Physics 17 Notes Part Q Dr. Alward

Video Lecture 1: Refraction
Video Lecture 2: Convex Lenses
Video Lecture 3: Concave Lenses

Light Refraction, Lenses

Index of Refraction

The speed of light in air or vacuum is $c = 3.0 \times 10^8$ m/s. In transparent substances, other than air or vacuum, the speed of light is less than c. Let v = speed of light in the substance.

Transparent substances have a property called "index of refraction, "symbolized as n

$n = c/v$

Note that since n is the ratio of quantities with the same units (m/s), the units cancel, so n is unit-less.

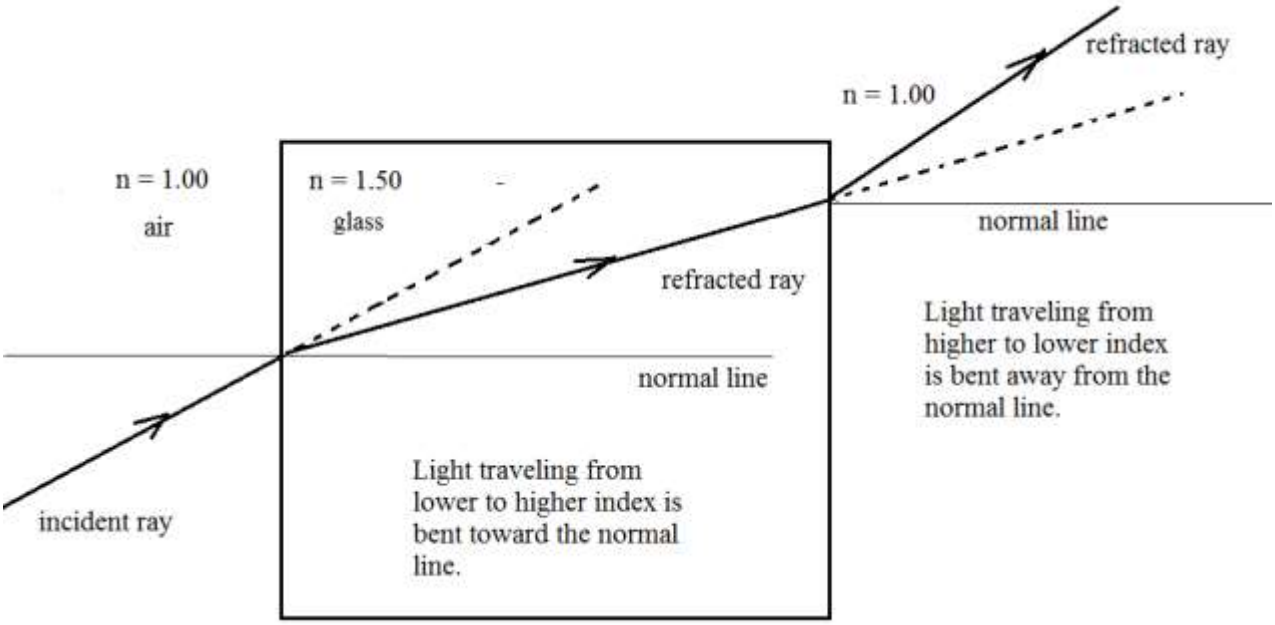
The word "refract" means "to bend."

Light traveling from one medium to another is bent, or, "refracted."

Substance	n
Vacuum	1.00
Air	1.00
Water	1.33
Glass	1.50

Example: What is the speed of light in water?

$c/v = 1.33$
$v = c/1.33$
$= 3.0 \times 10^8 / 1.33$
$= 2.3 \times 10^8$ m/s

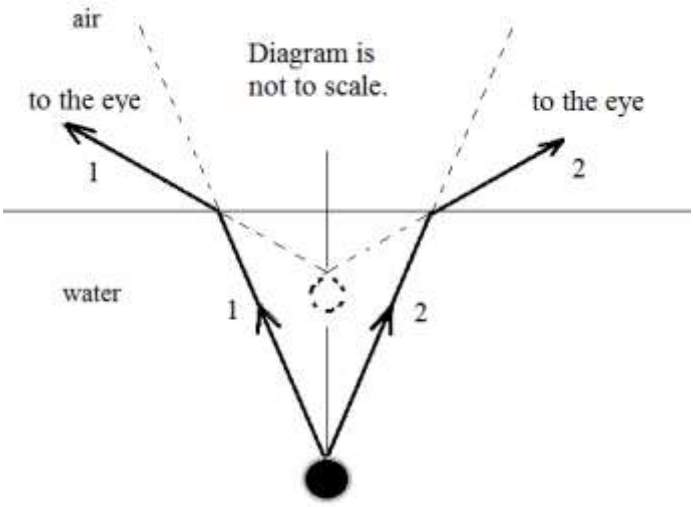


A “normal” line is a line that is perpendicular to a surface; in this case, the surface is the interface plane between air on the left, and glass on the right.

