

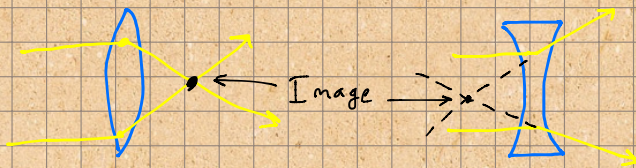
Warm-up:

Lighten Up

Reflection results when light bounces off an object. Refraction results when light passes through something transparent.

Look around the room and identify three objects on which light is reflecting and three objects through which light is refracting.
Hint: Some objects might be an example for both!

- **Lens:** translucent material that refracts light
- **Convex Lens:** bulges out and causes converging rays
- **Concave Lens:** bulges inward and causes diverging rays



Thin Lens Equation:

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

object distance image distance focal length

Magnification Equation:

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

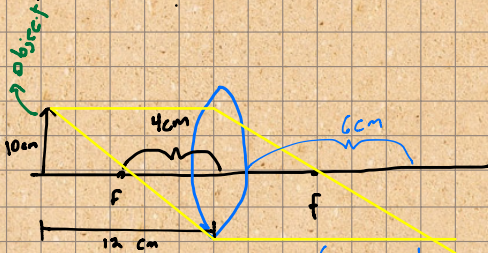
image height object height

$d_i = + =$ real image

$d_i = - =$ virtual image

$h_i = + =$ upright

$h_i = - =$ inverted



$d_i = ?$ $M = ?$ $h_i = ?$

Real/virtual? upright/inverted?

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

$$M = \frac{-d_i}{d_o} = \frac{-6}{12} = -\frac{1}{2}$$

$$\frac{1}{4} = \frac{1}{12} + \frac{1}{d_i}$$

$$10 \cdot \frac{-1}{2} = \frac{h_i}{10} \cdot 10$$

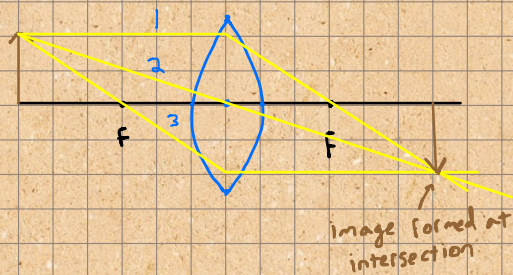
$$0.1666 = \frac{1}{d_i}$$

$$h_i = -5 \text{ cm}$$

$$d_i = 6 \text{ cm}$$

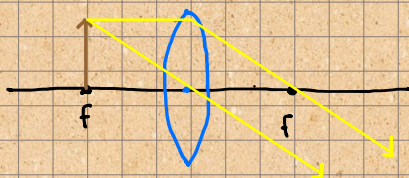
• Ray Diagram steps:

- 1) Parallel line to axis and through the focal point
- 2) Through lens center [not refracted]
- 3) Through focal point and parallel to axis

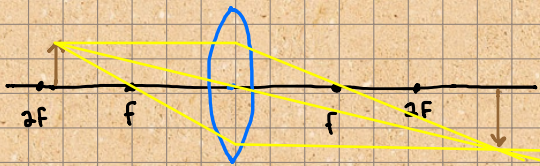


Special Cases:

• If the object is at the focal point, no image is formed

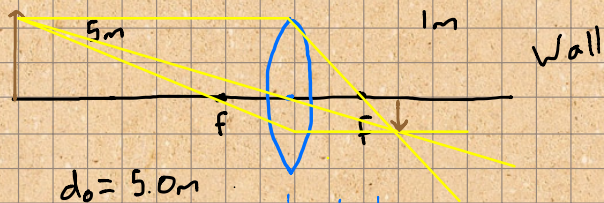


• If the object is between F and 2F, the image will be beyond 2F and magnified



Example 1:

- A lens is 1.0m from a wall. An image of an object 5.0m away is cast on the wall. What is the focal length?



$d_o = 5.0m$
 $d_i = 1.0m$

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

$$\frac{1}{f} = \frac{1}{1.5} + \frac{1}{1}$$

$$\left(\frac{1}{f}\right) = (1.2)$$

$f = 0.833m$