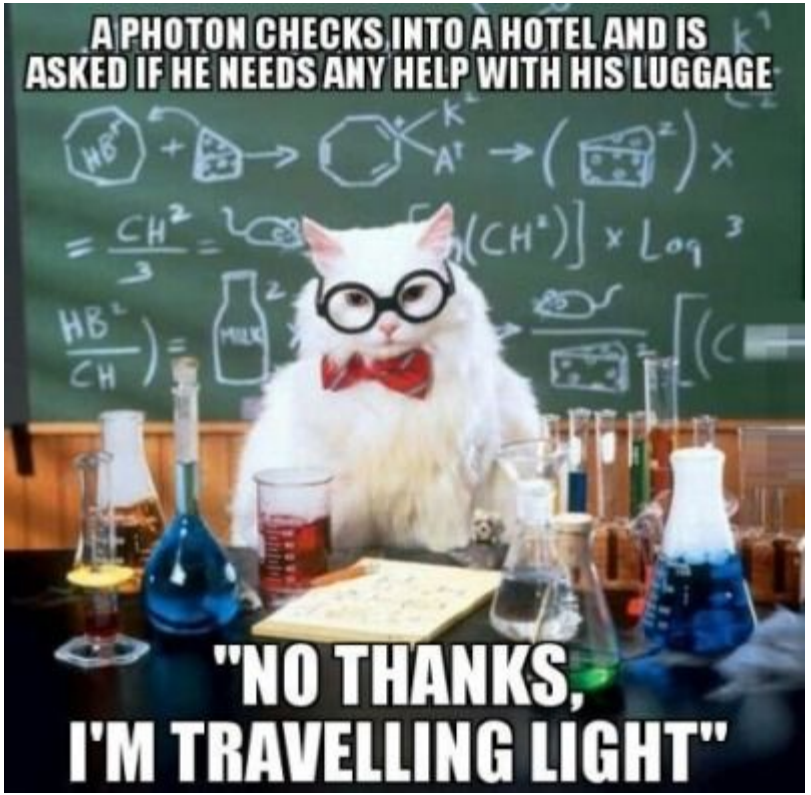
Why do airplanes sometimes crash?

Review!

a) What is a focal point?

b) What is amplitude?

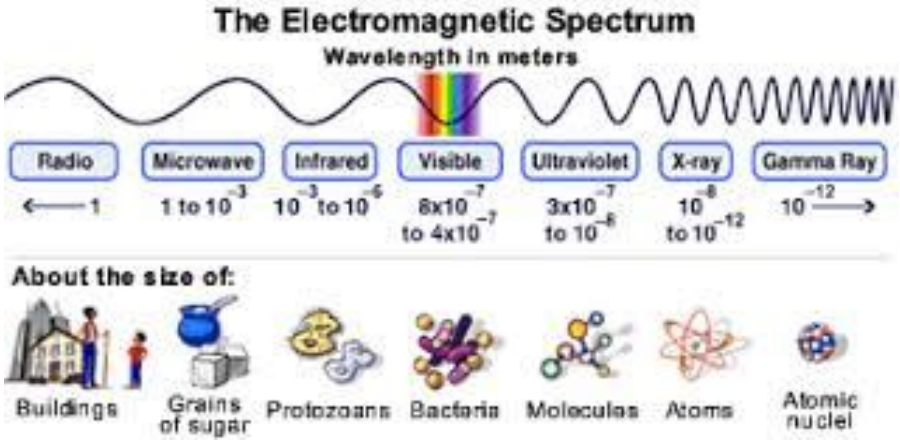
c) What is light?



The Electromagnetic Spectrum

The electromagnetic spectrum is a range of wavelengths or frequencies over which electromagnetic radiation extends.

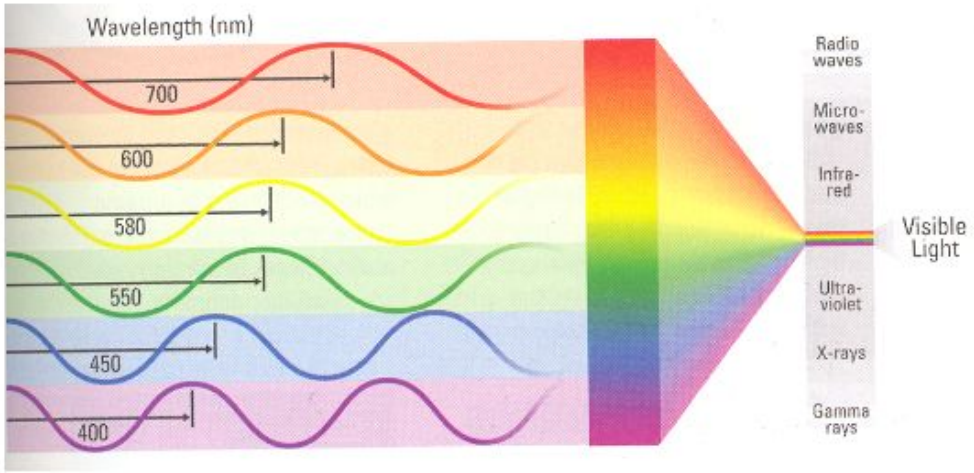
The electromagnetic spectrum includes radio waves, gamma rays, and visible light.



The Visible Light Spectrum

Visible light only represents a very small amount of all possible wavelengths. We are only able to see light from a range of about 700 to 400 nanometers.

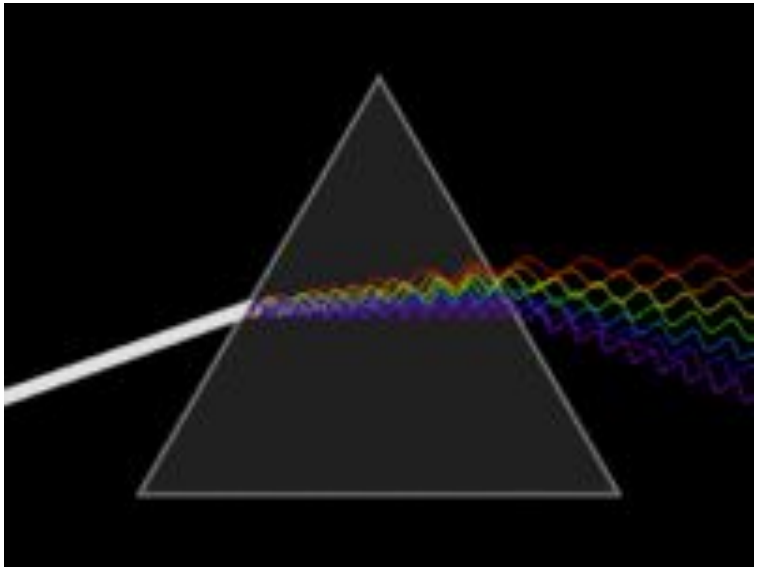
Different colours are all different wavelengths of energy.



Fun Fact!

In the 17th century, Isaac Newton discovered that prisms could disassemble and reassemble white light, and described the phenomenon in his book Opticks.

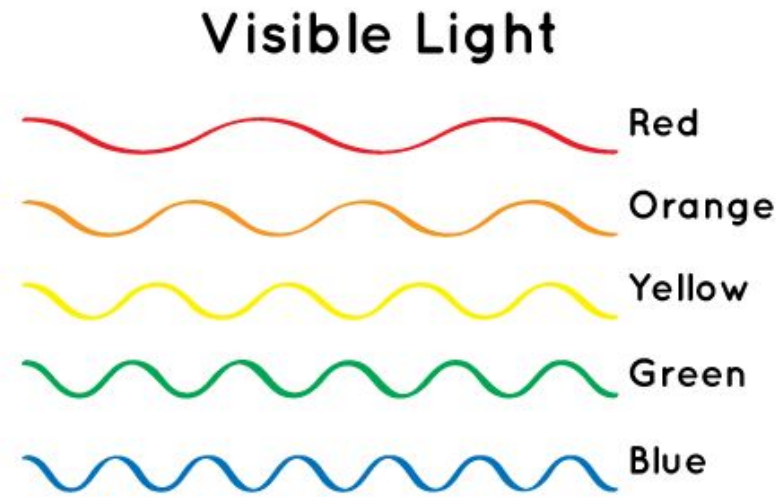
The result is that red light is bent (refracted) less sharply than violet as it passes through the prism, creating a spectrum of colors.



Fun Fact pt. 2 - The Sky is Blue

Blue light is scattered in all directions by the tiny molecules of air in Earth's atmosphere.

Blue is scattered more than other colors because it travels as shorter, smaller waves. This is why we see a blue sky most of the time.

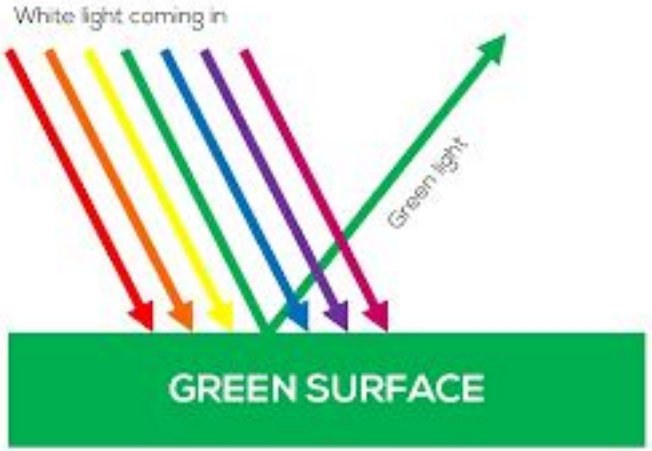


How We See Colour

We see colour when an object absorbs all other wavelengths of light except the wavelength of the color we are seeing.

