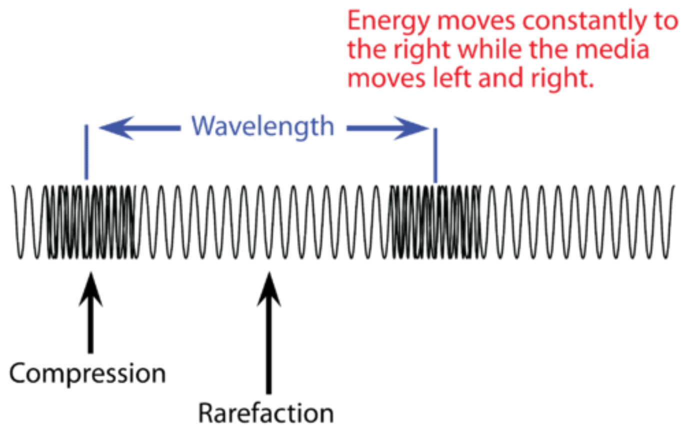
Longitudinal Wave



Longitudinal waves are a type of wave where the particles of the medium vibrate parallel to the direction of wave propagation. This is in contrast to transverse waves, where the particles of the medium vibrate perpendicular to the direction of wave propagation.

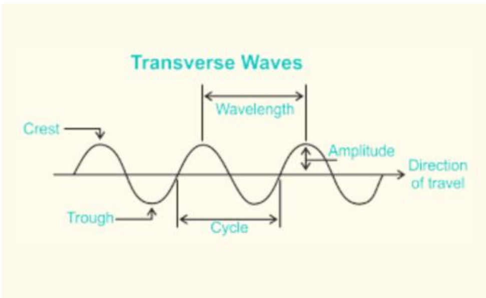
Properties of longitudinal waves:

- Compressions and rarefactions: Longitudinal waves are characterized by compressions and rarefactions. A compression is a region where the particles of the medium are closer together than usual. A rarefaction is a region where the particles of the medium are further apart than usual.
- Speed: The speed of a longitudinal wave depends on the medium it is traveling through. In general, longitudinal waves travel faster through solids than through liquids and gases.
- Wavelength: The wavelength of a longitudinal wave is the distance between two consecutive compressions or rarefactions.
- Frequency: The frequency of a longitudinal wave is the number of compressions or rarefactions that pass a point in space in a given amount of time.
- Amplitude: The amplitude of a longitudinal wave is the maximum displacement of the particles of the medium from their rest position.

Longitudinal waves have a wide range of applications in science and technology. Some examples include:

- Sound waves: Sound waves are used in a variety of applications, such as communication, entertainment, and medical diagnosis.
- Ultrasound waves: Ultrasound waves are used in medical imaging and therapy.
- Seismic P-waves: Seismic P-waves are used to study the Earth's interior.
- Sonar: Sonar uses sound waves to detect and locate objects underwater.

Transverse Waves



Transverse waves are a type of wave where the particles of the medium vibrate perpendicular to the direction of wave propagation. This is in contrast to longitudinal waves, where the particles of the medium vibrate parallel to the direction of wave propagation.

Properties of transverse waves:

- Crests and troughs: Transverse waves are characterized by crests and troughs. A crest is a region where the particles of the medium are displaced above their rest position. A trough is a region where the particles of the medium are displaced below their rest position.
- Speed: The speed of a transverse wave depends on the medium it is traveling through. In general, transverse waves travel faster through solids than through liquids and gases.
- Wavelength: The wavelength of a transverse wave is the distance between two consecutive crests or troughs.
- Frequency: The frequency of a transverse wave is the number of crests or troughs that pass a point in space in a given amount of time.
- Amplitude: The amplitude of a transverse wave is the maximum displacement of the particles of the medium from their rest position.

