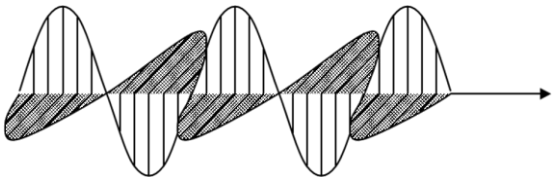
Optics Name _____

Video 1003 (6:08)

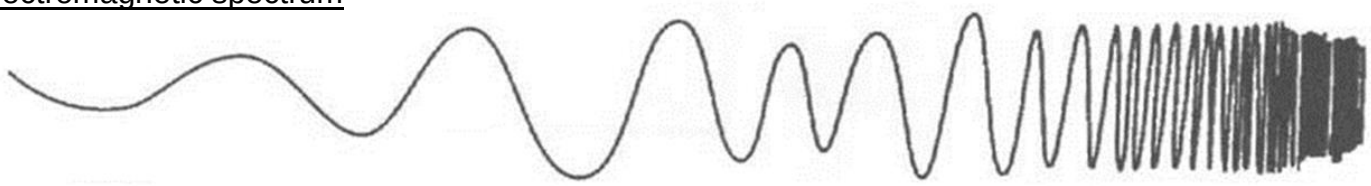
Electromagnetic Radiation (i.e., light)

--

-- source is…



electromagnetic spectrum



radio waves | microwaves | IR | visible | UV | X-rays | gamma rays | cosmic rays

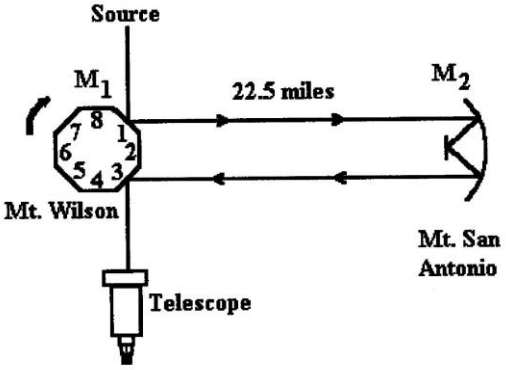
Video 1006 (6:24)

The Speed of Light

Albert Michelson (1879)

--

speed of light in vacuum (and air) is constant

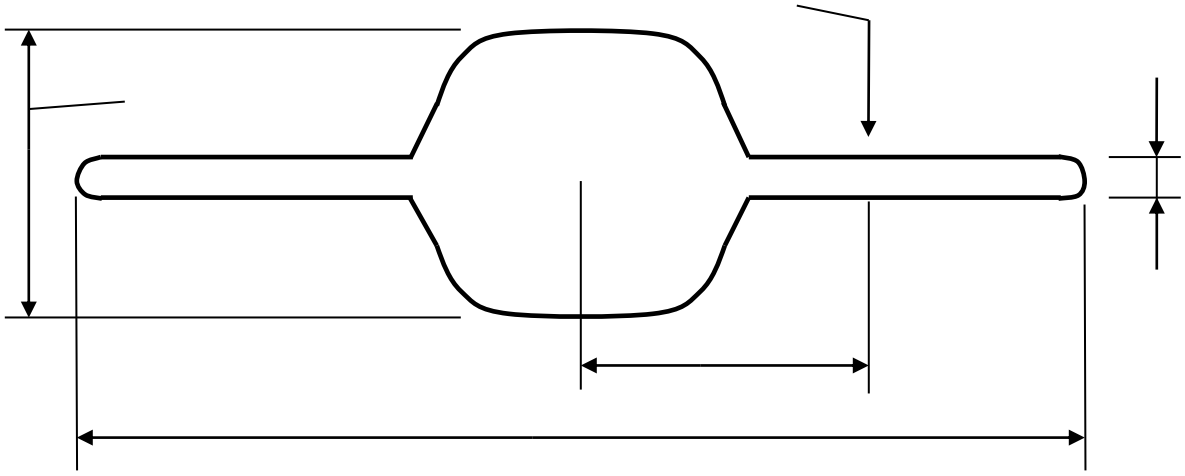


EX. Find the wavelength of a B-104 radio wave (FM 104.1, with f = 104.1 MHz).