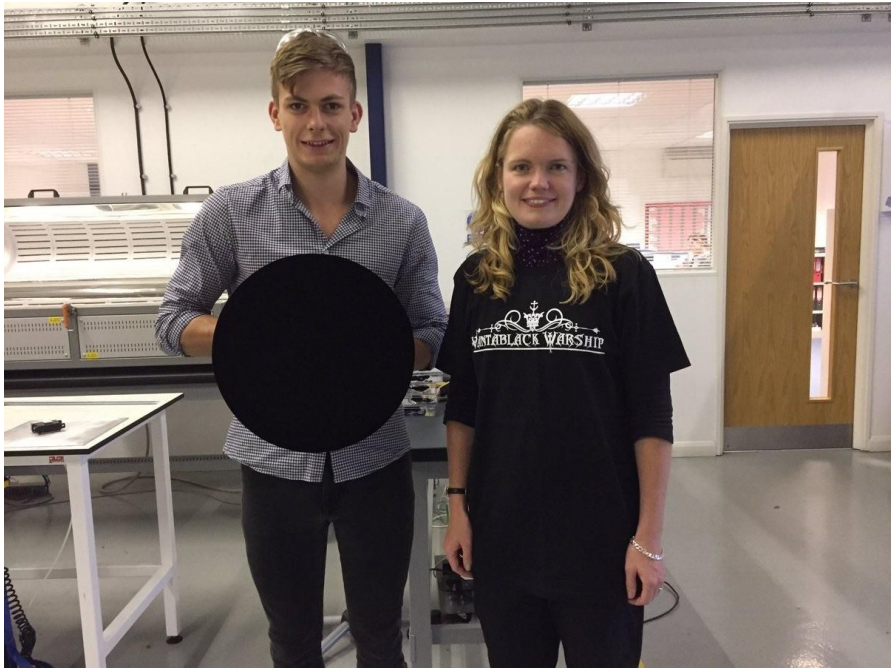
White objects will reflect any and all wavelengths of light that hit it.

Black objects absorb all of the wavelengths that hit it.



Vantablack!

Vantablack is a material developed by Surrey NanoSystems in the United Kingdom and is one of the darkest substances known, absorbing up to 99.96% of visible light.



Question

Given what you know about colour, what would an apple look like under a red light?

Answer

In red light, the apple appears red because it reflects the red light. But the leaves look black.

In green light, the apple appears black because no red light strikes it. But the leaves look green.

In blue light, both the apple and the leaves appear black.

Review

How are we able to see colour?

What is the one difference between Red and Violet Light?

Theory on Light

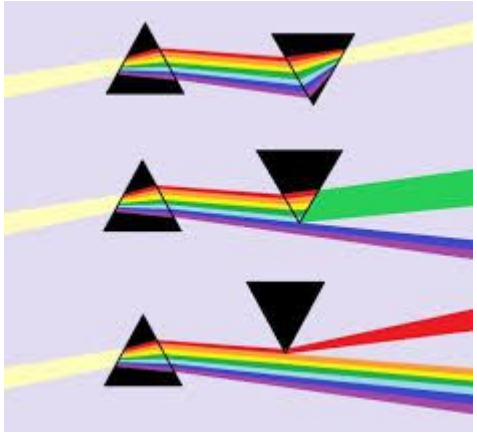
Pythagoras

Euclid

al-Haytham

Rene Descartes

Newton



Pythagoras

In ancient Greece, a mathematician developed a theory about light beams.

He believed that light was made up of straight beams that came from a person’s eyes and “lit up” the things they looked at.

The obvious problem being, if that were true, people would be able to see in the dark.

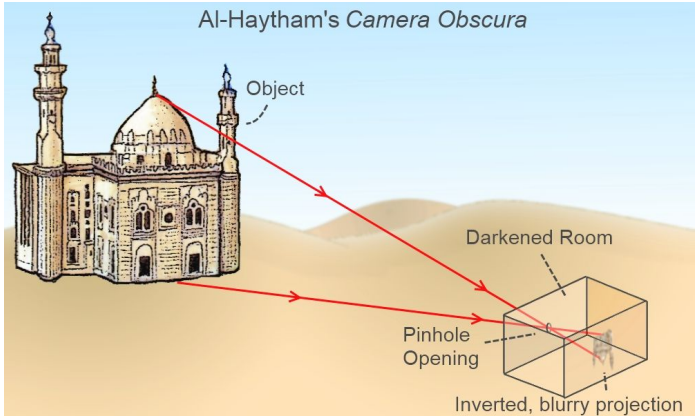
Euclid

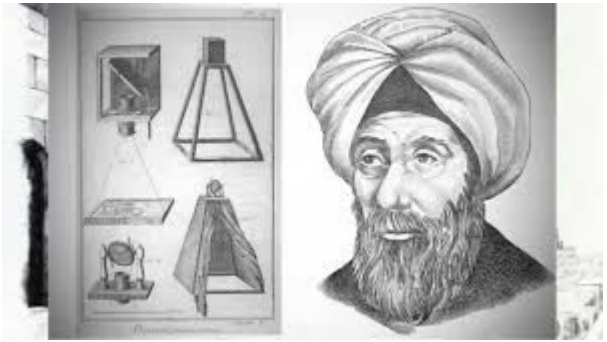
Another scientist from Greece, also believed that light travels in straight lines.

He used that knowledge to prove that the angle that a beam of light hit a mirror was exactly the same as the angle of the reflected beam

al-Haytham

In the year 1000, an Arab scientist came up with a theory of how vision worked. Opposite to Pythagoras and Euclid, he believed that light bounced off objects and travelled towards our eyes, making us see.



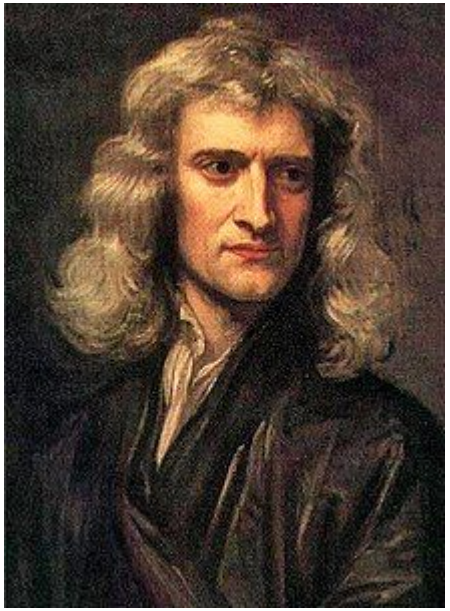


He tried very hard to discover how light was responsible for rainbows, he was unable to find the answer.

Newton

Sir Isaac Newton, an English Scientist, conducted an experiment where shined a beam of light through a prism.

When the white light beam passed through the prism, it split into different colours. When another prism was put in front of the coloured light, it combined to form the white light beam again.



Sources of Light

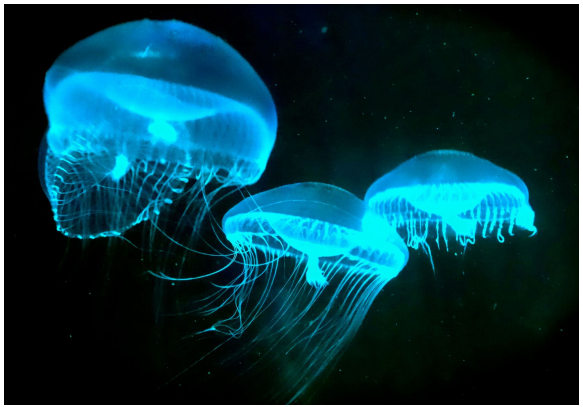
Light can come from a variety of sources, many man made, but there are some natural forms of light as well. We will look at:

Incandescent

Fluorescent

Phosphorescent

Bioluminescent

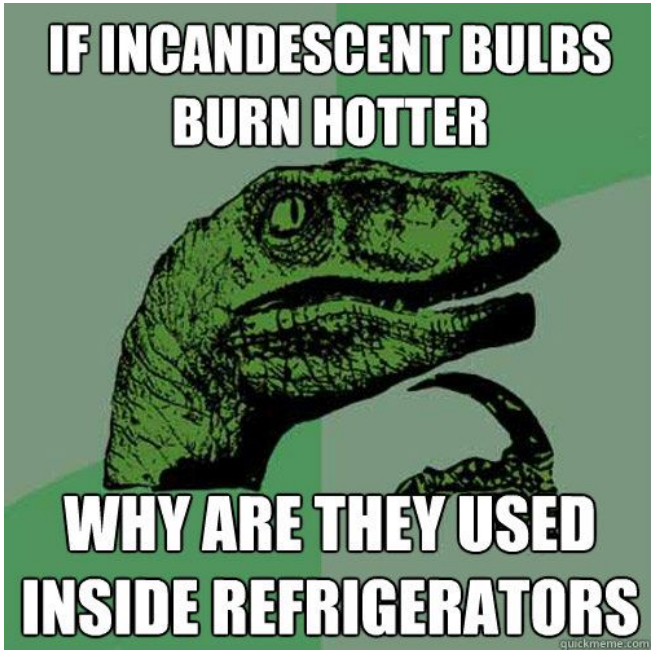


Incandescent Light

The classic light bulb.

Light sources emit electric light with a wire filament that gets heated to such a high temperature that it glows with visible light.

