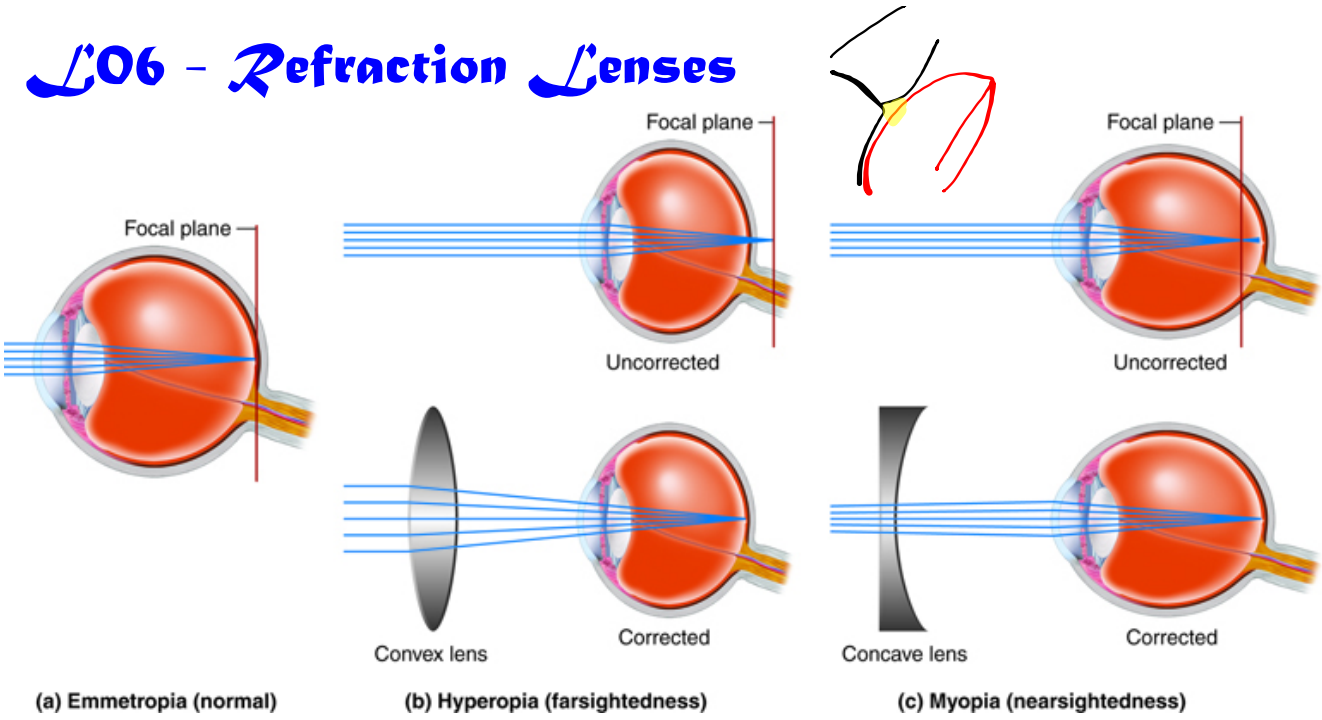
L06 - Refraction Lenses



Before going too far... What is a "Ray Diagram" and what does it look like?

https://phet.colorado.edu/en/simulation/geometric-optics

Settings:

- Principal Rays
- Change object to Arrow (bottom of arrow on Principal Axis)
- Maximize diameter to 1.3 meters.
- Goggle on "Virtual Image"

NOTE: This simulation is for Converging Lenses only.