EX. Find the wavelength of a WBBM radio wave (AM 780, with f = 780 kHz).

light year: **MILKY WAY GALAXY**

Video 1009 (6:38)

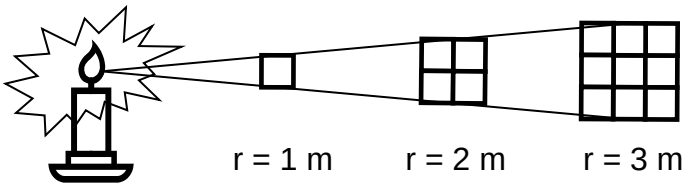


Video 1012 (2:45) **Behavior of Light**

For radiant objects, the brightness we sense depends on two factors:

1.

2.



Video 1015 (4:14) **Light-Material Interaction**

transparent: most light rays travel through material and remain parallel

--

e.g.,

translucent: many light rays travel through material, but the material scatters them

--

e.g.,

opaque: essentially no light travels through material; all light is reflected and/or absorbed

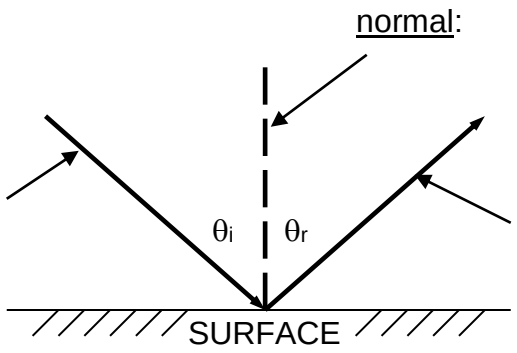
e.g.,

Video 1018 (1:29)

Reflection

θ_r: angle of reflection

θ_i: angle of incidence

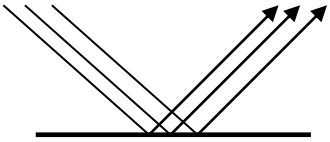


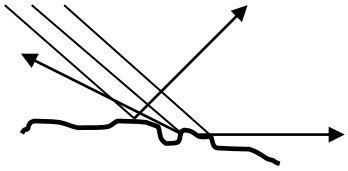
θ_r and θ_i are measured…

Law of Reflection:

Video 1021 (5:24)

Types of Reflection





Compared to surface irregularities, light λs are… … …

Video 1027 (5:32)

Spherical Mirrors

convex mirror:

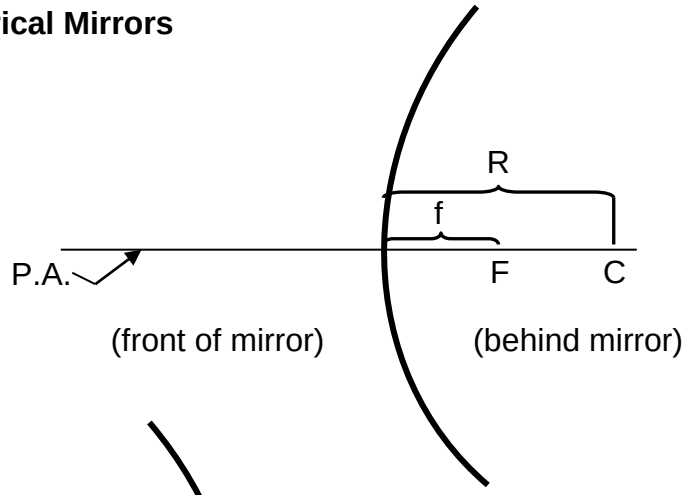
P.A. = principal axis

C = center of curvature

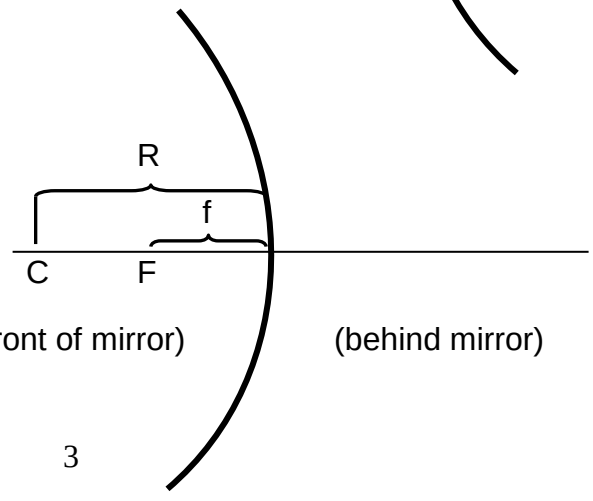
F = focal point

f = focal length

R = radius of curvature = 2f



concave mirror:



Mirror Ray Diagrams

Video 1030 (6:48)

Line up top of object…	Draw ray from top of object to mirror.	The light ray reflecting back to the left will be along a line connecting pt. of intersection w/mirror…
// to P.A.		
w/F.		
w/C.		

real image: rays actually intersect; can project it on a screen

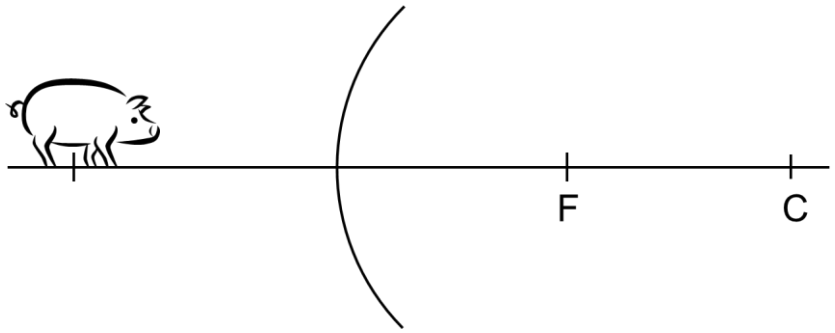
virtual image: rays appear to intersect, but don't; cannot project it on a screen

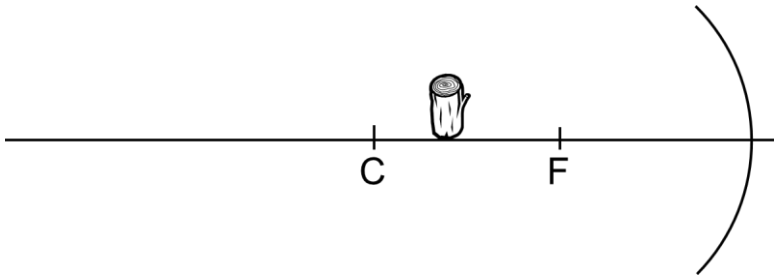
Mirror Variables

- p = object dist. → always +; always on left
- q = image dist. → +, real, left; –, virtual, right
- h = object height → always +, always upright
- h' = image height → +, upright; –, inverted
- f = focal length
- R = radius of curvature

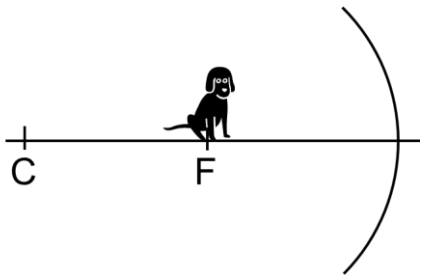
Mnemonic for Mirror Variables p and q

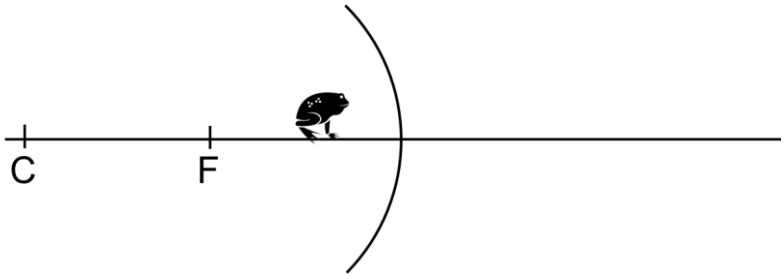
o**b**ject ima**g**e





Video 1031 (4:33)





Video 1033 (6:12)

Mirror Equation and Magnification

EX. Concave mirror has radius of mag. 55 cm. Object is 84 cm from mirror, is 24 cm tall. Find focal length, image distance, and magnification. Describe image.