Apparent Depth under Water

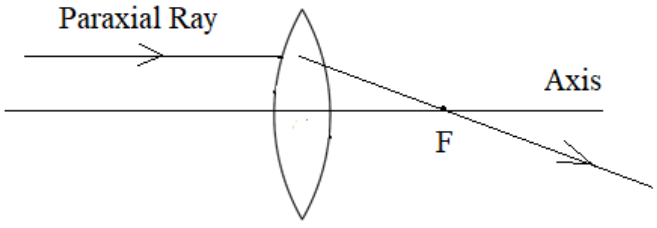
Objects under water are farther below the surface than they appear. Normal lines are not shown.

Light traveling from water to air is bent away from the normal line.



Convex Lenses

Rays parallel to the axis are called “paraxial rays.”



Paraxial rays refract through the focus.

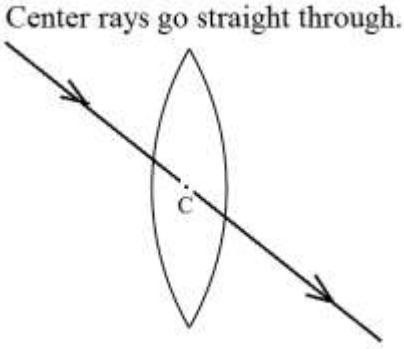


Image Formation with Convex Lenses

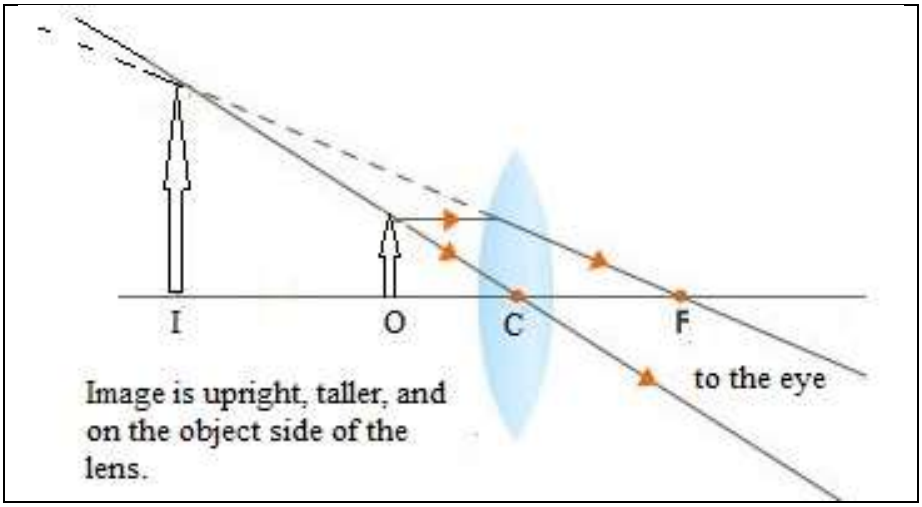
Example: The focal point of a convex lens is 20 cm from the lens. A 10-cm tall object is placed 15 cm from the lens. What is the height of the image?

Sunlight or room light reflects off the top of the object arrow; we follow just two of the rays--a paraxial ray, and a center ray. The two rays reaching the eyes are extrapolated backward to their intersection point. The intersection point appears to the eye to be the common point from which the two rays of light originated, just as if there were an object there. That point is the image location.

The distances below are roughly to scale.

The figure below indicates that the approximate height of the image is 25 cm.

Light is not really coming from the image location so the image type is labeled "virtual."



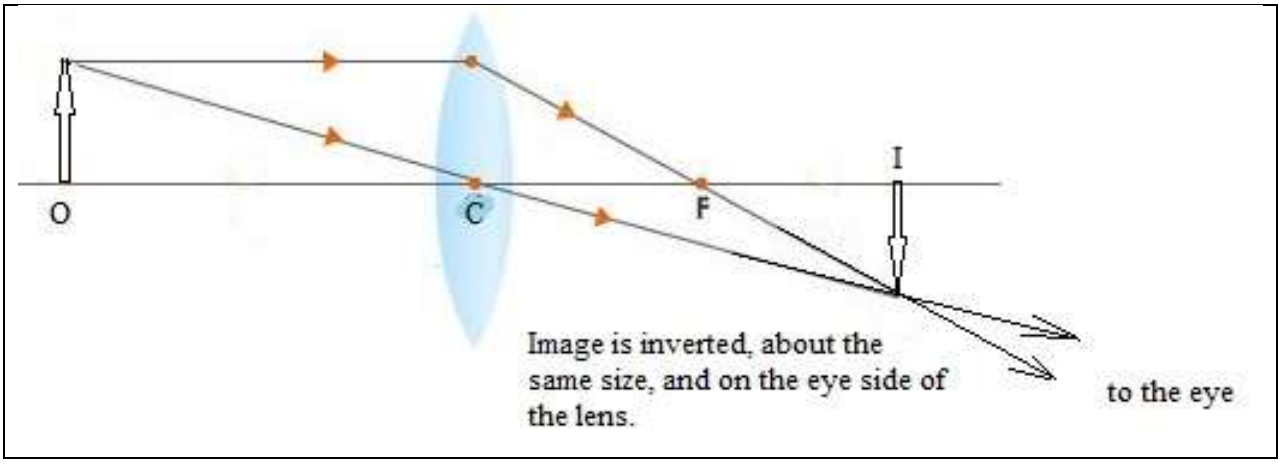
The diagram above is similar to the one drawn at the end of Video Lecture 1.