Applications of transverse waves:

Transverse waves have a wide range of applications in science and technology. Some examples include:

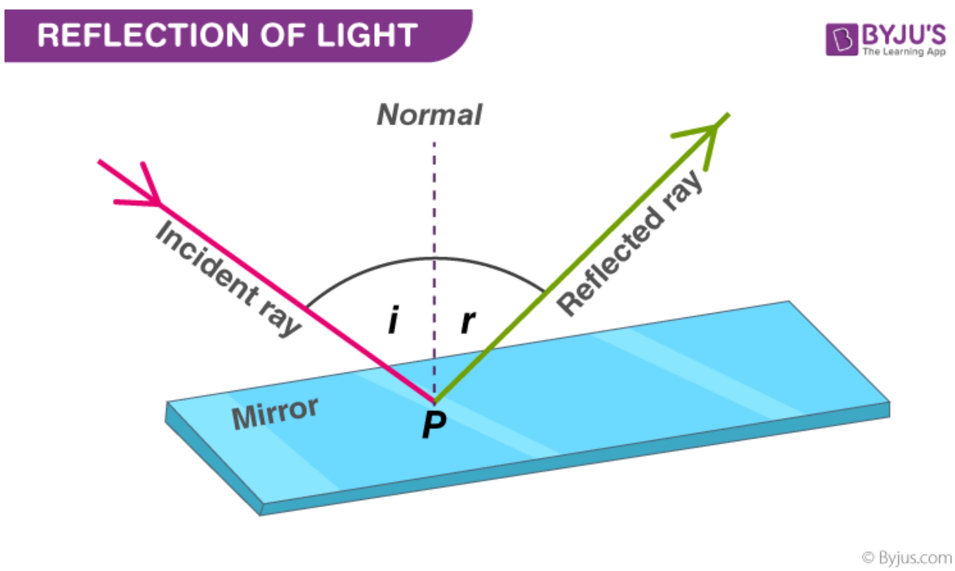
- Light waves: Light waves are used in a variety of applications, such as communication, entertainment, and medical diagnosis.
- Seismic S-waves: Seismic S-waves are used to study the Earth's interior.
- Radio waves: Radio waves are used in a variety of applications, such as communication, navigation, and broadcasting.

Wavelength= Speed of wave/ Frequency of Wave

Light

Properties of light

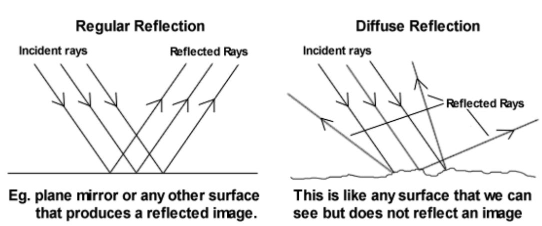
1. It is a wave and a particle. (particle duality)
2. It travels in a straight line.
3. Light can bend around corners.
4. Does not need a medium to travel.
5. It is a transverse wave.



The laws of reflection are two fundamental laws that describe how light reflects off of smooth surfaces.

First law of reflection: The incident ray, the reflected ray, and the normal to the surface all lie in the same plane.

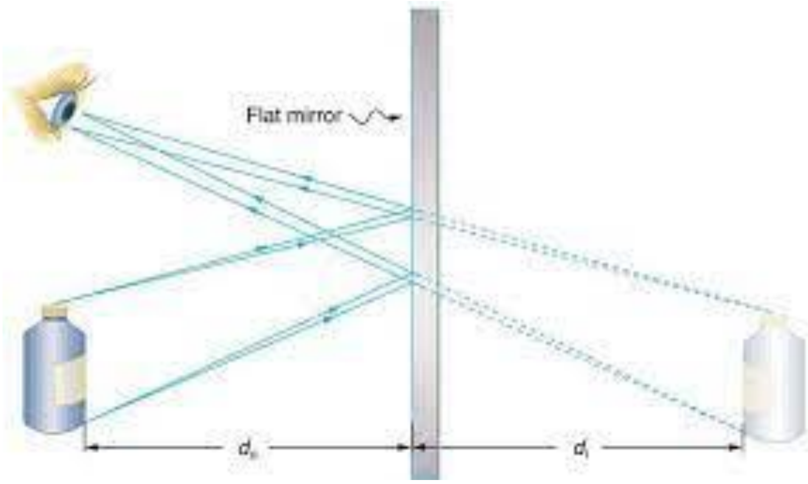
Second law of reflection: The angle of reflection is equal to the angle of incidence.



Plane Mirror Reflection

Regular reflection is when the mirror is straight is not rough. The reason that irregular reflection does not form an image is due to the fact that the normal drawn from each point is different, and the reflected rays move respective to the normal.