Video 1034 (6:35)

EX. Concave mirror has focal length of mag. 36.0 cm. Object has height 18.0 cm, is 8.00 cm from mirror. Describe image.

EX. Concave mirror has focal length of mag. 30 cm. Object of height 10 cm is at mirror's focal point. Describe image.

Video 1036 (6:16)

EX. Convex mirror has radius of mag. 64.0 cm. Object has height 24.0 cm, is 30.0 cm from mirror. Describe image.

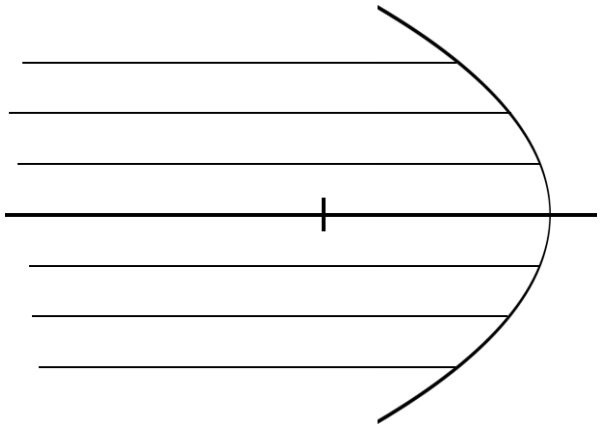
Video 1039 (4:25)

Parabolic Mirrors

Drawback of spherical mirrors:

-- resulting blurring =

-- remedied using <u>parabolic mirrors</u>



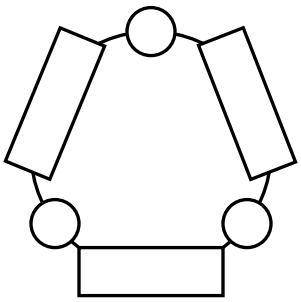
If a mirror is spherical…

Video 1042 (7:11)

Color White light contains all visible λs.

Objects that "are"… white / colored / black } reflect { } visible λs, and absorb {

Primary colors of light (NOT pigments):

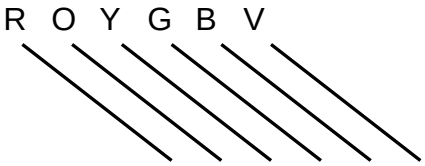


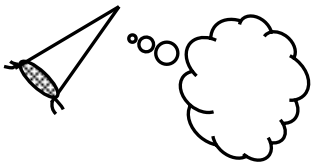
Light is <u>additive</u>.

Two colors of light are <u>complimentary</u> if, when added, they produce white light.

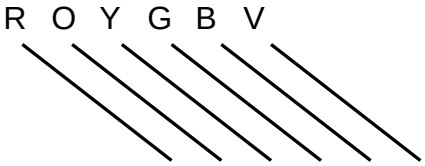
Pigments are <u>subtractive</u>.

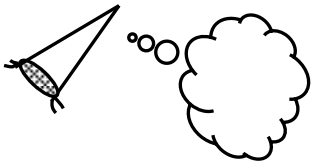
blue pigment (incident W light)



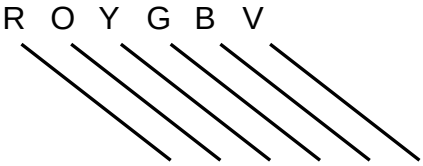


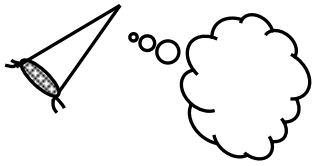
yellow pigment





blue pigment + yellow pigment



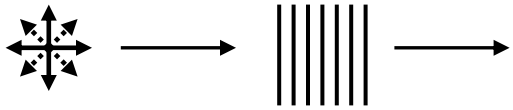


Video 1048
(5:27)