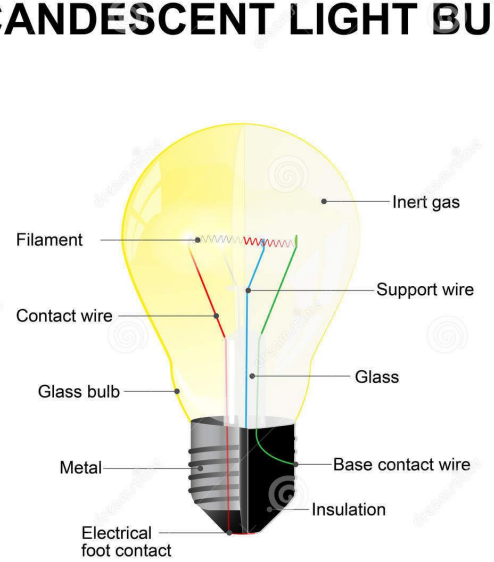
The filament is protected from oxidation with a glass or fused quartz bulb that is filled with inert gas or a vacuum.



Incandescent Bulbs

Incandescent bulbs are much less efficient than other types of electric lighting; incandescent bulbs convert less than 5% of the energy they use into visible light.

Where is the rest of the energy going?



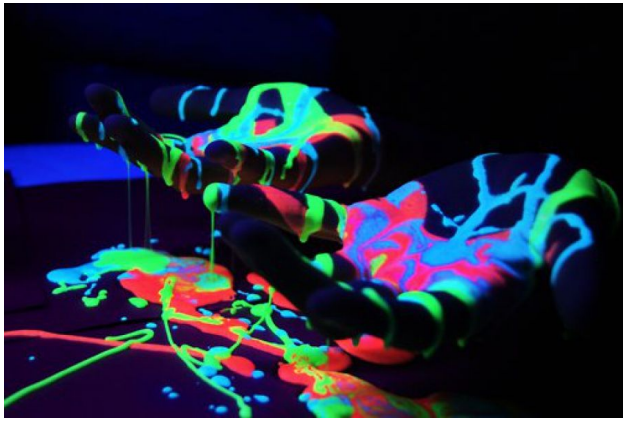
Fluorescent Light

A low-pressure mercury-vapor gas-discharge lamp that uses fluorescence to produce visible light.

An electric current in the gas excites mercury vapor, which produces short-wave ultraviolet light that then causes a phosphor coating on the inside of the lamp to glow.

Phosphorescent Light

Its energy absorbed by a substance is released relatively slowly in the form of **light**.



phosphorescent material does not immediately re-emit the radiation it absorbs.

Everyday examples of phosphorescent materials are the glow-in-the-dark toys, stickers, paint, and clock dials that glow after being charged with a bright light such as in any normal reading or room light.

Bioluminescent Light

Bioluminescence is the production and emission of light by a living organism

This occurs widely in marine vertebrates and invertebrates, as well as in some fungi, microorganisms including some

LED Lights

LED is an electric light for use in light fixtures that produces light using one or more light-emitting diodes (LEDs)

A **light-emitting diode** (**LED**) is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons (light particles)

Human Eye

The human eye is very complex. It consists of a variety of parts that help us see. We will focus on 8 parts of the eye.

Iris

Lens

Cornea

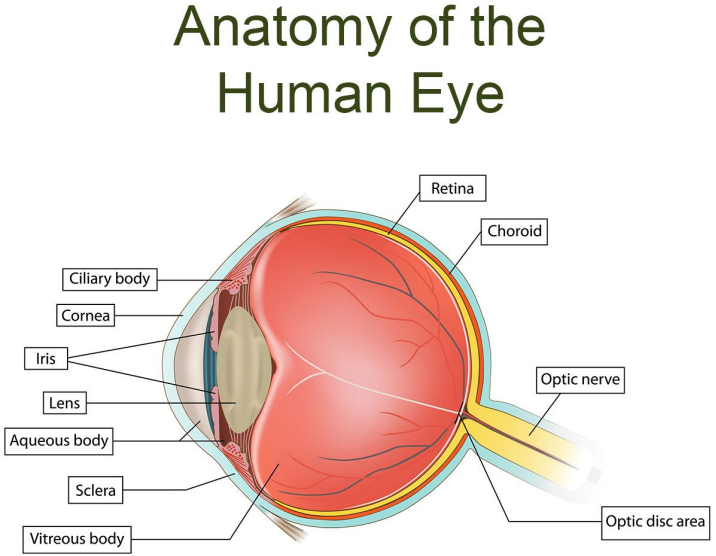
Ciliary Body

Aqueous Humor

Vitreous Humor

Retina

Optic Nerve



Iris

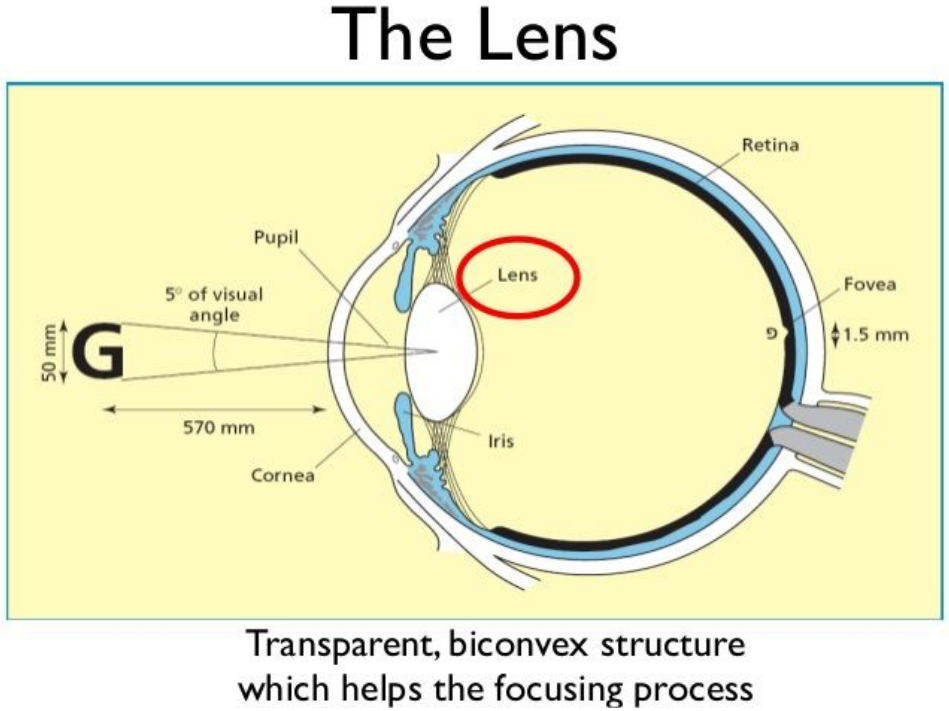
It is a thin, circular structure in the eye, responsible for controlling the diameter and size of the pupil and thus the amount of light reaching the retina.

Eye color is defined by that of the iris. In optical terms, the pupil is the eye's aperture, while the iris is the diaphragm.

Lens

The **lens** is a transparent, biconvex structure in the eye that, along with the cornea, helps to refract light to be focused on the retina.

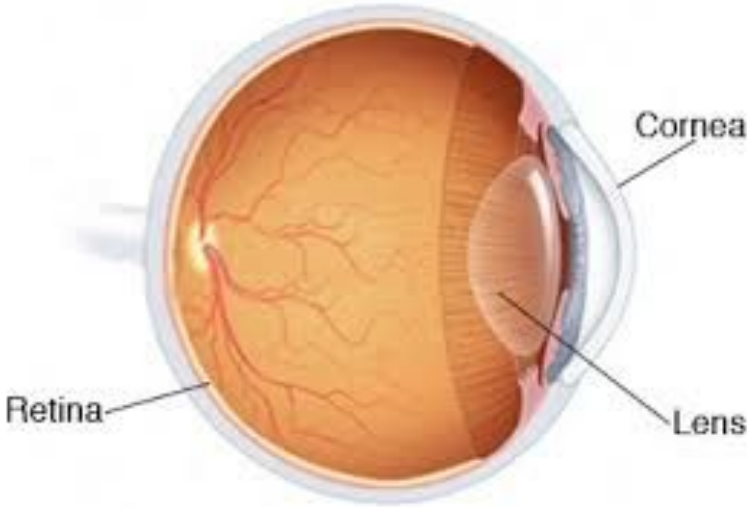
The lens, by changing shape, functions to change the focal distance of the eye so that it can focus on objects at various distances, thus allowing a sharp real image of the object of interest to be formed on the retina



Cornea

The **cornea** is the transparent front part of the eye that covers the iris, pupil, and anterior chamber. The cornea, with the anterior chamber and lens, refracts light.

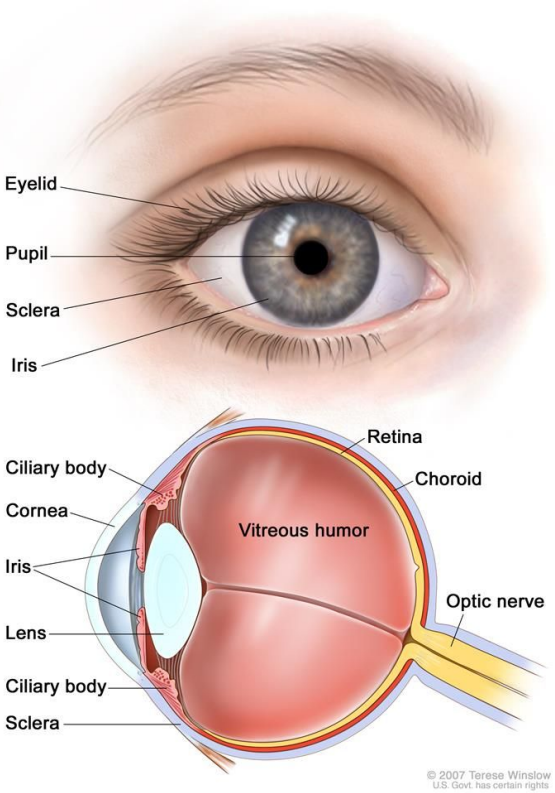
The cornea is responsible for protecting the iris and pupil from debris and damage.