Converging Lens Ray Diagrams

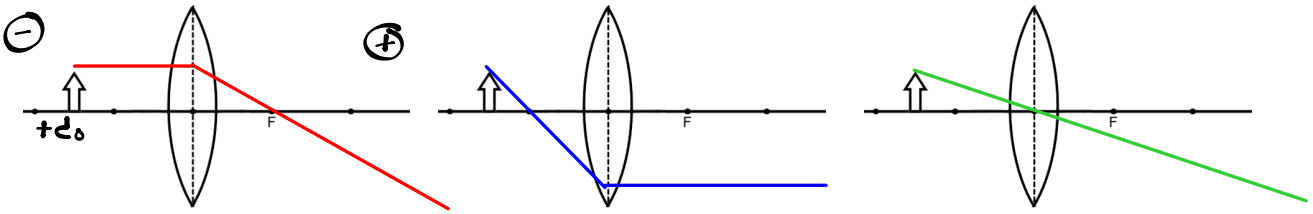
Drawing Ray Diagrams for Converging Lenses

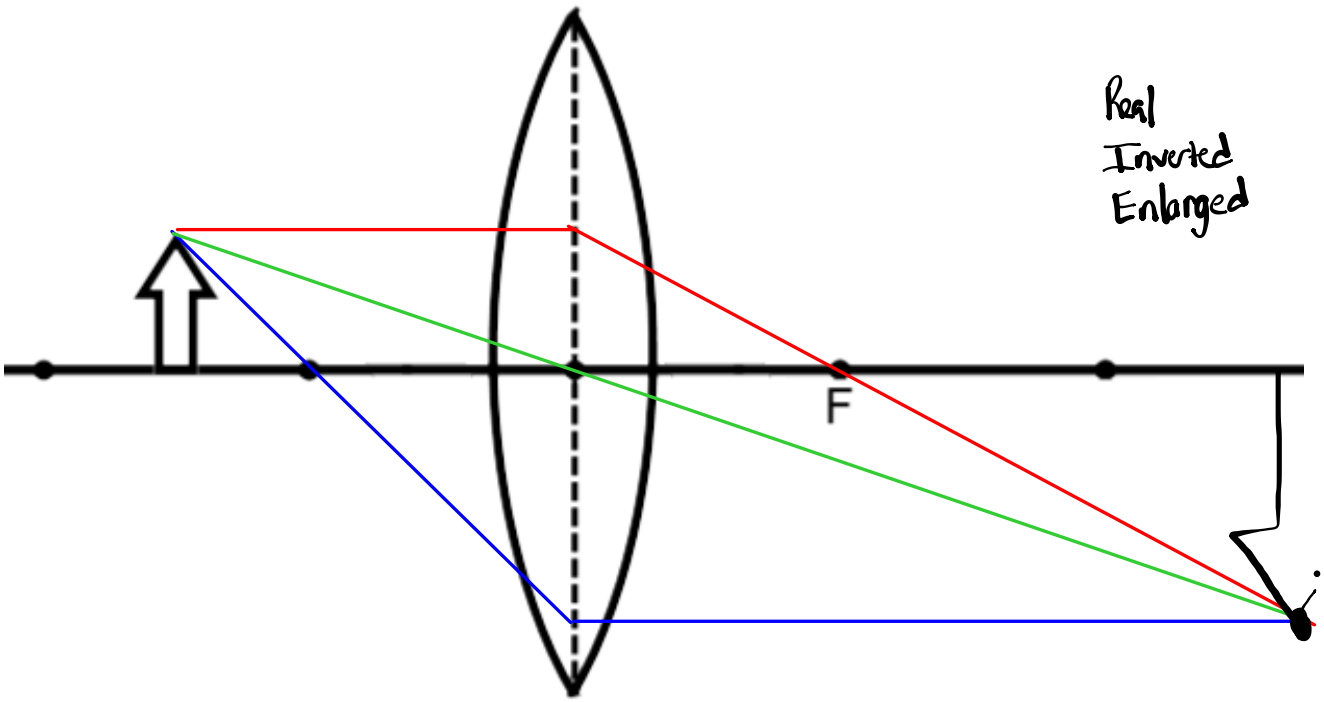
1. Parallel to the Principal Axis refracts through the Focal Point
2. Through the Focal Point refracts parallel to the Principal Axis
3. Through the Vertex travels straight through