Polarization of Light

Normally, light is <u>unpolarized</u>;

i.e.,

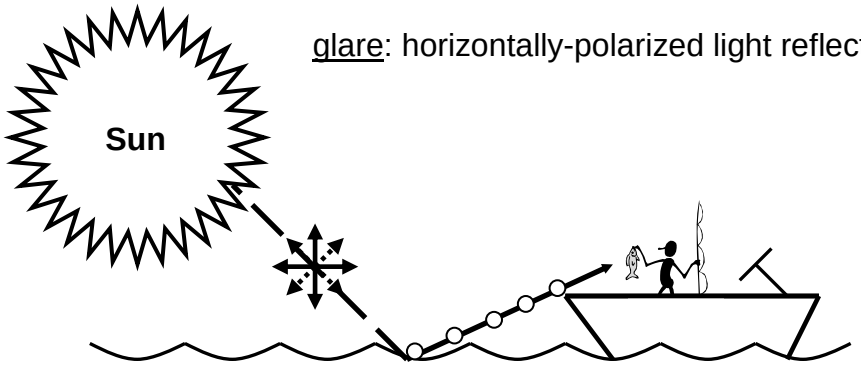


unpolarized light

polarizing filter

<u>polarized light</u>: orderly vibrations

<u>glare</u>: horizontally-polarized light reflected off horizontal surfaces



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Video 1103
(6:06)

refraction: the bending of light as it travels at an angle from one transparent medium into another

When light goes from a [less] / more optically dense medium to a [more] / less optically dense medium, it bends [toward] / away from the normal.

BEACH

LESS OPTICALLY DENSE MEDIUM

OCEAN

MORE OPTICALLY DENSE MEDIUM

AIR (less dense)

GLASS (more dense)

AIR (less dense)

Video 1106
(4:34)

Index of Refraction

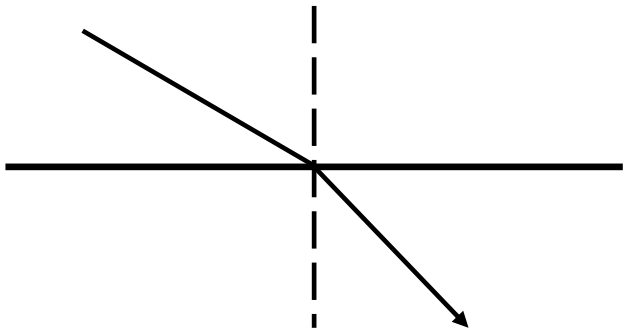
n = index of refraction;

c = 3.00×10^8 m/s;

v = speed of light in mat'l (m/s)

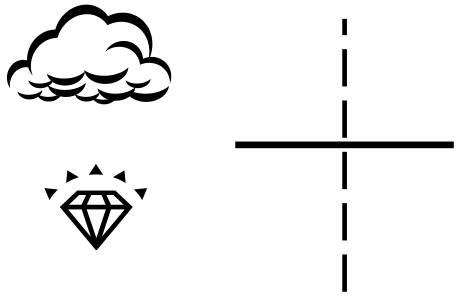
In general...

Snell's Law

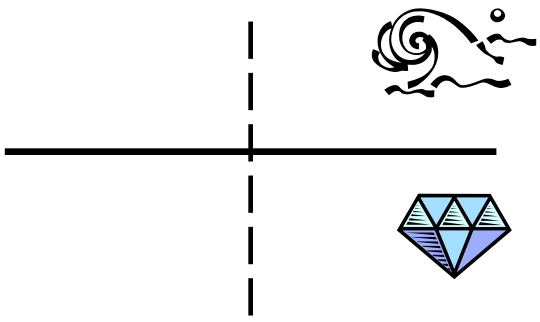


Video 1109
(5:11)

EX. Light in air is incident on diamond (n = 2.419) at 43.0°. Find the angle of refraction.



EX. Light in water is incident on cubic zirconia at 31.5°. Angle of refraction is 18.5°. Water's index of refraction is 1.333. Find speed of light in cubic zirconia.

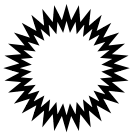


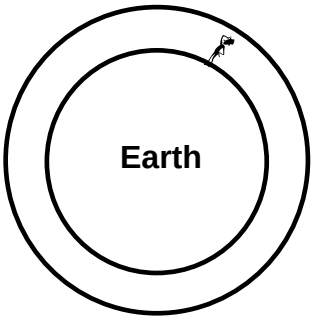
Examples of Refraction

Video 1112 (5:29)

atmospheric refraction

We continue to see the Sun after it has set.