Reflection in a plane mirror



The properties of reflection in a plane mirror are:

- The image formed is virtual, meaning that it is not actually there.
- The image is the same size and shape as the object, but it is reversed left to right(lateral inversion).
- The image is located at the same distance behind the mirror as the object is located in front of the mirror.
- The angle of reflection is equal to the angle of incidence.
- The image is always erect/upright.

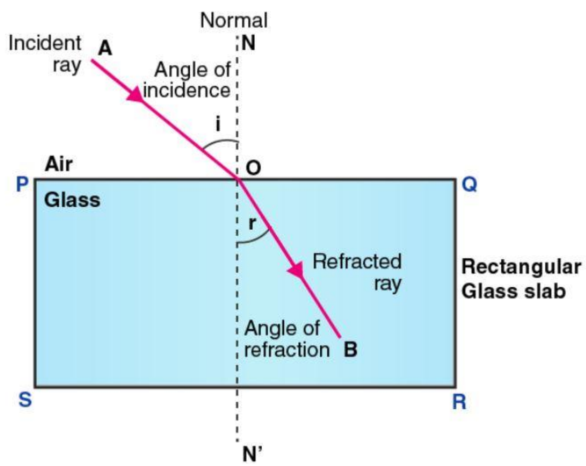
These properties can be explained by the laws of reflection. The first law of reflection states that the incident ray, the reflected ray, and the normal to the surface all lie in the same plane. The second law of reflection states that the angle of reflection is equal to the angle of incidence.

The properties of reflection in a plane mirror have a wide range of applications. For example, mirrors are used to create images, to change the direction of light, and to focus light. Mirrors are also used in a variety of optical devices, such as telescopes, microscopes, and cameras.

Refraction

What is refraction?

Refraction is the bending of a light ray when passing from one medium to another, when light passes through a rarer (less dense) medium to a denser medium, it will move towards the normal vice versa.



Refractive index is a measure of the magnitude of bending of light when it passes from one medium to another.

There are 5 formulas of the refractive index:

(n) is the symbol of refractive index

(i) is the angle of incidence measured above

Small (r)is the angle of refraction

(C) is the critical angle

1. n1*sin1=n2*sin2

2. n=sin(I)/sin(r)

3. n=1/sinC

4. n=Real Depth/Apparent Depth is the formula for images in water

5. n=Speed of light in a vacuum (E)/ Speed of light in medium

Things to consider

- Refraction is the bending of a ray of light when it passes through different mediums.
- This is caused by a change in speed of light due to the difference in optical densities (not covered, better to know.)
- It changes the wavelength of the light; the frequency does not change.

Total Internal Reflection:

Total internal reflection is when a light ray passes through a medium (not air) and all of the light gets reflected back into the same medium.

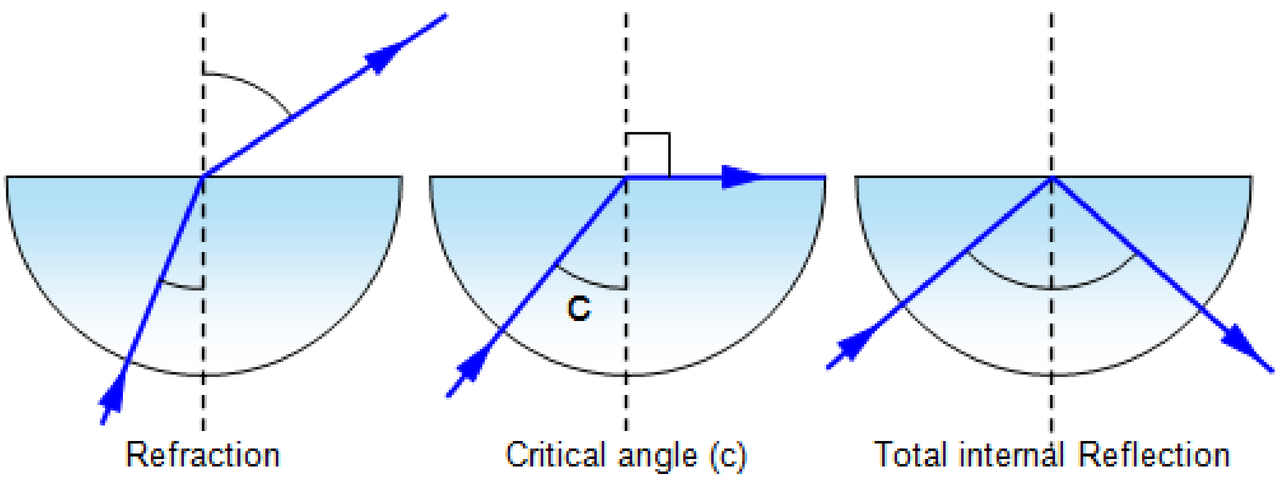
<u>Conditions for this to occur:</u>

1. Light ray must be moving from a dense medium to a rare medium.
2. The angle of incidence is greater than the critical angle.