Ciliary Body

The **ciliary body** is a part of the eye that includes the **ciliary** muscle, which controls the shape of the lens, and it produces the aqueous humor

The ciliary body is a ring-shaped thickening of tissue inside the eye. When the ciliary body contracts (gets smaller) is lengthens the lens, making the lens thinner. When it expands, the lens squishes together and becomes fatter



Review

What sources of light have we talked about?

What part of the eye protects the iris and pupil?

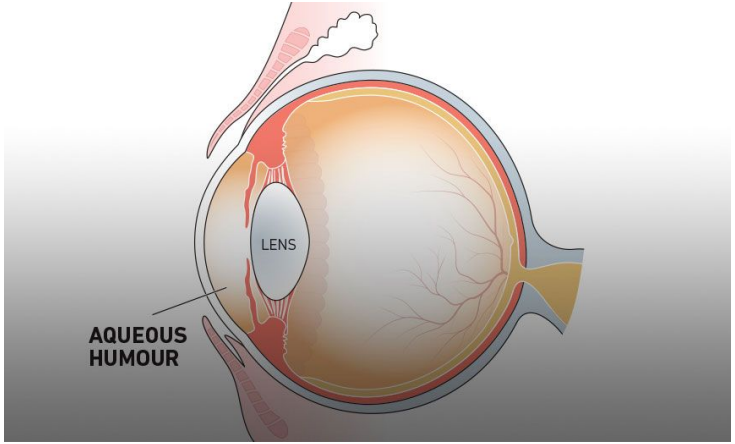
Which lightbulb is the least efficient?

Aqueous Humor

It is a transparent, watery fluid similar to plasma, but containing low protein concentrations. It is secreted from the ciliary epithelium, a structure supporting the lens.

It fills both the anterior and the posterior chambers of the eye, which is between the lens and the cornea.

It nourishes the cornea and lens, as well as supplies important amino acids to the eye.

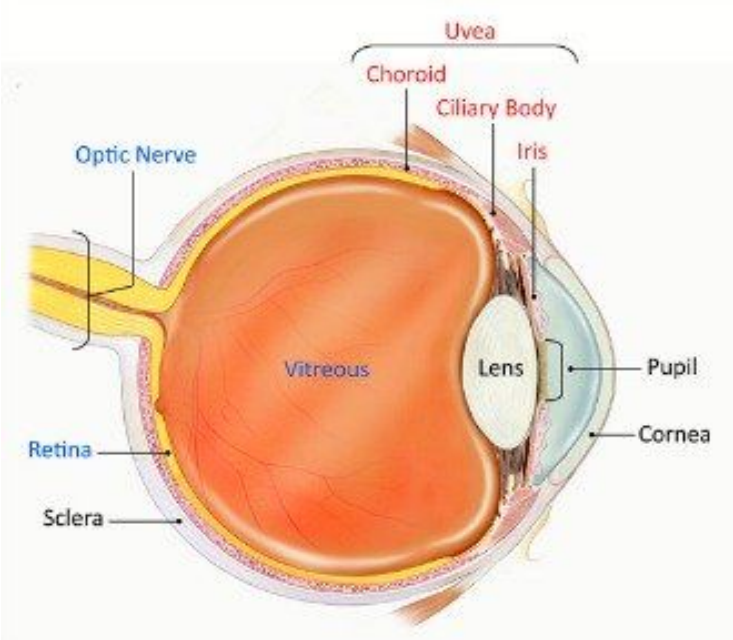


Vitreous Humor

It fills the space between the lens and the retina

The vitreous humor is a clear gel-like substance that is composed mostly of water and gives the eye its shape and form.

Light enters the eye through the cornea, pupil, and lens, and is then transmitted through the vitreous humor to the retina.

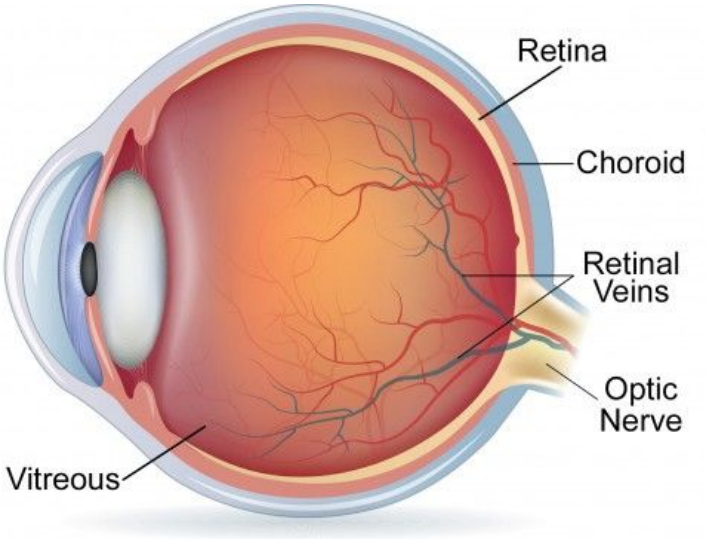


Retina

The **retina** is a thin layer of tissue that lines the back of the eye on the inside.The purpose of the **retina** is to receive light that the lens has focused, and send the light signals on to the brain.

The retina processes light through a layer of photoreceptor cells. These are essentially light-sensitive cells, responsible for detecting qualities such as color and light-intensity.

Rods and Cones



Rods and Cones

There are two types of photoreceptors in the human retina, rods and cones.

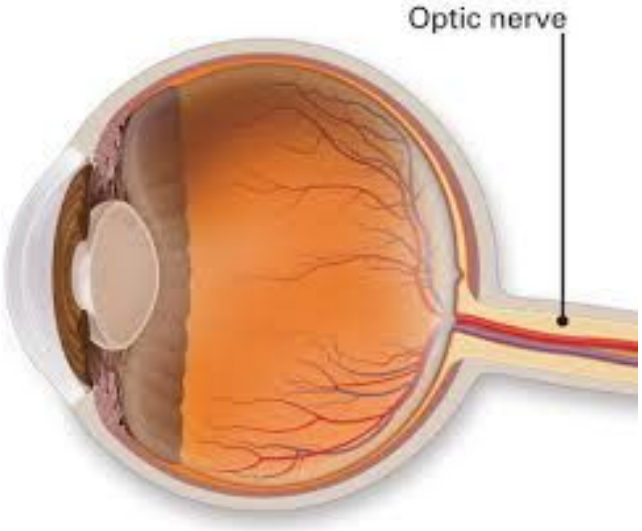
Rods: are responsible for vision at low light levels (scotopic vision). They do not mediate color vision, and have a low spatial acuity.

Cones: are active at higher light levels and are capable of color vision and are responsible for high spatial acuity. The central fovea is populated exclusively by cones.

Optic Nerve

The optic nerve connects the eye to to occipital lobe of the brain.

It is located at the back of the eye, behind the retina, and sends visual information to the brain to be processed and understood.



It is also called the second cranial nerve or cranial nerve II

Blind Spot Test

Blind Spot Test #2

+

Make a small dot on the left side separated by about 6-8 inches from a small + on the right side.

Close your right eye. Hold the image (or place your head from the computer monitor) about 20 inches away.

With your left eye, look at the +. Slowly bring the image (or move your head) closer while looking at the +.

At a certain distance, the dot will disappear from sight...this is when the dot falls on the blind spot of your retina.

Review

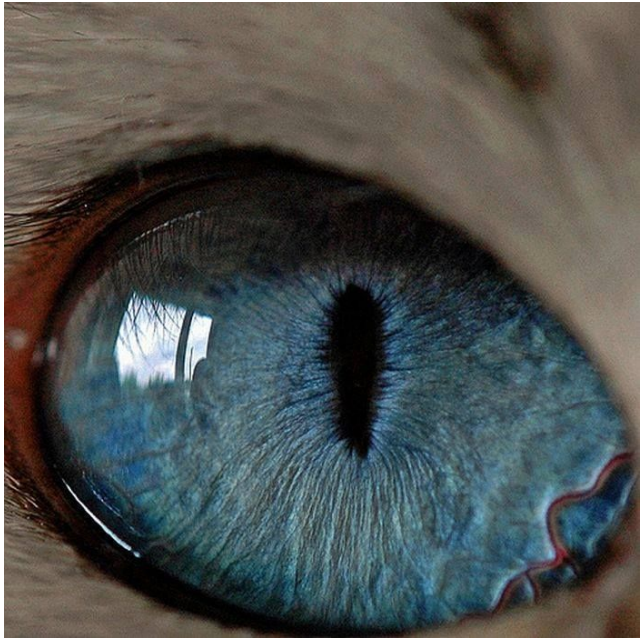
What part of the eye focuses light onto the retina?

What light sensitive cells can be found on the retina?

Where is our blind spot located?

