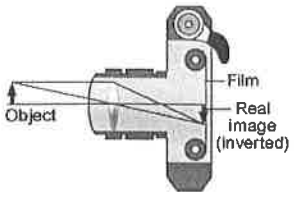
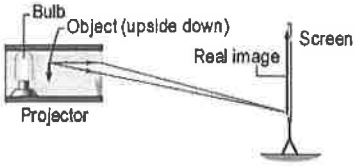
Applications

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

a) Camera **b) Projector** **c) Magnifying Glass** **d) Security "Peephole"**





(convex)

(concave)

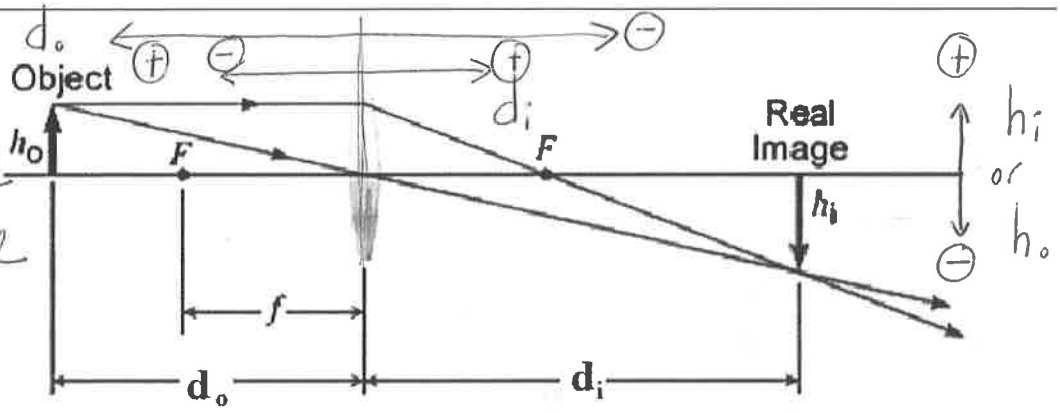
Lens: converging
Object: beyond 2F
Image: between F + 2F
smaller, inverted + real

Lens: converging
Object: inside F + 2F
Image: beyond 2F
larger, real, inverted

Lens: converging
Object: inside F
Image: virtual, larger + upright

Lens: diverging
Object: anywhere
Image: smaller, upright + virtual

The Thin-Lens Equation and Linear Magnification



f = focal length

d_o or u = object distance

d_i or v = image distance

h_o = object height

h_i = image height

Thin-Lens Equation

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

Linear Magnification

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

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

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

$d_i = 10\text{cm}$

real image

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

$M = -\frac{2}{3}$

smaller

$$h_i = M \times h_o$$

$\left(-\frac{2}{3}\right)(3.0\text{cm})$

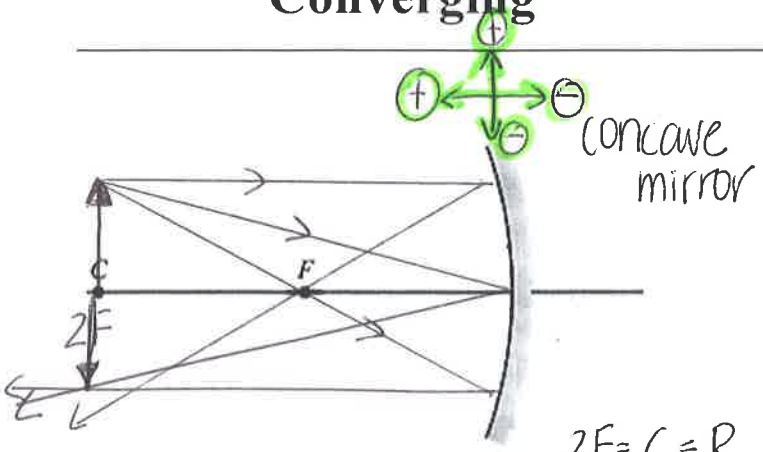
$h_i = -2\text{cm}$

inverted

⊕ real image ⊖ virtual image

Comparisons – Mirrors and Lenses

Converging



2F = C = R

1) In II, out F.
2) In F, out II.
3) In center, out center.

At 2F = At 2F
d_o d_i

Diverging

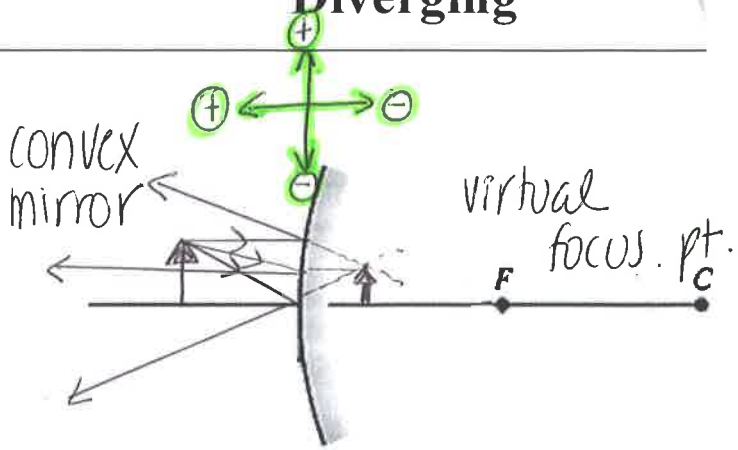
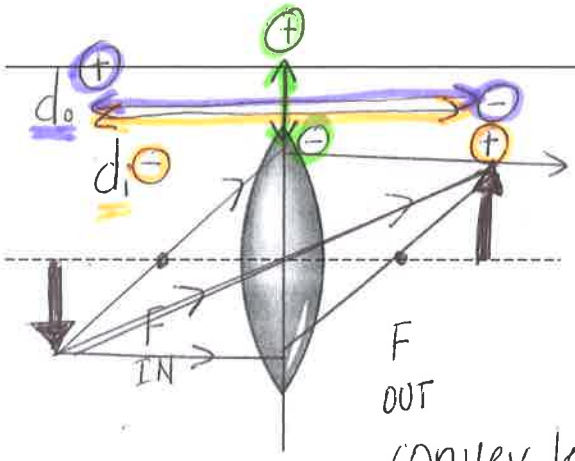
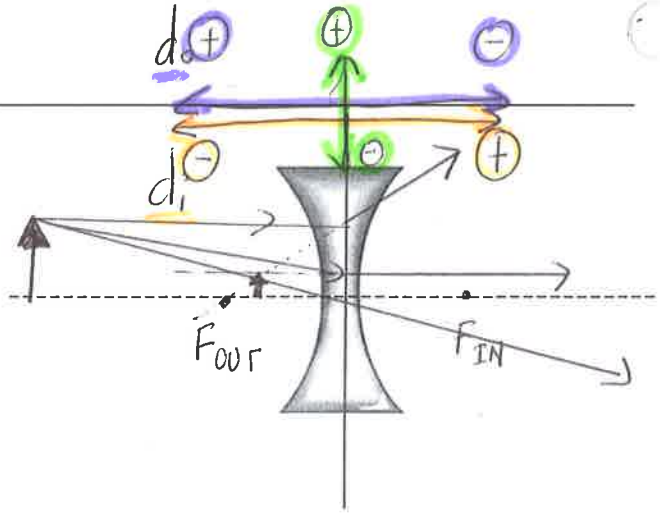


image = smaller
virtual
upright



convex lens
real focus

1) In II, out F_{OUT}
2) In F_{IN}, out II
3) In center, out center



concave lens
virtual focus

image is: virtual
smaller
upright