Image Characteristics

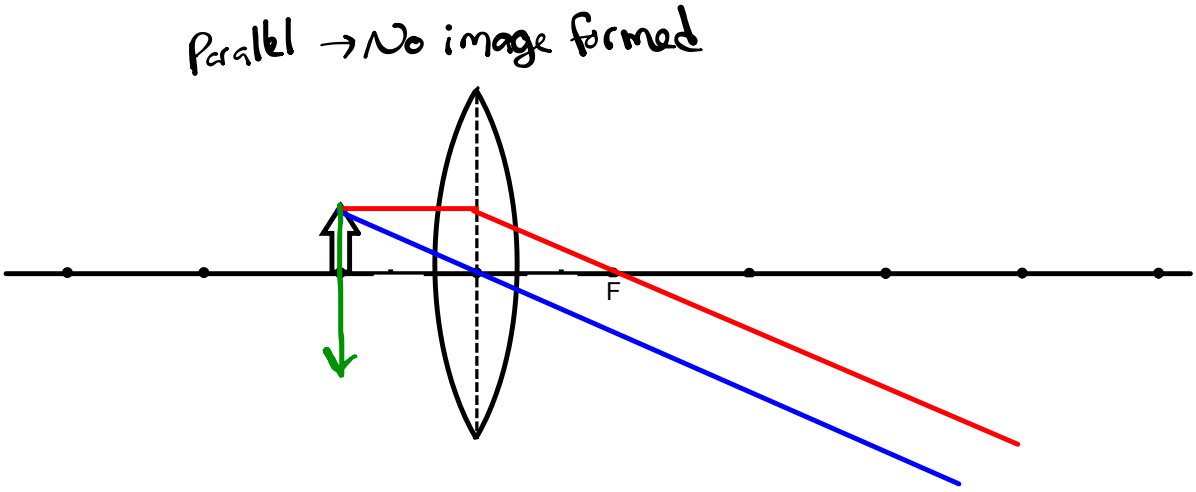
- Magnification: Relates the size of the image to the size of the object
- Attitude: Erect or inverted
- Position: Displacement from the mirror
- Type: Virtual or Real

Q1: Draw a ray diagram for an object between 2F and F.Describe its characteristics.