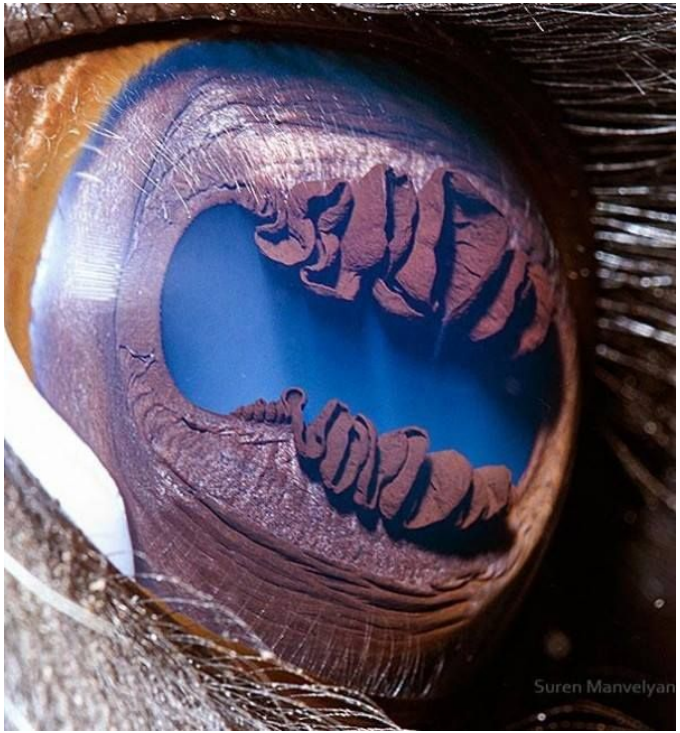
Name that Eye!

Talk to your partner and decide what kind of eye is seen below. Write it on a whiteboard.

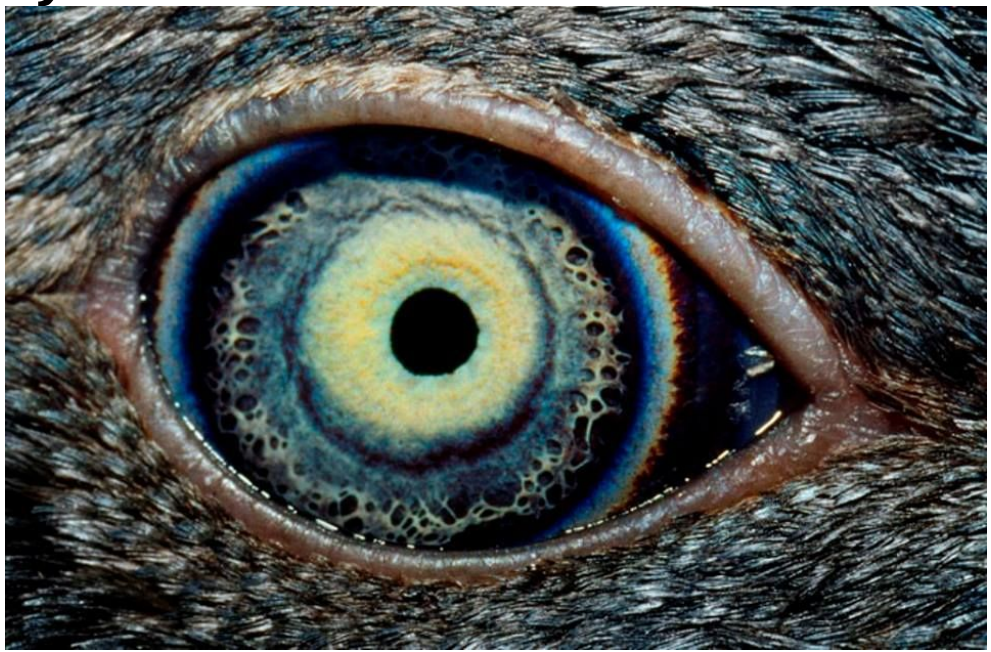


Name that Eye!

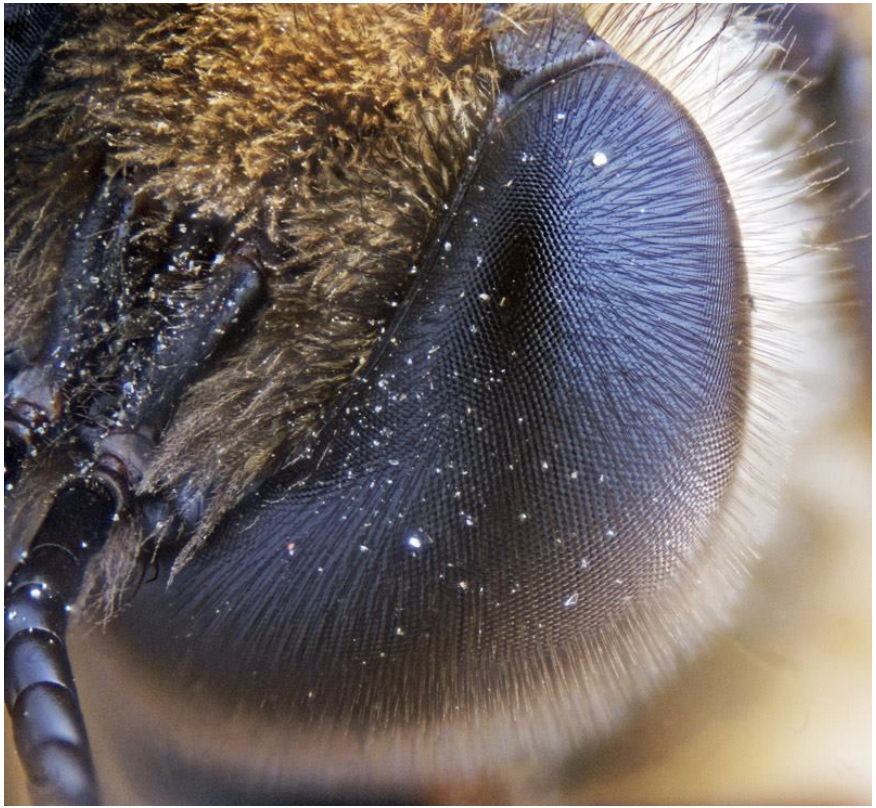
Name that Eye!



Name that Eye!



Name that Eye!



Name that Eye!

Name that Eye!

Eyes of Other Animals

Animals other than humans have a similar structure to the human eye, but may differ based on what they need their eyes to do.

Whether they need to see underwater, in the dark or infrared radiation, animals eyes are important for their daily life.

Eagle

Their eyesight is 4 to 8 times stronger than ours. This allows them to see fish in water and prey on land at hundreds of feet from their target.

Despite being of a much smaller stature, eagles have eyes that are about the same size as a humans.

Shark

Due to the position of their eyes, they have an almost 360 degree field of vision.

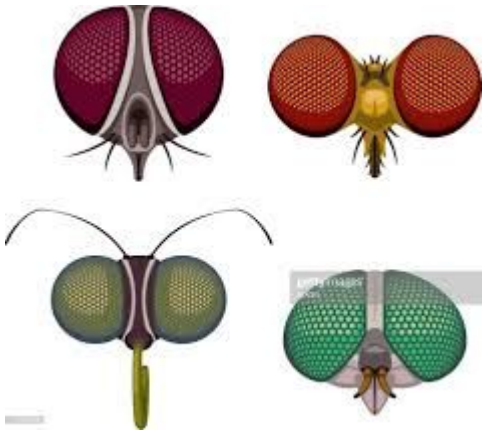
They also have monocular vision, which means they can move each eye separately

Insect Eyes

These are a little different. Insect eyes are considered Compound eyes.

Their eyes can consist of small thousands of sections called Ommatidia.

These are tiny independent photoreception units that consist of a cornea, lens, and photoreceptor cells which distinguish brightness and color.



Review

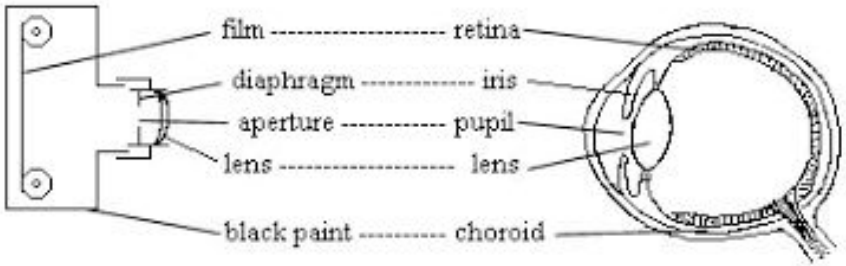
How can animal eyes be different from human eyes?

What are ommatidia?

How are Camera's and the Eye the same?

Shutter: Can be compared to the iris in a human eye. It controls how much light is able to enter the lens.

Aperture: Similar to the pupil, where light enters the camera.



Comparing a Camera

Lens: similar to the lens in the human eye, which are both used to focus light and create an image.

Film: An image is recorded on a film. In the human eye, the image is displayed on the retina.

The Invisible Switch

Automatic doors

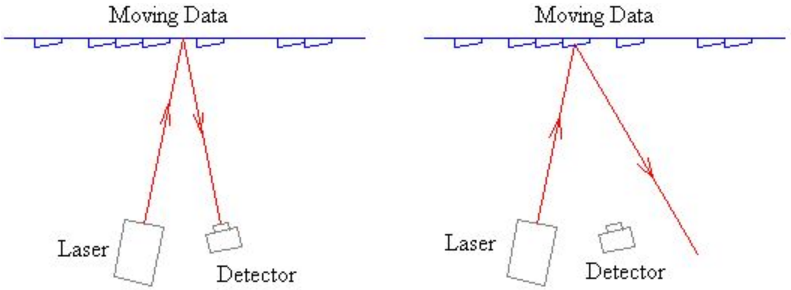
You've probably walked through automatic doors hundreds of times. You walk up and the door seems to open like magic. But it's not magic. There's a small cell connected to the door switch. That cell, called a photocell, is sensitive to light and shadows. When your shadow falls across the photocell, it triggers the door to open.