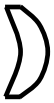
Video 1115 (4:32)

mirages

Video 1121 (5:25)

Lenses

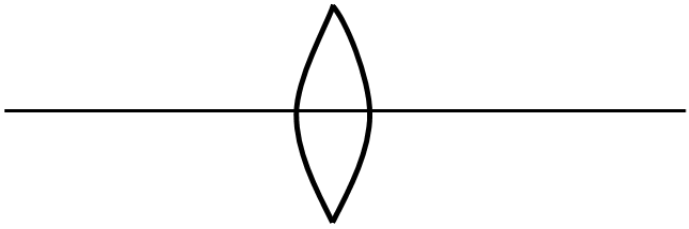
Types of Lenses

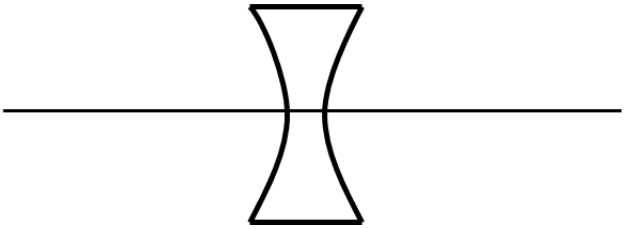
converging lenses		diverging lenses	
double convex		double concave	
plano-convex		plano-concave	
concavo-convex		convexo-concave	

Lens Ray Diagrams

First… 1. Draw a centerline vertically through lens.

2. Draw two F's, measured from centerline.





Line up top of object…	Draw ray from top of object to lens' centerline. Keeping in mind the type of lens…	…the light ray refracts and continues toward the right along a line from its pt. of intersection w/centerline…
// to P.A.		
w/F		
w/center of lens		

real image: rays actually intersect; can project it on a screen

virtual image: rays appear to intersect, but don't; cannot project it on a screen