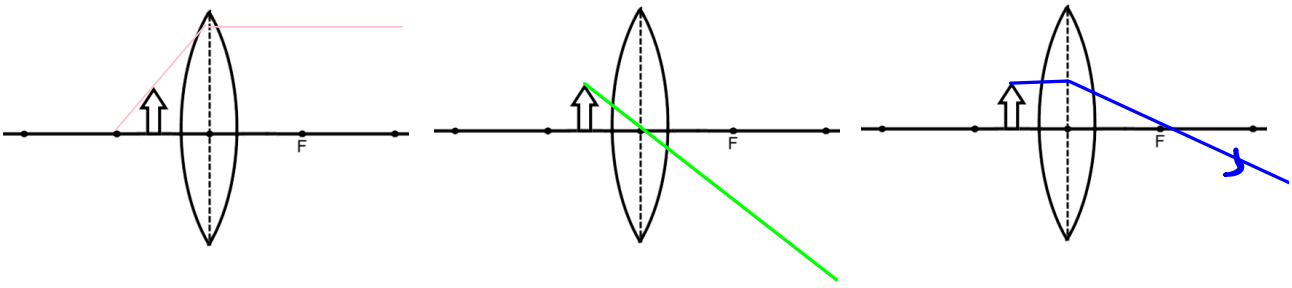


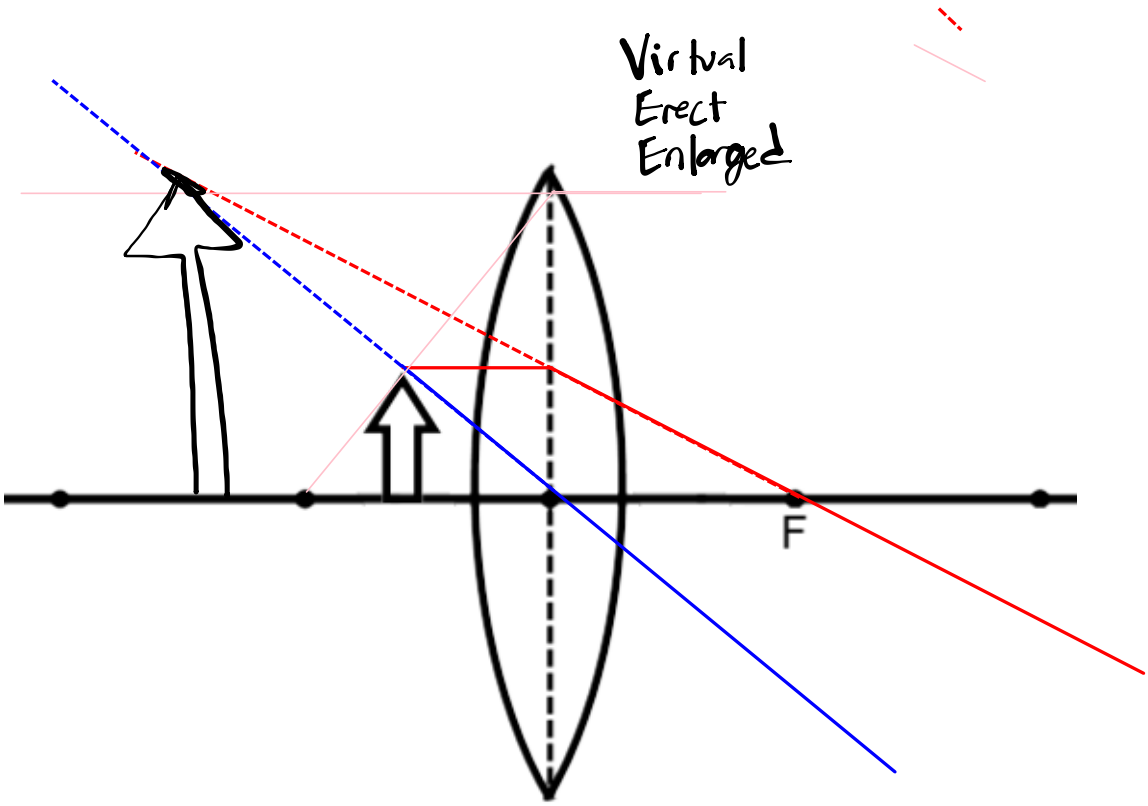


Q2: Draw a ray diagram for an object on F. Describe its characteristics.



Q3: Draw a ray diagram for an object inside F. Describe its characteristics.





Diverging Lens Ray Diagrams

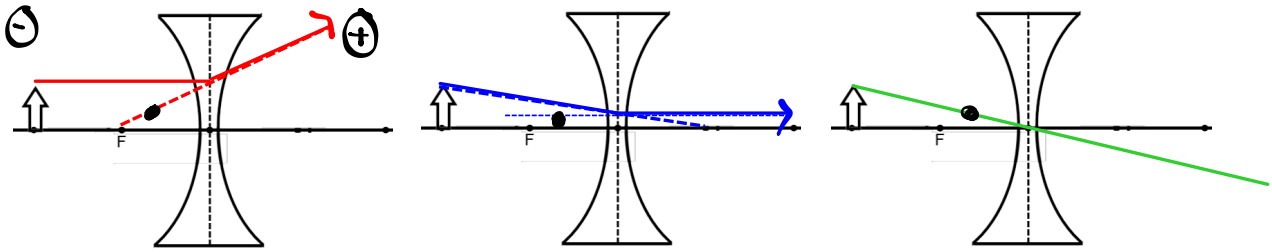
Drawing Ray Diagrams for Diverging Lenses