Light Power

Light Power

Light energy is often used to make electricity. Cells that do this are called **photoelectric cells**. A photoelectric cell that gets its light energy from the sun is called a **solar cell**. A small solar cell can collect light energy to run a calculator. A very large solar cell, or several of them, can collect a lot of light energy to make enough electricity to heat a house or a building.

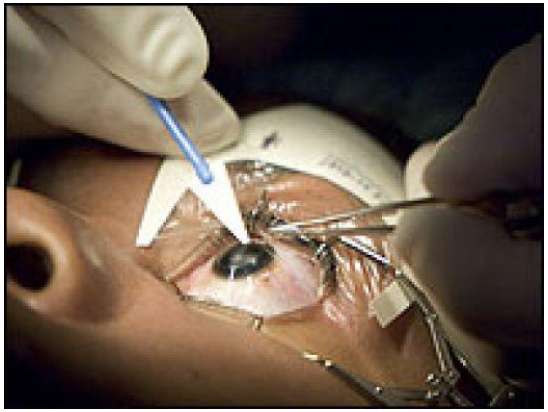
Lasers

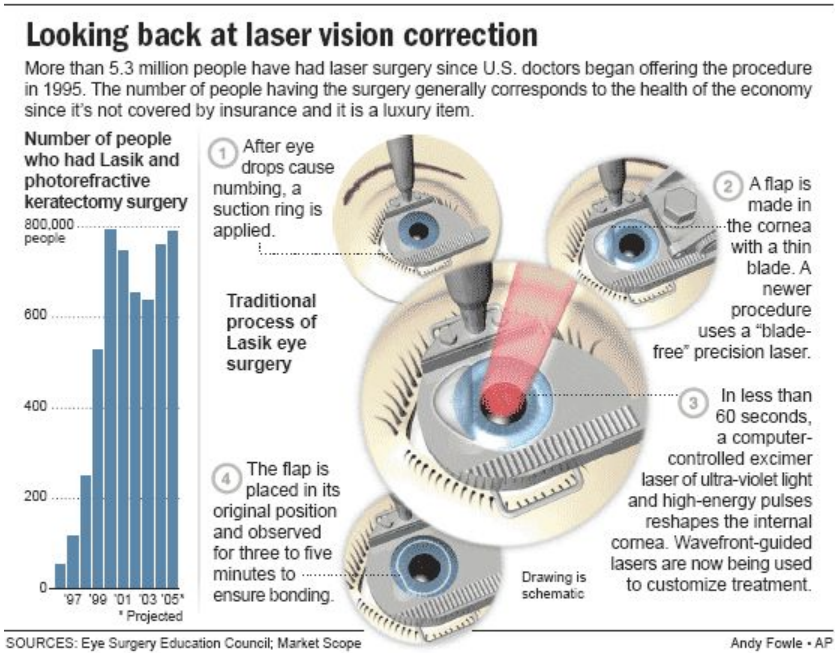


Light Music

Laser light is so powerful that it can be used to drill rock or cut metal. But you might find a laser beam in your own home. A compact disc player uses a beam of laser light to play CDs. A CD has a shiny metal surface with grooves in it. In the grooves are very small bumps that make a pattern. That pattern is a code. The laser beam reflects off the surface of the disc and reads the code. It turns the code into sound.

Laser Eye Surgery

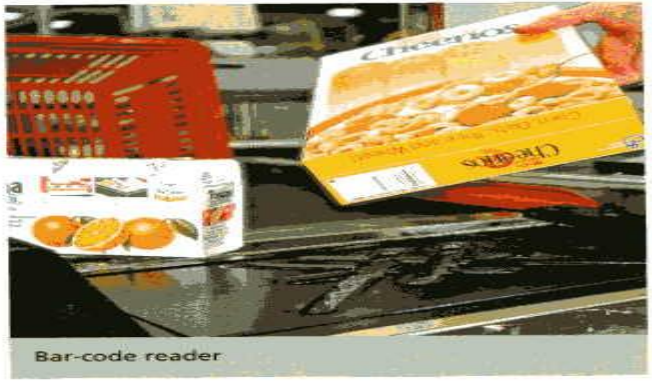




Light Reading

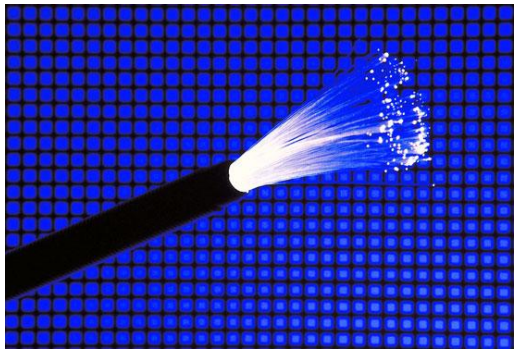
Light Reading

Have you seen those little black bars on things you buy at the supermarket? They might not mean much to you, but they mean everything to the beam of light at the check-out counter. A cashier passes the little black bars or **bar code** across the light beam. The beam "reads" the pattern of light and dark in the code. The pattern is checked against a computerized list. When there's a match, a signal is sent to the cash register that prints the correct name and price for the product.



Bar-code reader

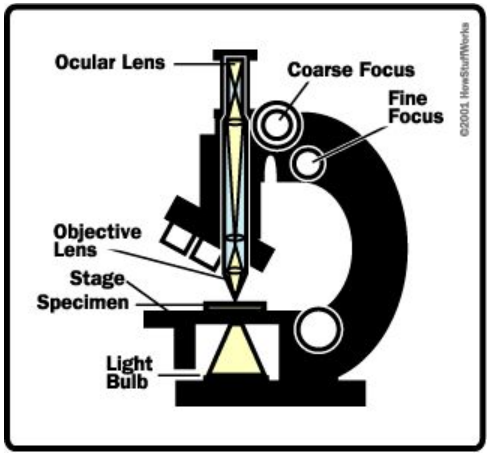
Fibre Optics



Light Conversation

You've seen telephone poles and wires. They carry our voices across the city and across the world so we can talk to one another. But those wires don't carry very many voices at once. That's why light tubes, called **optical fibres**, are used. While you talk, your voice is turned into electricity. That electricity is turned into codes of laser light flashes. Those flashes move along the optical fibre, which is about as thick as a human hair. One optical fibre can carry more than 1000 telephone messages at the same time—and it can do it much faster than regular wires.

Microscopes



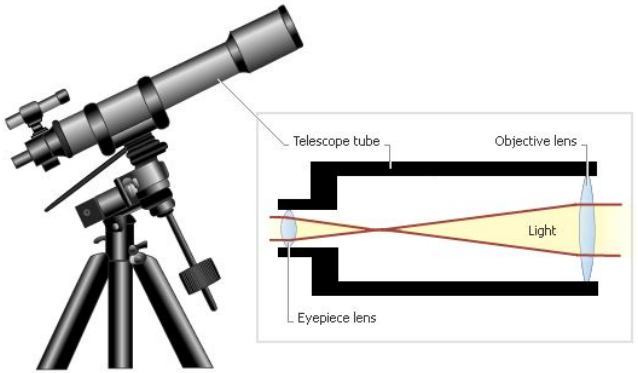
Is an instrument used to see objects that are too small to be seen by the naked eye.

The performance of a light microscope depends on the quality and correct use of the condensor lens system to focus light on the specimen and the objective lens to capture the light from the specimen and form an image.

Telescopes

- Magnify and focus light from distant objects such as stars
- Hubble Telescope: famous space telescope that has captured images of distant galaxies
- Discoveries: craters and mountains on the moon, moons of other planets, existence of distant galaxies
- Two kinds: reflecting and refracting

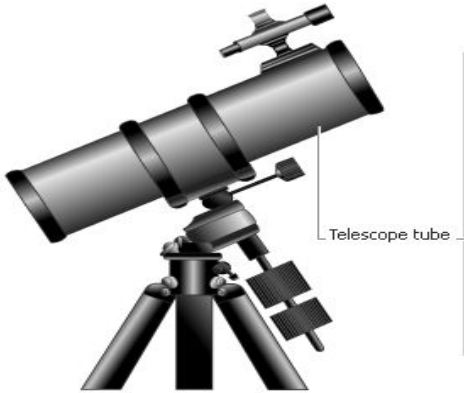
Refracting Telescope

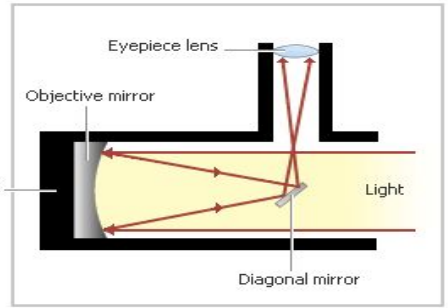


- Refracting telescopes, or refractors, use a convex lens to bend, or refract, light and bring it to a focus.

Reflecting Telescopes

- A reflecting telescope uses a precisely curved objective mirror instead of a lens to collect light. The mirror is concave and focuses the incoming light. This increases the telescope's light sensitivity, so dimmer objects can be seen. A convex eyepiece lens magnifies the image fro the eye.