Example: The focal point of a convex lens is 30 cm from the lens. A 20-cm tall object is 52 cm from the lens. The distances below are approximately to scale.

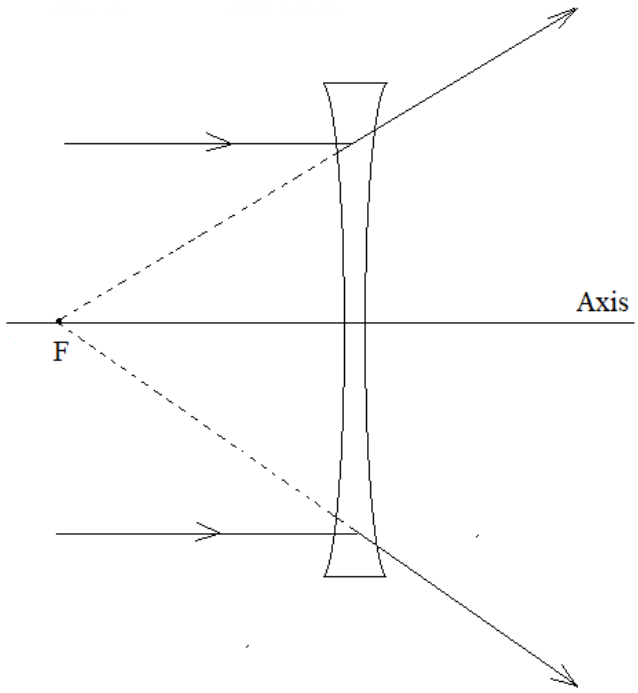
What is the height of the image? Is it real, or virtual?

Answer: Based on the diagram below, the approximate height of the image is about 15 cm.

Light really *is* emanating from the image location, rather than just appearing to do so: The image is real.



Concave Lenses



Paraxial rays, after passing through concave lens, seem to have originated at the focal point, F.

Rays aimed at the center go straight through.

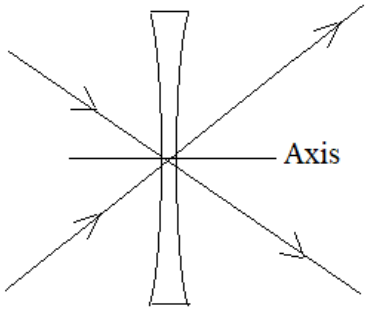
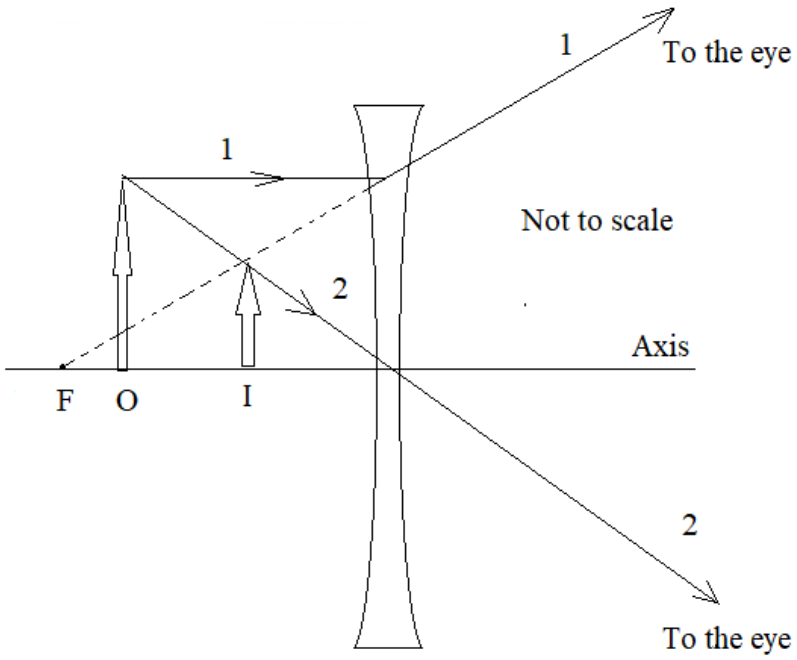


Image Formation with Concave Lenses

Image is smaller, upright, and virtual.



This example will be discussed in Video Lecture 3.