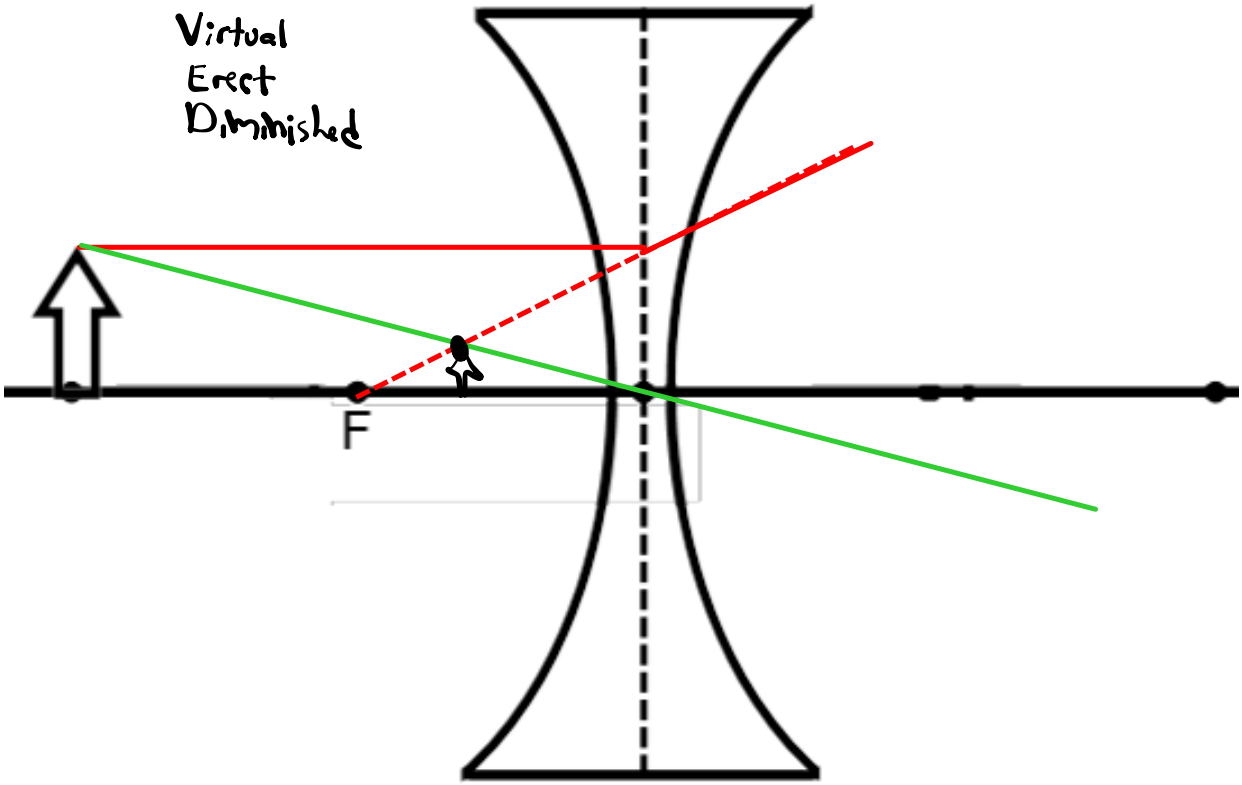
1. Parallel to the Principal Axis refracts away from the Focal Point
2. Towards the Focal Point refracts parallel to the Principal Axis
3. Through the Vertex travels straight through