Digital Images

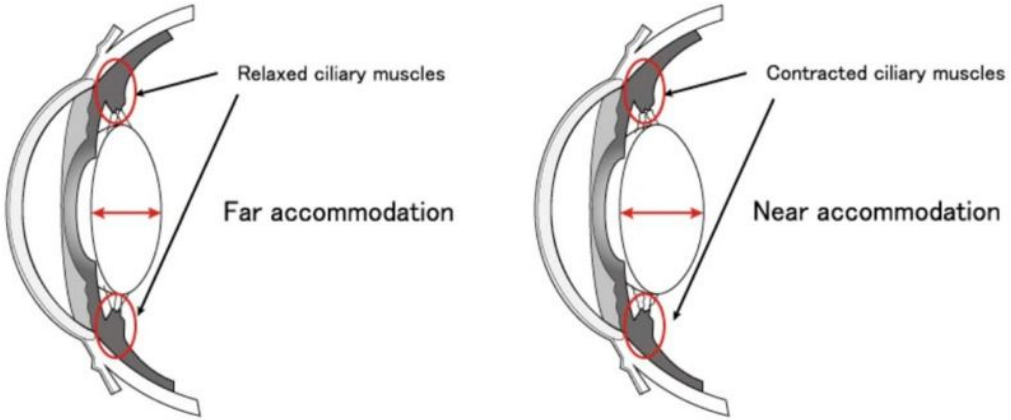
- The process of creating a big picture out of many small pieces or pixels
- Devices such as cameras
- Can use visible light or other forms (infrared, X-ray, etc.)

Why do we cry?

The Lens and Ciliary Muscles

The lens in the human eye is a convex lens, which focuses the light rays entering your eye to a point on your retina.

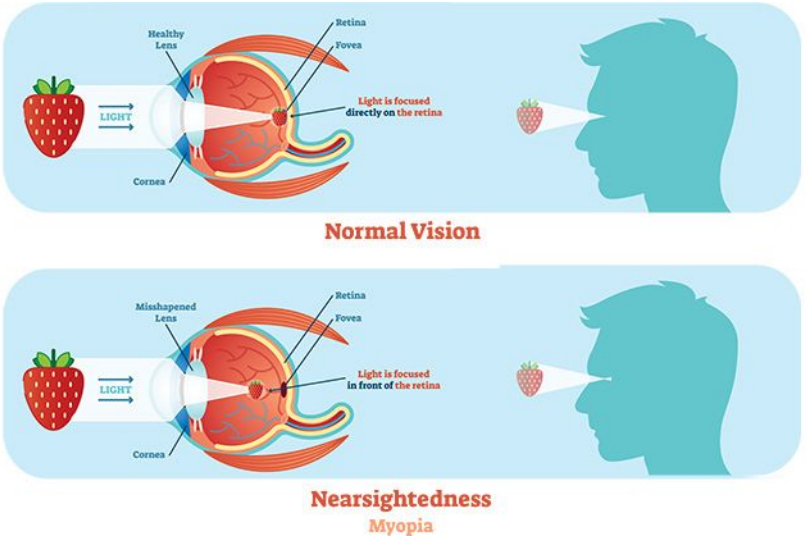
In the human eye, the lens cannot move, so the ciliary muscles change the shape of the lens. The process of changing the shape of the lens is called accommodation.



Myopia

Nearsightedness (myopia) is a vision condition in which you can see objects near to you clearly, but objects farther away are blurry.

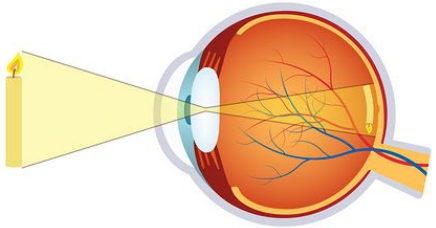
It occurs when the shape of your eye causes light rays to bend incorrectly, focusing images in front of your retina instead of on your retina.



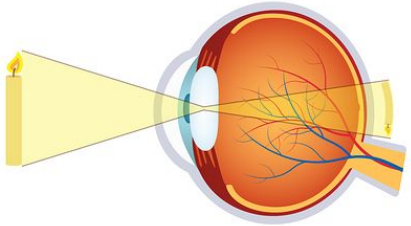
Hyperopia

Hyperopia, or farsightedness, is a vision problem, in which you can see objects far away, but objects closer to you are blurry.

Hyperopia develops in eyes that focus images behind the retina instead of on the retina, which can result in blurred vision. This occurs when the eyeball is too short, which prevents incoming light from focusing directly on the retina.



Normal vision

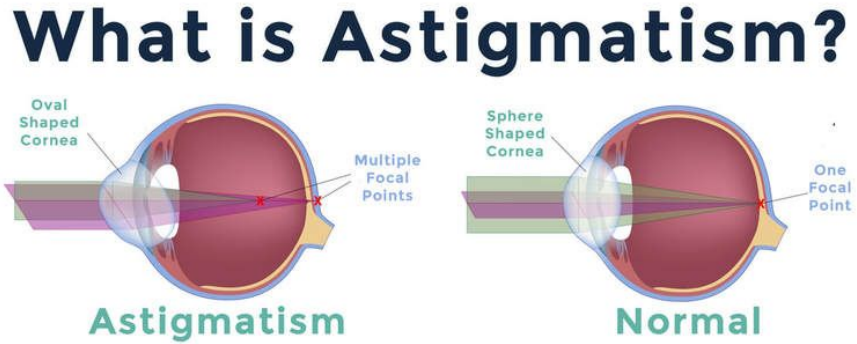


Hyperopia

Astigmatism

Astigmatism occurs when your eye can’t focus light evenly onto the retina because your cornea, the clear round dome that covers your iris and pupil, and your lens, is irregularly shaped.

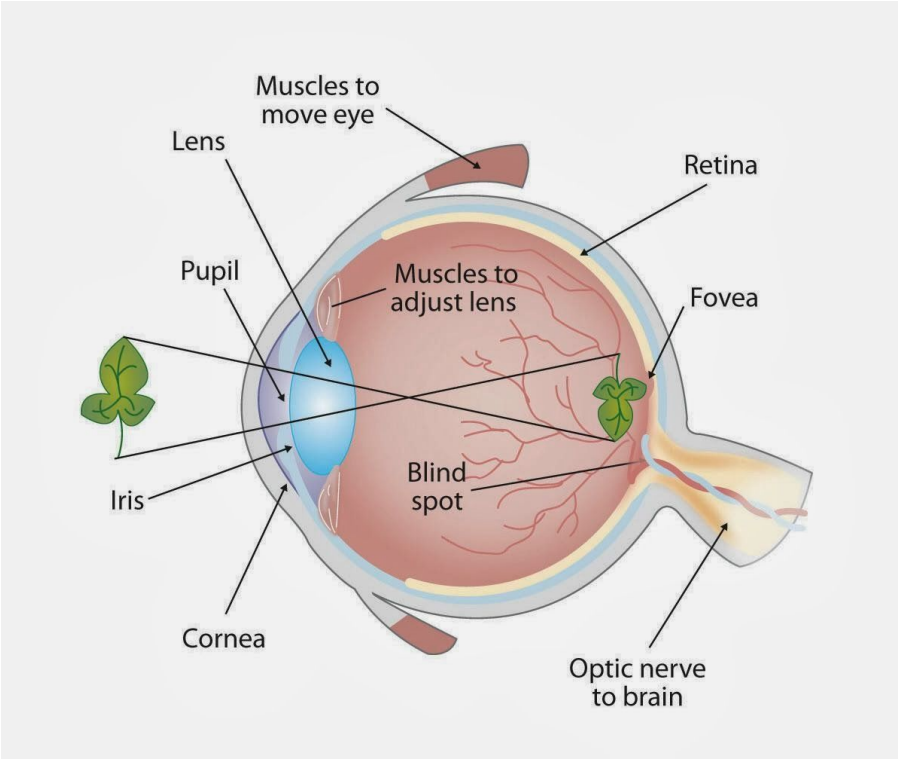
With astigmatism, irregular shape in the cornea and lens prevents light rays from focusing on one point.



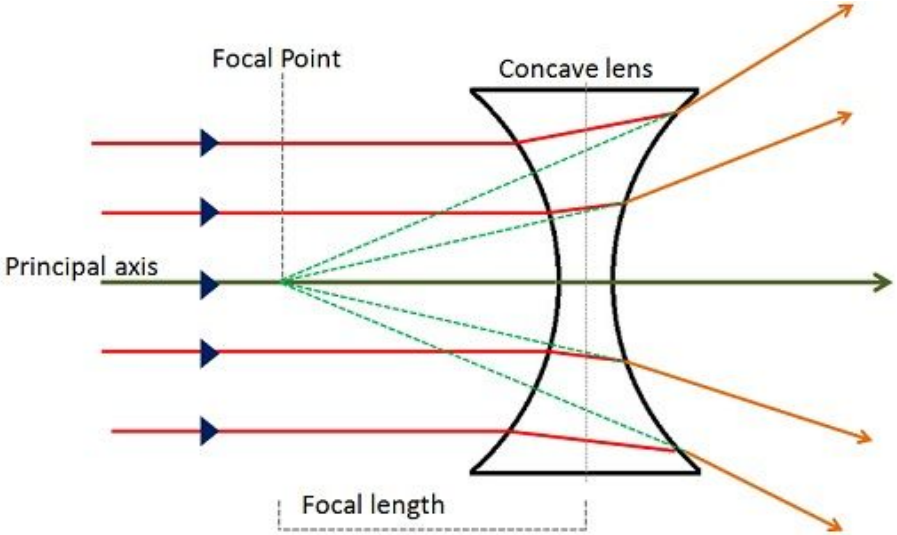
Fun Fact!