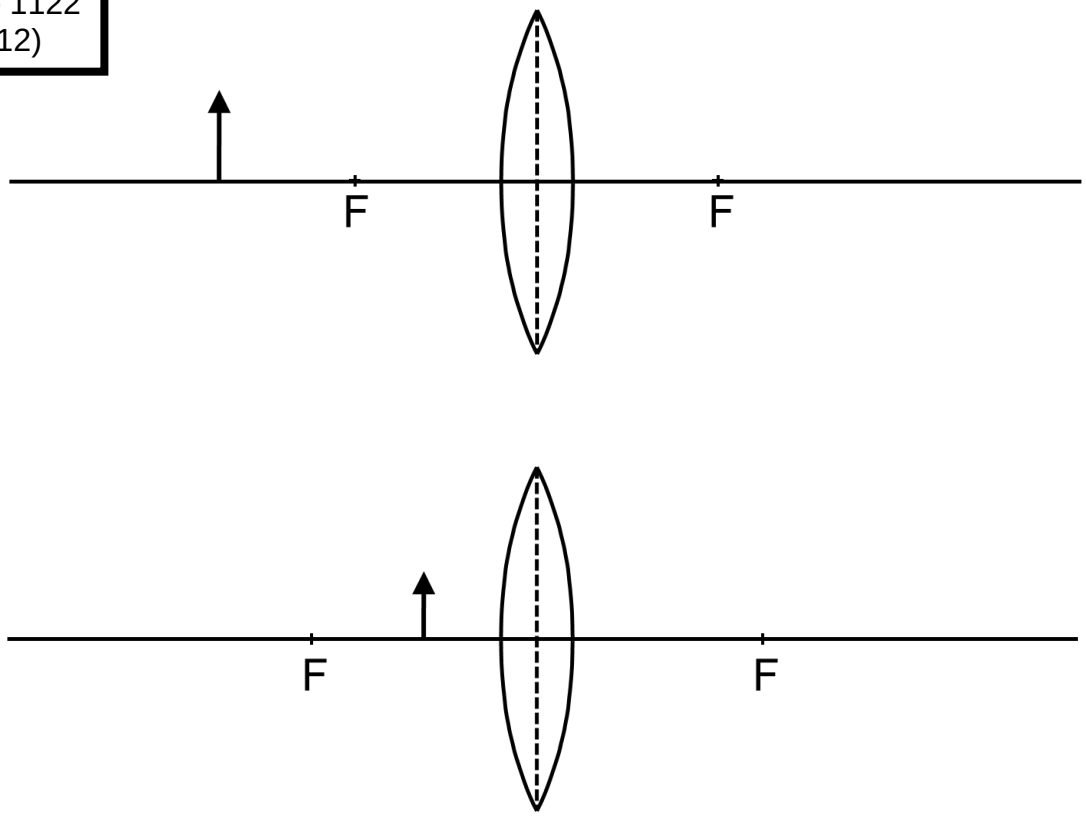
Lens Variables

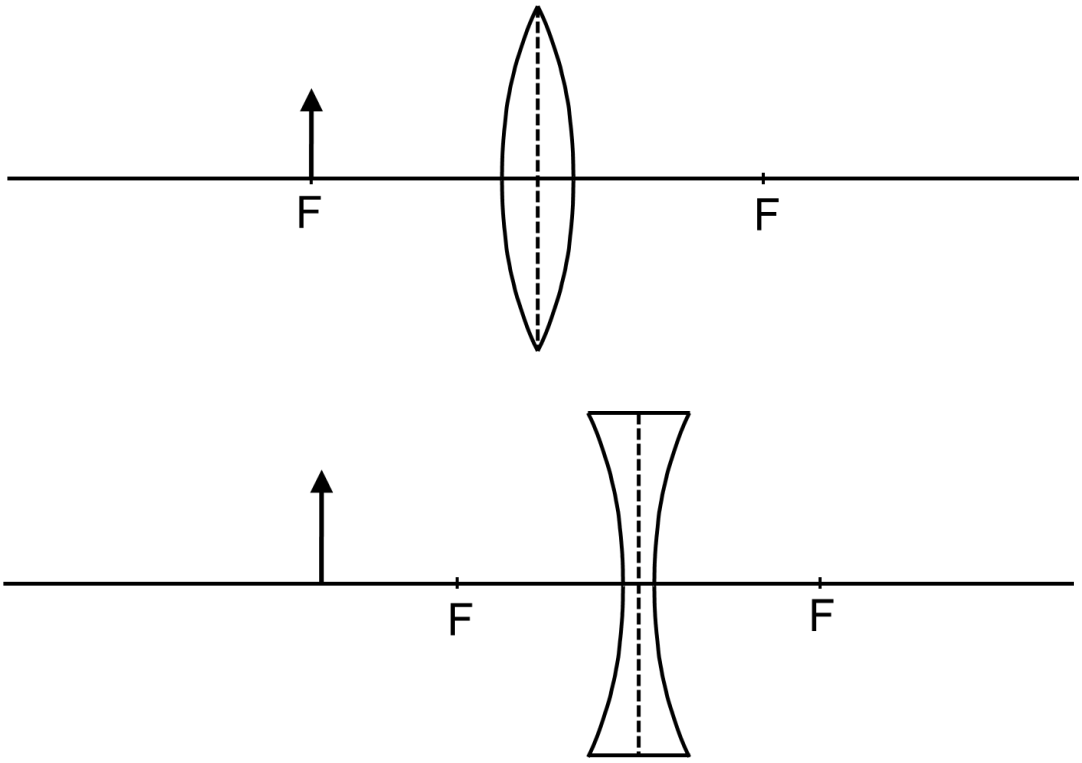
- p = object dist. → always +; always on left
- q = image dist. → +, real, RIGHT; –, virtual, LEFT
- h = object height → always +, always upright
- h' = image height → +, upright; –, inverted
- f = focal length
- R = radius of curvature

Mnemonic for Lens Variables p and q

o**b**ject ima**g**e

Video 1122 (7:12)





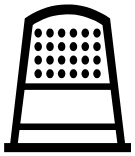
Video 1124 (4:18)

Thin Lens Equation and Magnification

EX. Diverging lens has focal length of mag. 10.0 cm. A wiener-dog puppy 15.0 cm tall is 22.0 cm from lens. Describe image.

