

# CALCULATIONS USING LENS EQUATIONS

$d_i$	distance of image from optical centre	
$d_o$	distance of object from optical centre	
$f$	focal length	
$M$	magnification	
$h_i$	height of image	
$h_o$	height of object	

The image position and magnification can be calculated for various reasons using these formulas:

The Thin Lens Equation	The Magnification Equation
$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$	$M = \frac{h_i}{h_o} = \frac{-d_i}{d_o}$

Variable	Positive (+)	Negative (-)
<b>d<sub>o</sub>, object distance</b>	Always positive	Never negative
<b>d<sub>i</sub>, image distance</b>	Real Image (image is on the opposite side of the lens from the object); image is also inverted	Virtual image (image is on the same side of the lens from object); image is also upright
<b>h<sub>o</sub>, height of object</b>	Object is upright	Object is Inverted
<b>h<sub>i</sub>, height of image</b>	Image is upright	Image is inverted
<b>f, focal length</b>	For converging lenses	For diverging lenses
<b>M, magnification</b>	Image is upright	Image is inverted

**Example Problem 1:**

A toy of height 8.4 cm is balanced in front of a converging lens. An inverted, real image of height 23 cm is noticed on the other side of the lens. What is the magnification of the lens?

**Example Problem 2:**

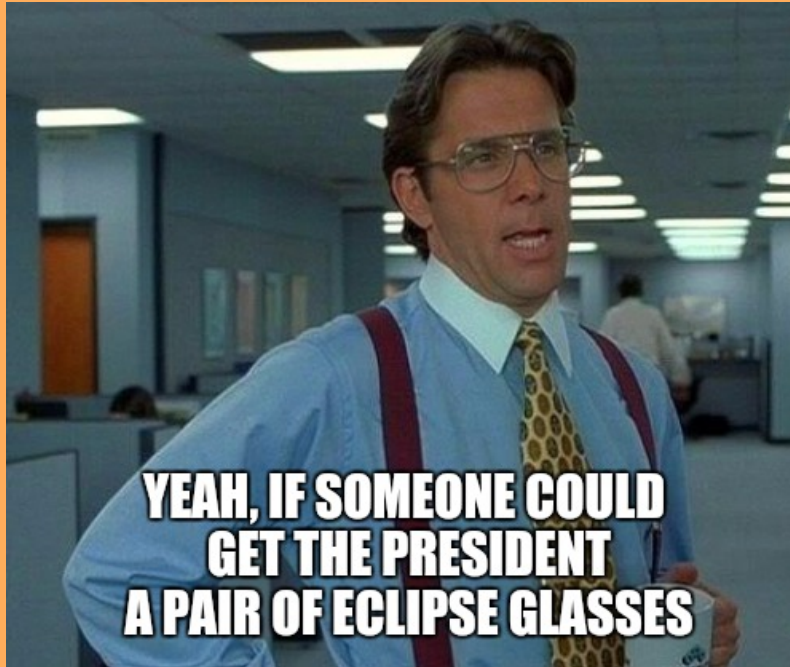
If a converging lens has a 30.0 cm focal length and is focused on a person 1.00 m away, find the image position and the lens' magnification. Describe the SALT characteristics of the image.

**Example Problem 3:**

A converging lens is being used as a magnifying glass. If the focal length of the lens is 15.0 cm and an ant that is 10.0 cm away is being viewed, find the location of the image and its magnification. Describe the SALT characteristics of the image.

**Example Problem 4:**

A diverging lens with a focal length of 200.0 cm is used to correct a person's vision. Find the image position for an object 3.00 m away.



## Questions

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Answers to Examples:

1.  $M = -2.7$
2.  $d_i = 42.9 \text{ cm} / M = -0.43$
3.  $d_i = -30 / M = 3$
4.  $d_i = -120$