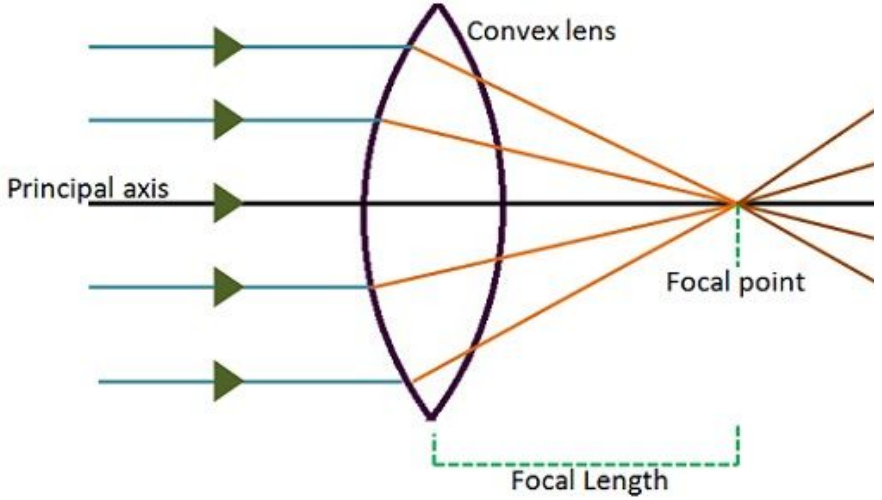
Our brains have learned to automatically flip the images that hit our retinas so we perceive our reality right side up.

Babies' brains haven't quite learned to do that yet, and until they do, it is believed that the babies live in an "upside-down" world.



Remember

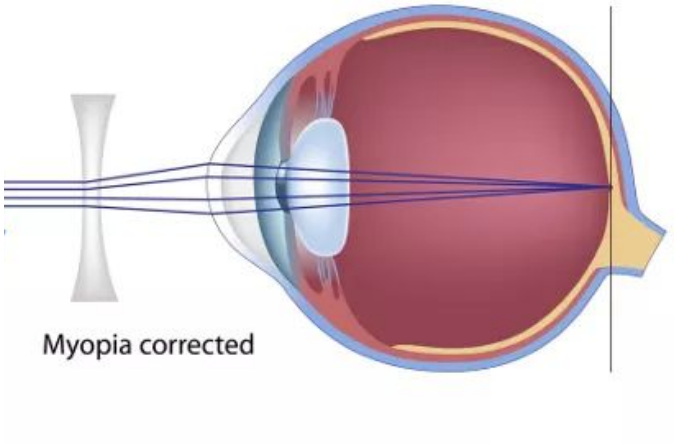

Focal Point
Concave lens
Principal axis
Focal length


Convex lens
Principal axis
Focal point
Focal Length

Fixing Myopia

Myopia is easily corrected using prescription glasses or contact lenses specifically designed to counteract the effect.

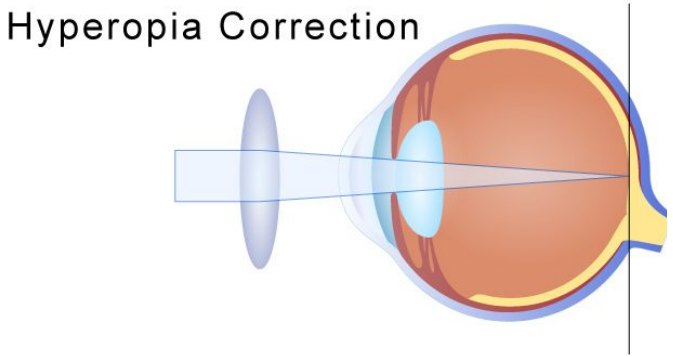
For myopia, a concave lens (minus powered) is placed in front of a myopic eye, moving the image back to the retina and clarifying the image.



Fixing Hyperopia

Hyperopia is fixed by placing convex lenses (plus powered) in front of the eye.

This allows for the image to move forward and focus correctly on the retina.

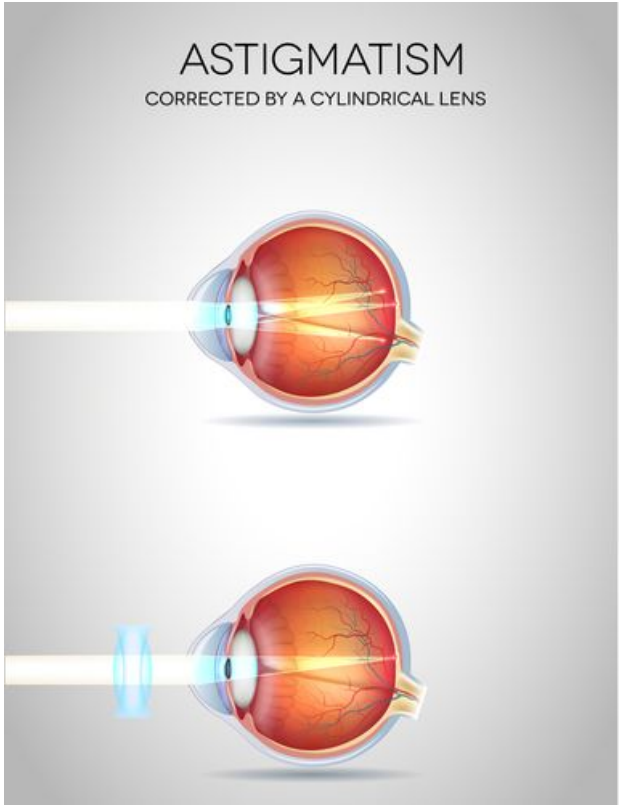


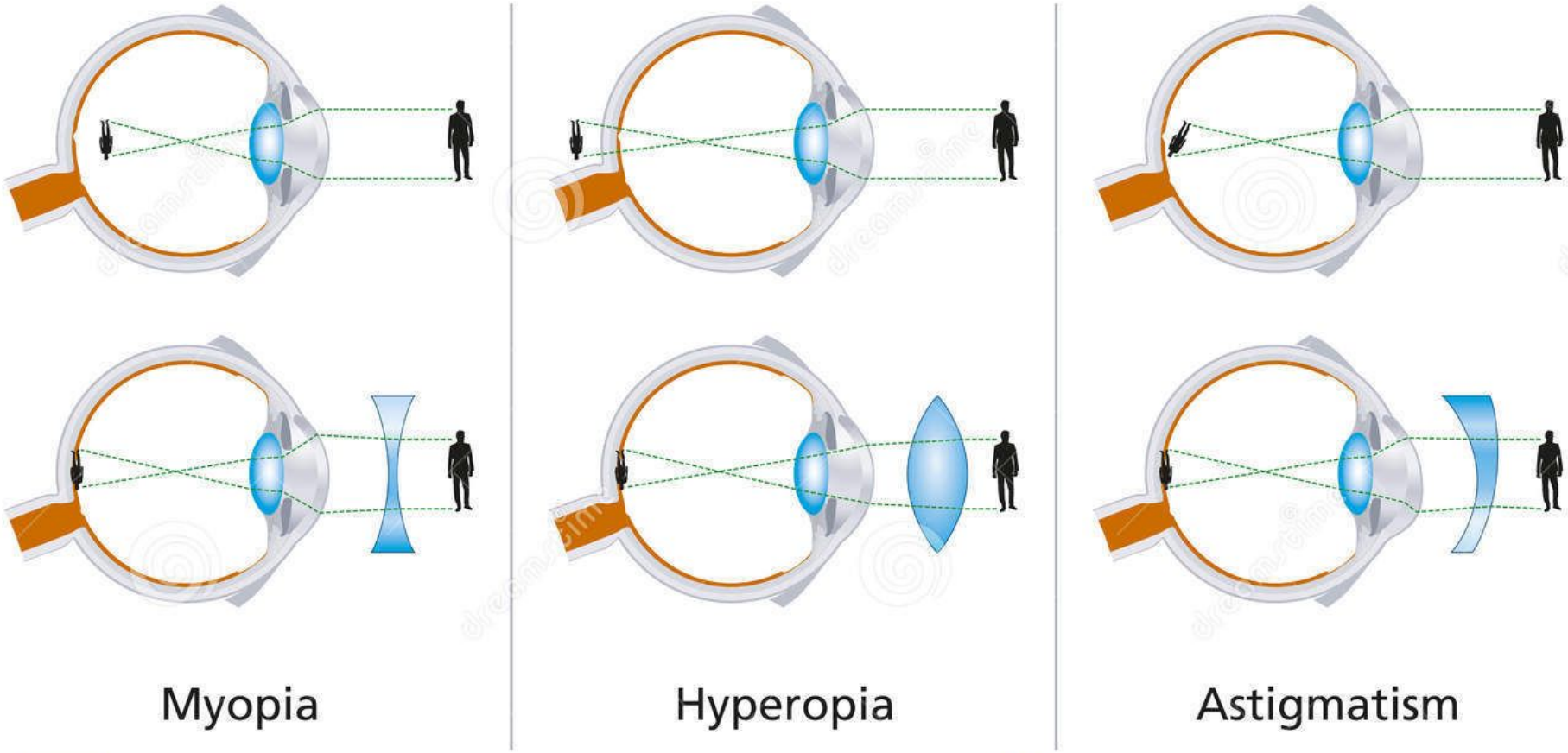
Fixing Astigmatism

Astigmatism can be corrected with eyeglasses, contact lenses, or surgery.

Eyeglasses are the simplest and safest way to correct astigmatism.

Contact Lenses work by becoming the first refractive surface for light rays entering the eye, causing a more precise refraction or focus.




Myopia
Hyperopia
Astigmatism

Laser Eyes?