Image Characteristics

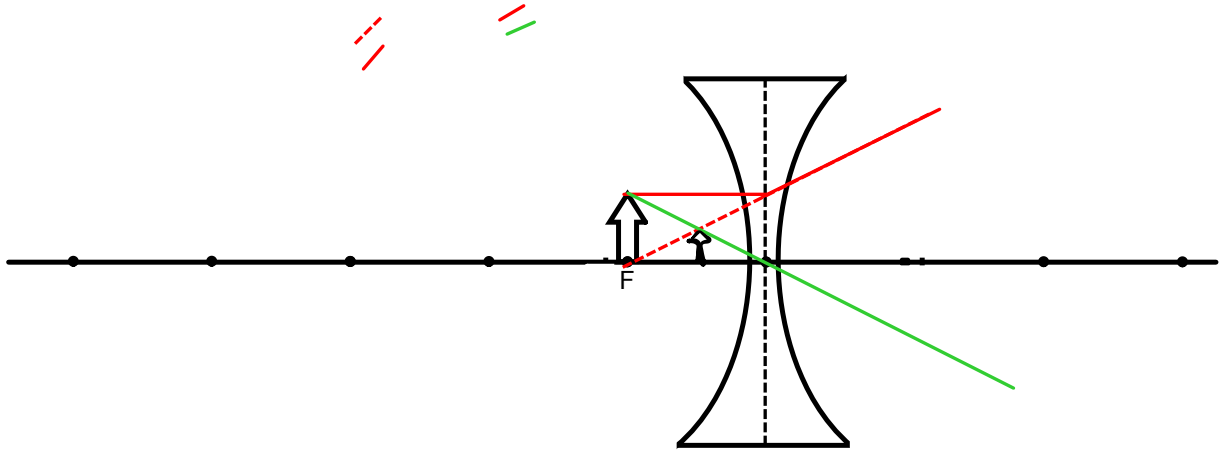
- Magnification: Relates the size of the image to the size of the object
- Attitude: Erect or inverted
- Position: Displacement from the mirror
- Type: Virtual or Real

Q1: Draw a ray diagram for an object outside F. Describe its characteristics.

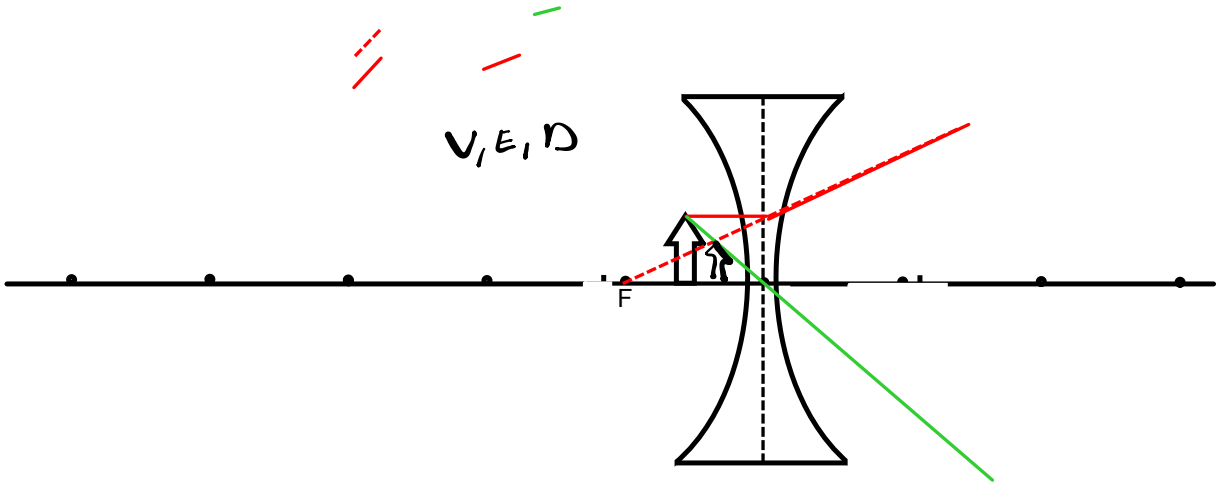




Q2: Draw a ray diagram for an object located at F. Describe its characteristics.



Q3: Draw a ray diagram for an object inside F. Describe its characteristics.



Lens Equations

Symbols:

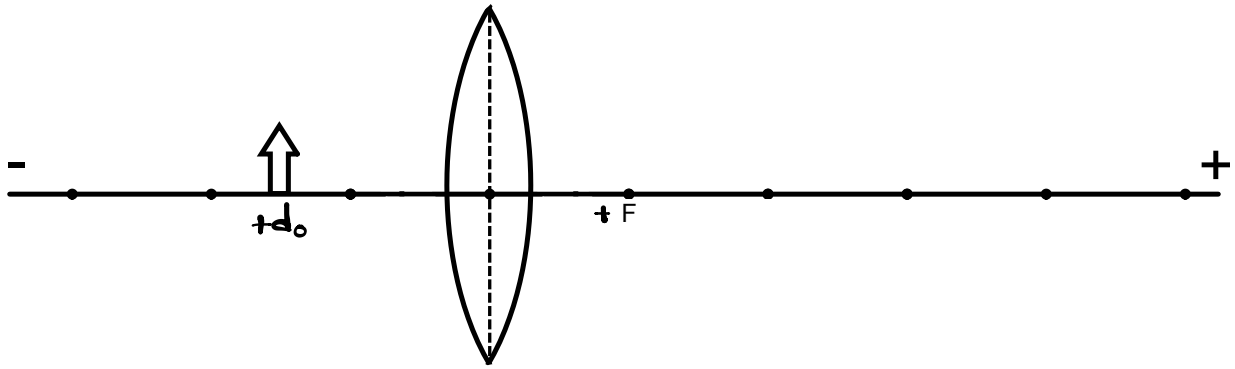
- h_o is the height of the object
- h_i is the height of the image
- d_o is the distance of the object
- d_i is the distance of the image

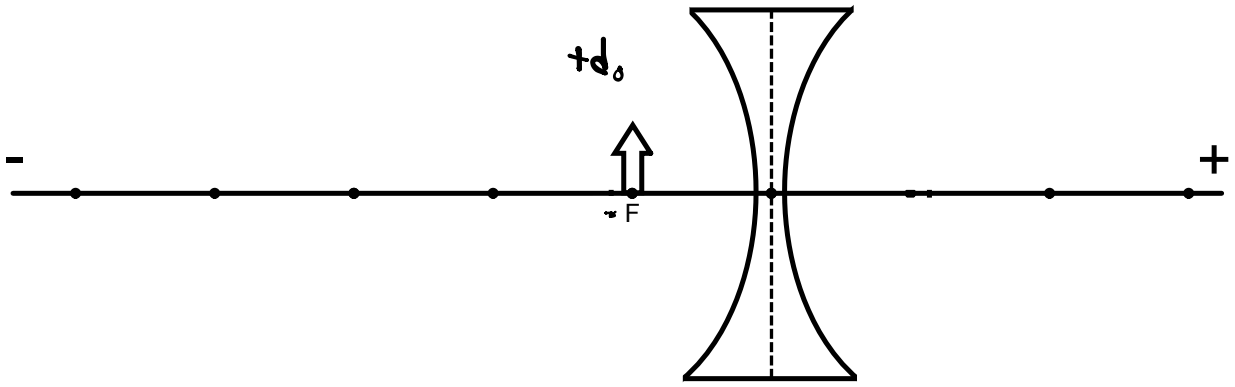
$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

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

Sign convention:

- Real images have positive distances (virtual negative)
- Erect (positive height), Inverted (negative height)
- Erect (positive magnification), Inverted (negative magnification)
- Converging (focal length positive)
- Diverging (focal length negative)
- Objects ***always*** have a positive distance





Q4: A 2.5 cm high object is placed 10.0 cm from a diverging lens of focal length 5.0 cm. Determine the image distance, height, and attributes.