Total internal reflection can be calculated using the formula above $n=1/\sin(C)$ where C is the critical angle.

Critical Angle: It is the angle at which the angle of refraction is 90˚, and where total internal reflection occurs.

Representation of Critical Angle:

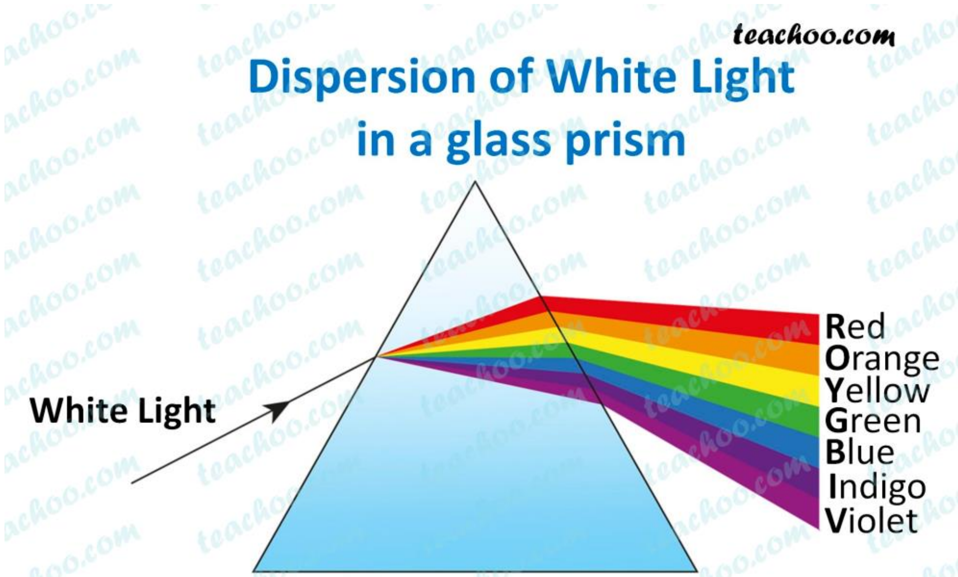


Uses in real life:

Swarovski the crystal jewelry franchise utilizes the critical angle of glass (42) in order to make their glass shiny as the light will keep bouncing inside the glass until it hits a non-critical angle.

Why does a prism split white light into the seven colors of the rainbow?

A prism splits white light into the seven colors of the rainbow because of a phenomenon called dispersion. Dispersion is the separation of light into its component colors by refraction. When light passes through a prism, it is refracted (bent) at different angles depending on its wavelength. Shorter wavelengths (like violet) are refracted more than longer wavelengths (like red). This causes the different colors of light to emerge from the prism at different angles, creating a rainbow spectrum.



The light enters the prism on the left side and is refracted as it passes through the prism. The violet light is refracted the most, followed by blue, green, yellow, orange, and red. The light then exits the prism on the right side, separated into its component colors.

