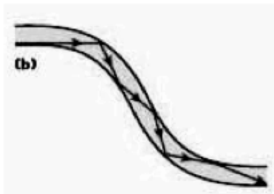
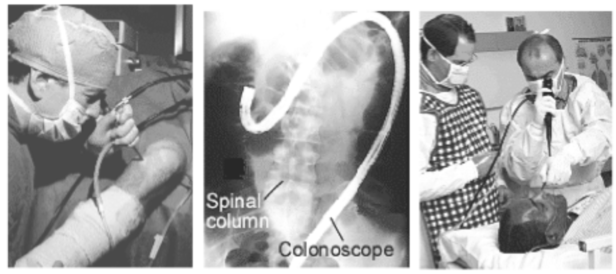
Applications of Total Internal Reflection

Fiber Optic Cables





How do fiber optic cables work?

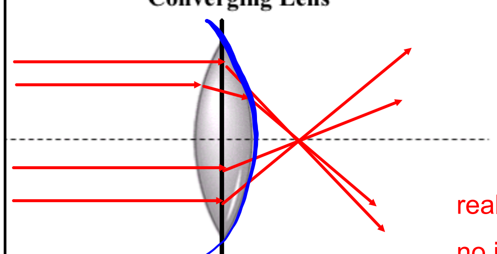
Light beam carrying coded signals strikes boundary at angle greater than critical angle

Lenses

Why do lenses converge or diverge light? refraction of light at each surface

How can the focal length of a converging lens be found? Allow light from a very distant source to focus on screen and measure distance from lens to screen

Converging Lens

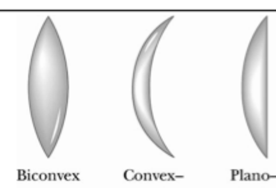


Shape: convex

Focal Point: Real

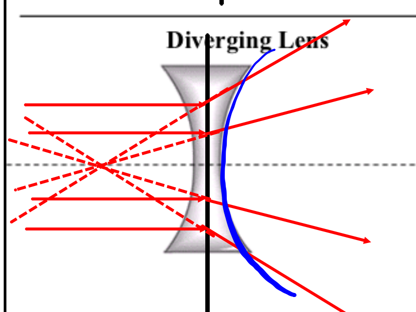
Focal Length: +

Images:
real - smaller, same size or bigger
no image, or larger/virtual



Converging lenses are . . . thicker in middle

Diverging Lens

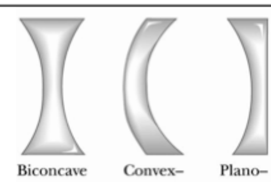


Shape: concave

Focal Point: virtual

Focal Length: −

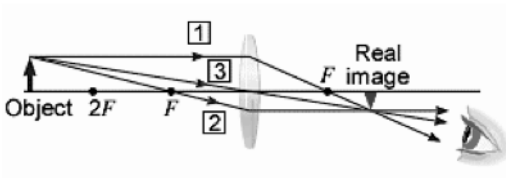
Images:
smaller, upright, virtual



thinner in middle

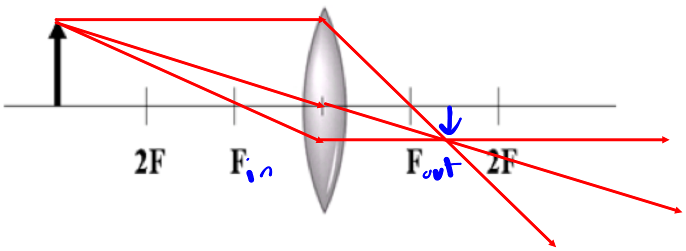
Image Formation by Converging Lenses

Sample of a ray diagram used to locate and describe image



Three Principal Rays used in Ray Diagramming

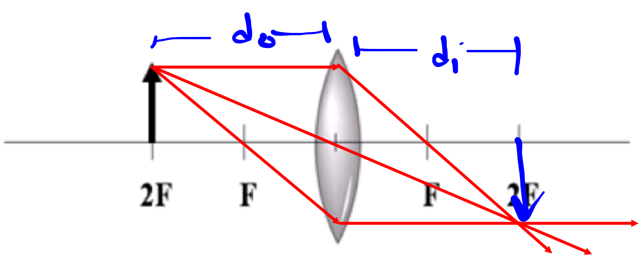
1. in ||, out f
2. in f, out ||
3. in C, out c



Case 1

Properties of image:

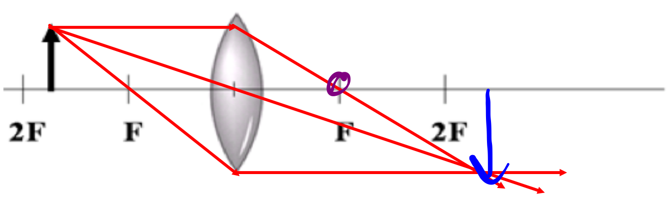
smaller
inverted
Real



Case 2

Properties of image:

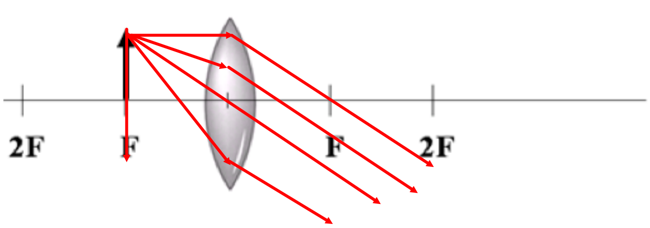
same size
real, inverted



Case 3

Properties of image:

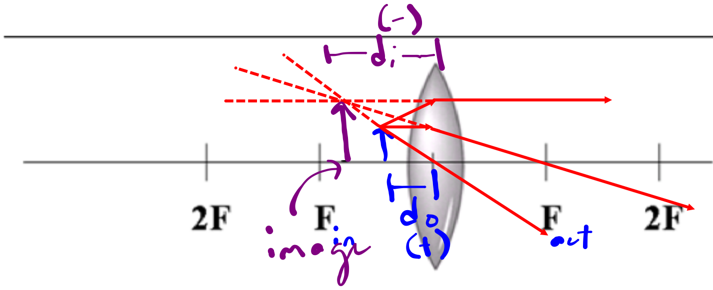
larger
real, inverted



Case 4

Properties of image:

No image

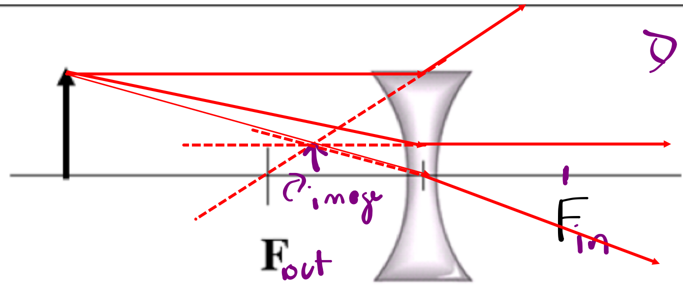


Case 5

Properties of image:

enlarged

virtual, upright



Case 6

Properties of image:

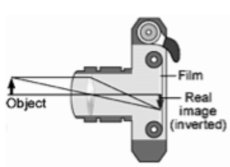
smaller

virtual, upright

Applications

State the type of lens, locate the object and image, and describe the image for each device below.

a) Camera

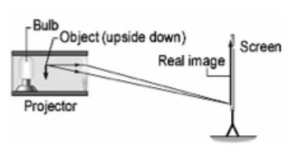


Lens: convex

Object: far from 2f

Image: Between f & 2f

b) Projector



Lens: convex

Object: inside 2f

Image: outside 2f

c) Magnifying Glass

Lens: convex

Object: inside f

Image: virtual

d) Security "Peephole"

Lens: concave

Object: anywhere

Image: smaller, virtual

The Thin-Lens Equation and Linear Magnification

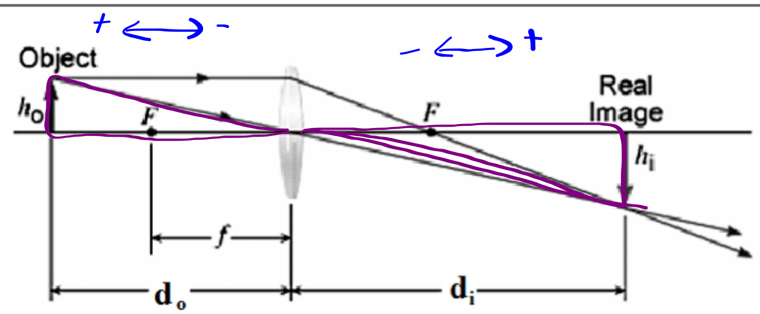
f = focal length

d_o or u = obj. dist.

d_i or v = image dist.

h_o = obj. height

h_i = image height



Thin-Lens Equation

$$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$$

Linear Magnification

$$M = \frac{h_i}{h_o} = \frac{-d_i}{d_o}$$

Sign Conventions

positive = real

negative = virtual

1. A 3.0 cm high object is placed 15 cm from a converging lens whose focal length is 6 cm. Determine the location of the image and describe its properties. Determine the magnification of the lens and the height of the image.

(h_o, d_o, f)

$$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$$

$$d_i = \left(\frac{1}{f} - \frac{1}{d_o}\right)^{-1} = \left(\frac{1}{6cm} - \frac{1}{15cm}\right)^{-1} = 10cm$$

$$M = \frac{-d_i}{d_o} = \frac{-10cm}{15cm} = -\frac{2}{3}$$

Comparisons – Mirrors and Lenses

Converging	Diverging