Video 1125 (4:02)

EX. Converging lens has focal length of mag. 7.7 cm. A 0.38 cm-tall real image of a thimble is formed 9.1 cm from lens. How far from lens is thimble? How tall is thimble?



Video 1127 (5:10)

Correcting Vision with Lenses

farsighted | nearsighted

What is in focus?

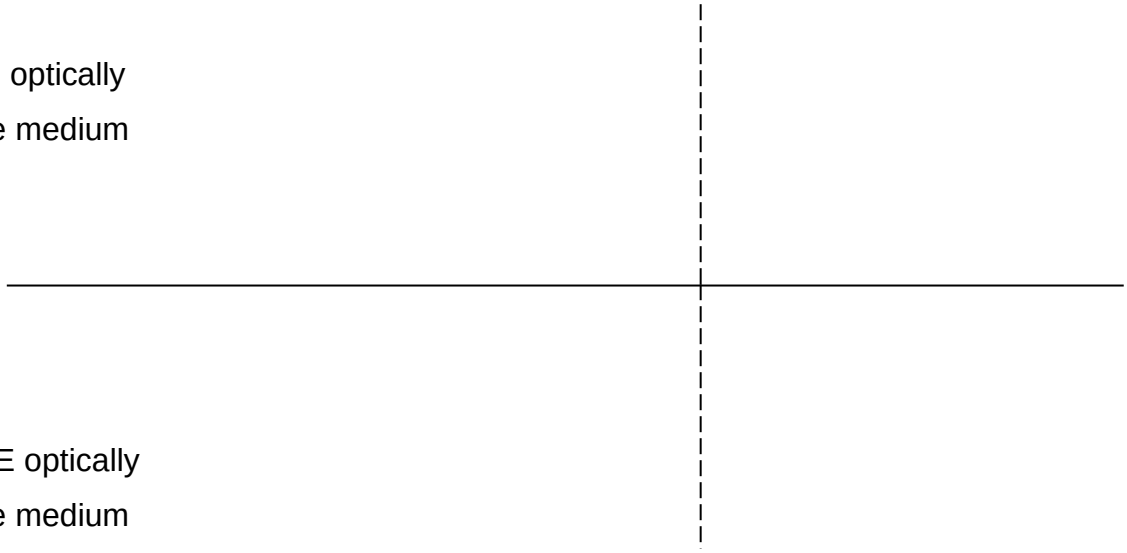
What is blurred?

How do we correct the condition?

Video 1130 (6:29)

Total Internal Reflection

The <u>Critical Angle</u>, θ_c →



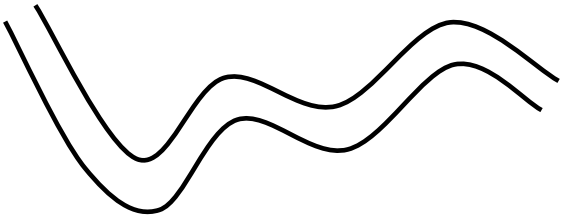
Equation for the Critical Angle:

EX. Find critical angle for light traveling from flint glass (n = 1.900) into crown glass (n = 1.522).

<u>total internal reflection</u> -- light is incident from a MORE optically dense medium to a LESS optically dense medium at $\theta_i \geq \theta_c$

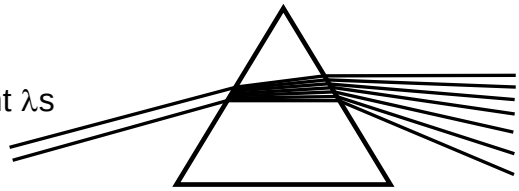
-- no light escapes from the MORE optically dense medium

e.g., total internal reflection in fiber optic cables



Video 1133 (3:46)

Dispersion → when polychromatic light is separated into its component λs



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-- By convention, the accepted index of refraction for a material is for λ = 589 nm.

Because n differs for different λs of light, the various λs traveling through a lens focus at slightly different points.

The resulting blurring is…

…which is reduced by...