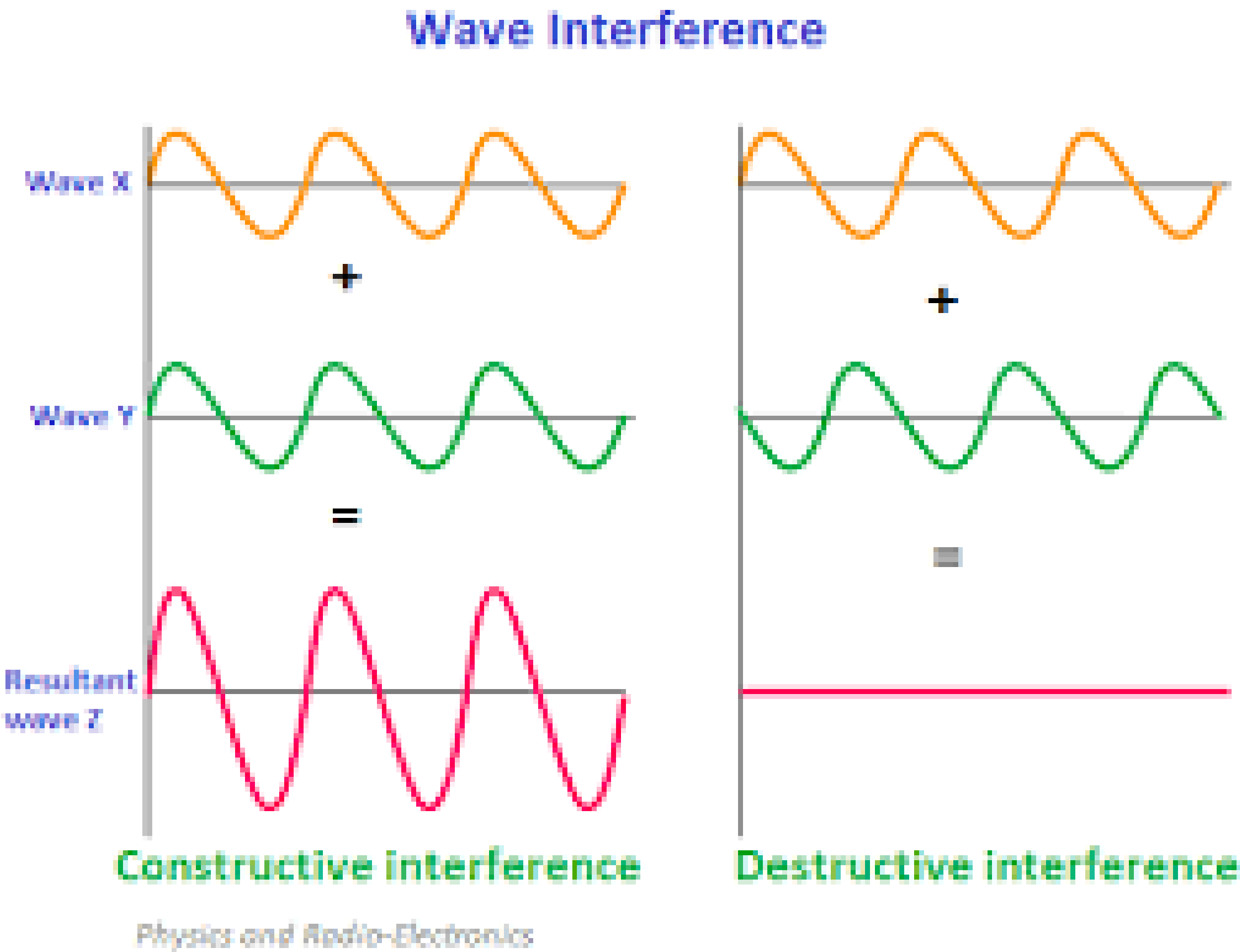
Here is a simplified explanation of the physics behind dispersion:

- Light is a form of electromagnetic radiation, and all electromagnetic waves travel at the same speed in a vacuum.
- However, when light travels through a material, its speed is slowed down. The amount by which the speed of light is slowed down depends on the material and the wavelength of the light.
- Short-wavelength light (like violet) is slowed down more than long-wavelength light (like red).
- When light passes from one material to another, it is refracted (bent) at an angle. The angle of refraction depends on the speed of light in the two materials.
- Because light of different wavelengths travels at different speeds in a material, it will be refracted at different angles.
- This is why a prism can split white light into its component colors.

Dispersion is a very important phenomenon in optics and has many applications, such as in rainbows, binoculars, and spectroscopes.

Interference

Interference is a fundamental phenomenon in physics that occurs when two or more waves combine to form a new, resultant wave. The resulting wave can have a greater, lower, or equal amplitude to the original waves depending on their phase relationship



Conditions for interference:

1. The waves must be of a similar type, i.e. light or sound.
2. The waves must be coherent sources which means that they must have the same frequency and wavelength.