$h_o = +2.5\,cm$

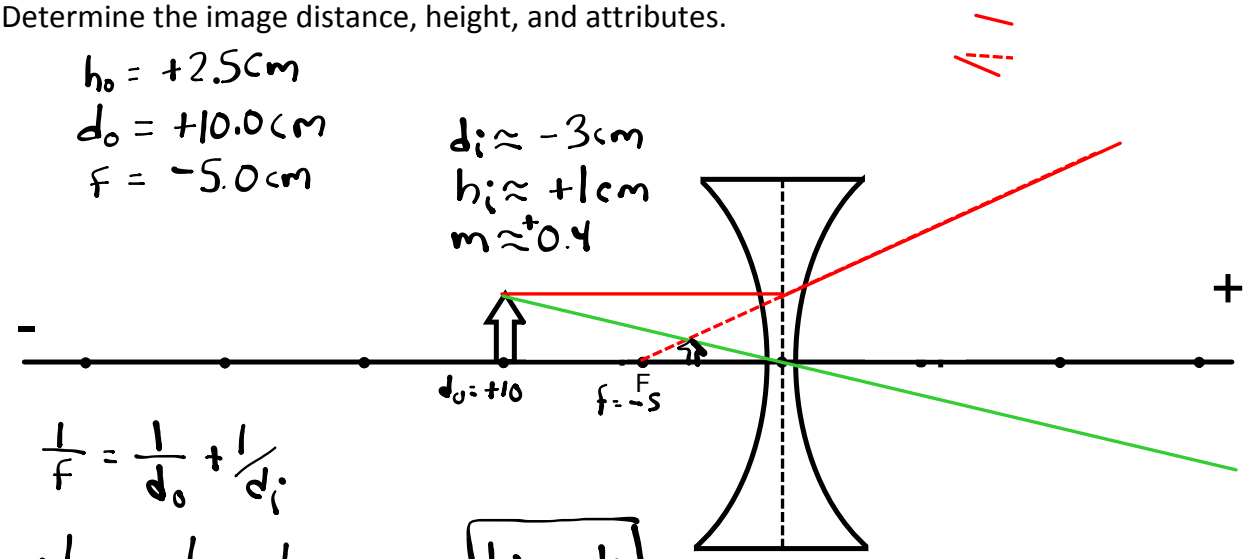
$d_o = +10.0\,cm$

$f = -5.0\,cm$

$d_i \approx -3\,cm$

$h_i \approx +1\,cm$

$m \approx +0.4$



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

$$\frac{1}{-5} = \frac{1}{10} + \frac{1}{d_i}$$

$$d_i = -3.\bar{3}\,cm$$

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

$$\frac{h_i}{2.5} = \frac{-(-3.\bar{3})}{10}$$

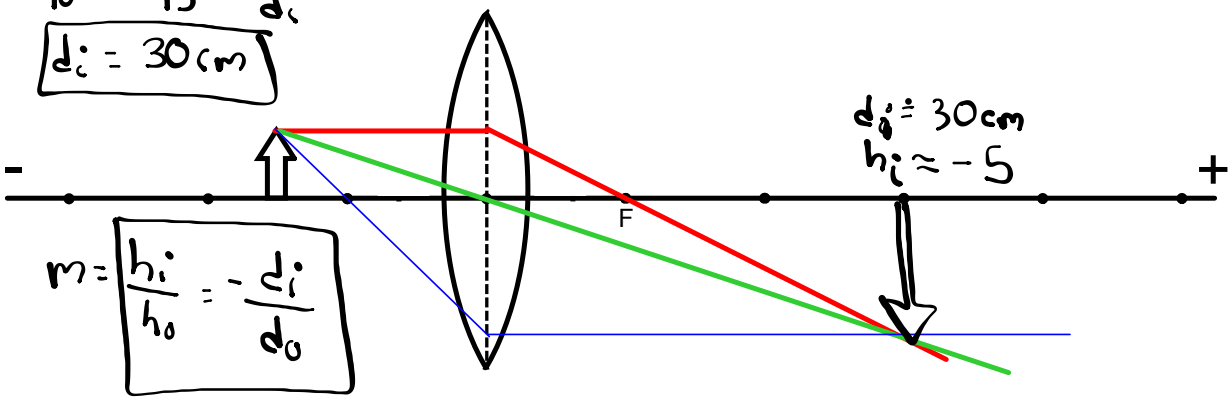
$$h_i = 0.8\bar{3}\,cm$$

Q5: A 2.5 cm high object is placed 15.0 cm from a converging lens of focal length 10.0 cm. Determine the image distance, height, and attributes.

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

$$\frac{1}{10} = \frac{1}{15} + \frac{1}{d_i}$$

$$d_i = 30\,cm$$



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

$$\frac{h_i}{2.5} = -\frac{(30)}{15}$$

$$h_i = -5\,cm$$

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