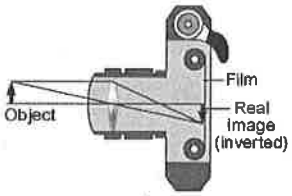
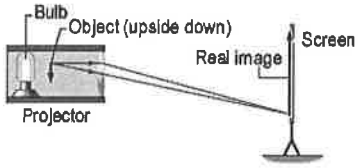
Applications

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

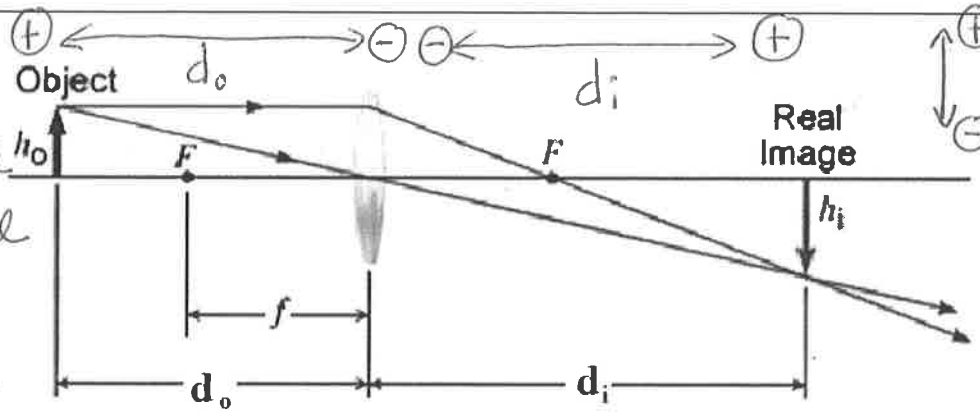
Lens: converging
Object: beyond 2F
Image: between F + 2F
smaller, inverted, real

Lens: converging
Object: inside 2F
Image: outside 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 = height object

h_i = height of image

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 (h_o) is placed 15 cm (d_o) from a converging lens whose focal length is 6 cm (f). Determine the location of the image and describe its properties. Determine the magnification of the lens and the height of the image.

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \qquad M = \frac{\ominus d_i}{d_o} = \frac{h_i}{h_o} \qquad M \times h_o = h_i$$

$$d_i = \left(\frac{1}{f} - \frac{1}{d_o}\right)^{-1} \qquad M = \frac{-10\text{cm}}{15\text{cm}} = \frac{-2}{3} \qquad \frac{-2}{3} \times 3\text{cm} = -2\text{cm} = h_i$$

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

real image

smaller

inverted