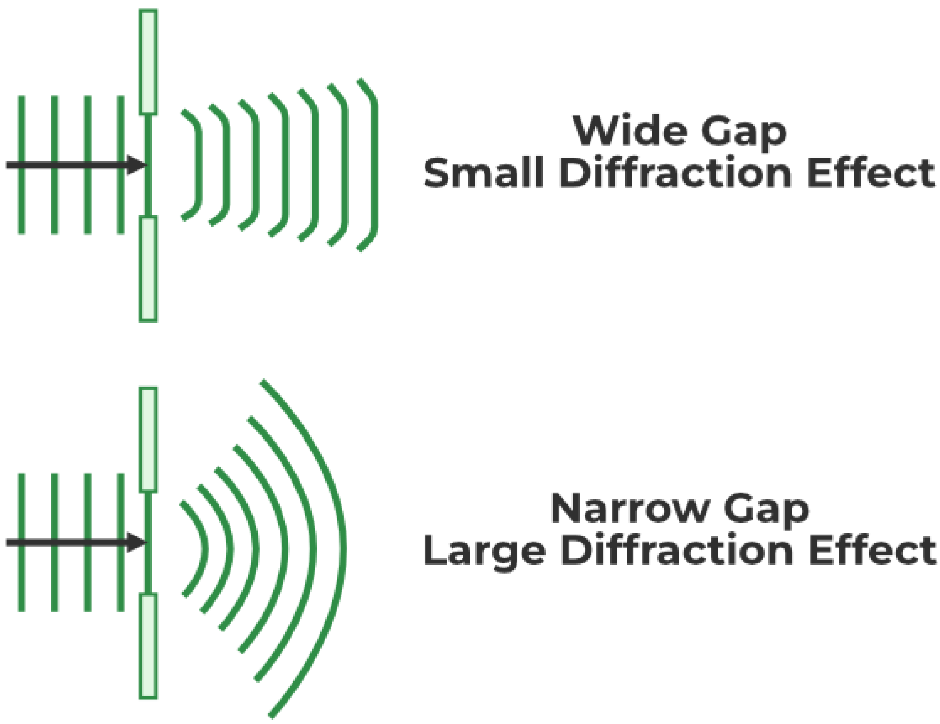
Constructive interference occurs when the waves are in phase with each other, and destructive interference occurs when they are out of phase.

Superimposition: When two waves are on the same plane.

Diffraction

Diffraction:

Diffraction is the spreading out of waves as they pass through or around an obstacle. This occurs when the size of the obstacle is comparable to the wavelength of the wave.



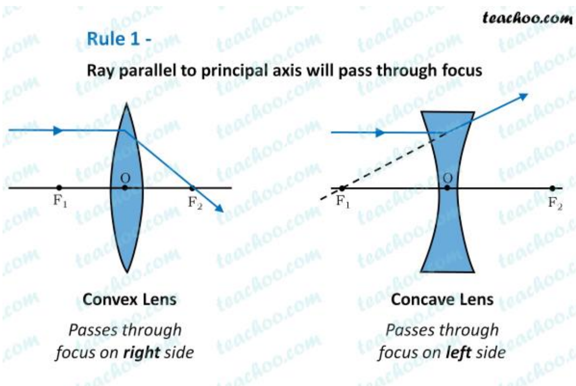
Lenses

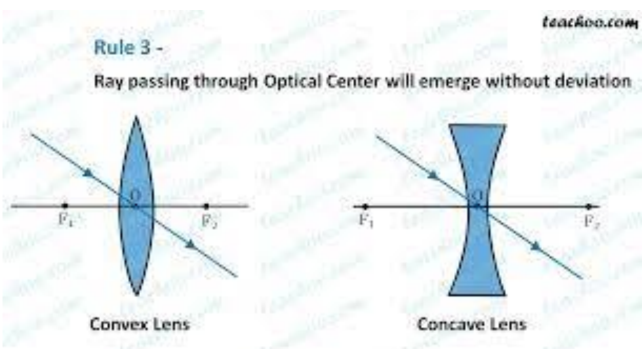
Convex Lenses

Convex lenses are outward curving lenses used with the purpose to form images, they have many uses worldwide, however, some everyday uses are glasses, cameras etc. (Converging lens)

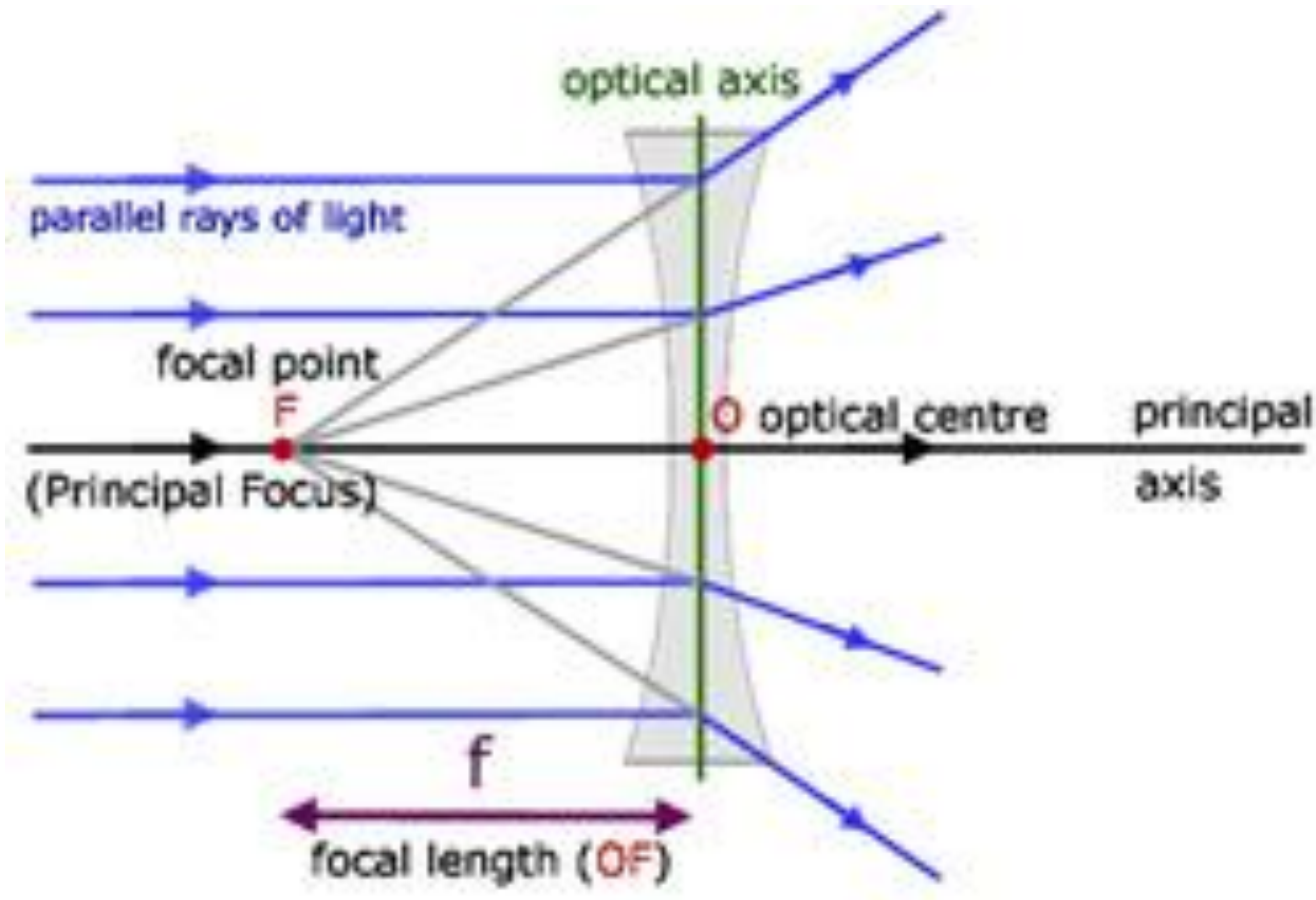
<u>Laws of Lenses:</u>

1. If a light ray passes through the optical center, it will pass through without deviation.
2. If the light ray is parallel to the principal axis, once it passes through the lens it will pass through the focus.
3. If the ray passes through the initial focal point, it will become parallel with the principle axis after being deflected through the lens.





Fully labeled ray diagram to understand all the keywords. (Concave lens acts differently)



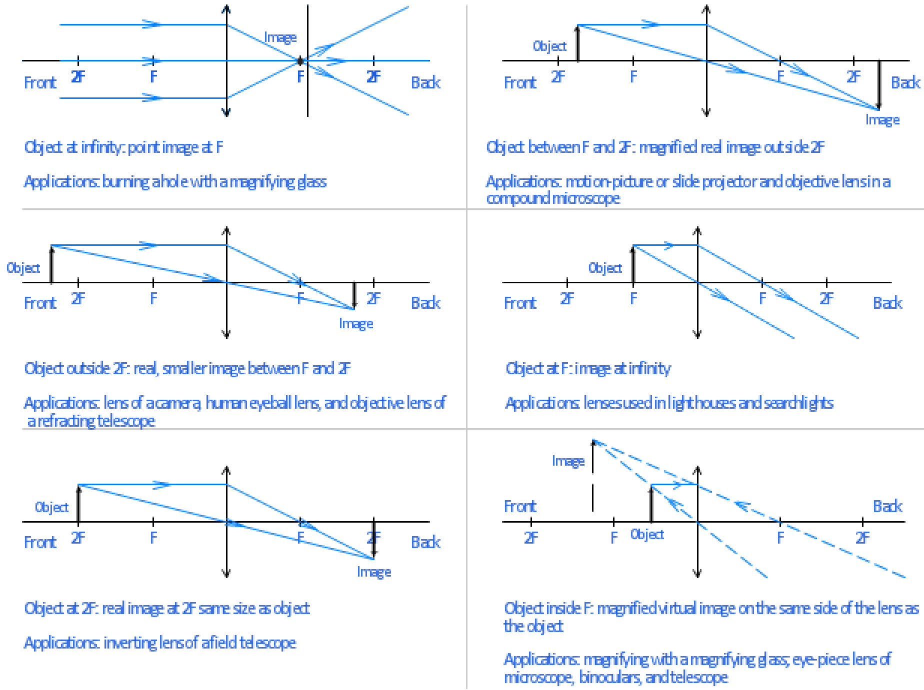
How to draw a ray diagram in a convex lens

1. Begin by finding the point at the top of the image.
2. Draw a line passing through the optical center and extend it beyond the first focal point.
3. Draw a line parallel to the principal axis and once it passes the lens ensure that it passes through the second focal point.
4. (Optional) Draw a line passing through the initial focal point and after it is deflected ensure it is parallel to the principal axis.
5. Finally, the point at which the three lines intersect is the top of the image.
6. Draw a line from the top of the image to the principal axis.
7. Describe the image.

How to describe an image.

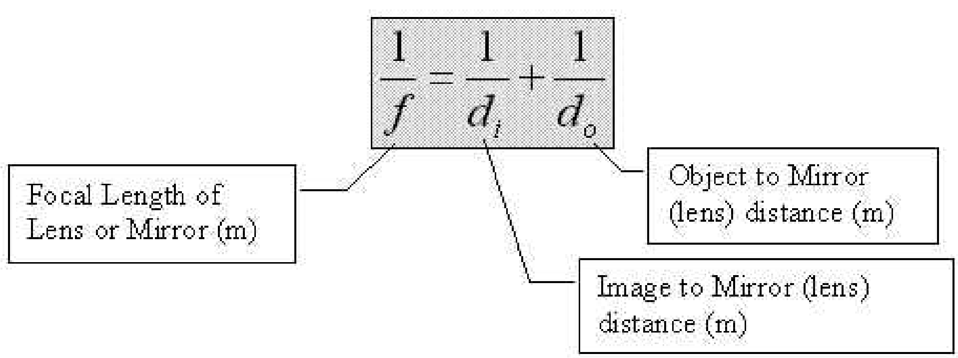
1. Erect/Upright.
2. Inverted.
3. Virtual.
4. Real.
5. Magnified/Enlarged.

6. Diminished.



A virtual image only happens when the object is between the focal point and the optical center, therefore, the diagram must be traced back in order to form a virtual image.

Focal length formula



Magnification Formula

Height of Image ÷ Height of Object= -(distance from lens to image) ÷ distance from lens to object

Concave Lens:

A concave lens, also known as a diverging lens, is a type of lens that is thinner in the middle than at the edges. This shape causes light rays to bend outwards (diverge) when they pass through the lens, unlike a convex lens which converges light rays.

These always form virtual images as the rays do not converge.