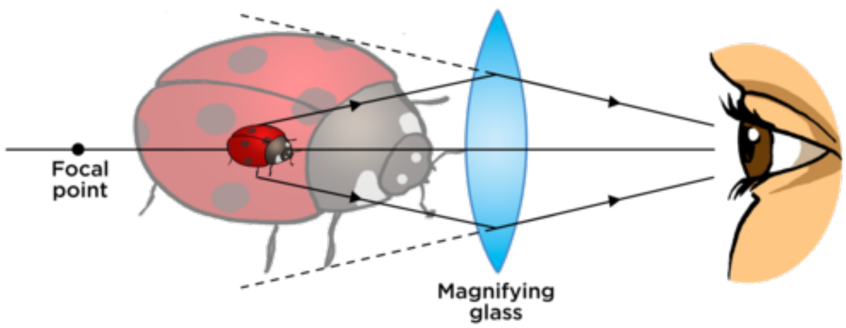
Lab 17: Convex Lens Magnification

Purpose

To determine the relationship between object distance, image distance and magnification for a thin convex lens.

Introduction

Telescopes, microscopes, cameras and many other examples of optical technology use a combination of convex lenses to magnify images.

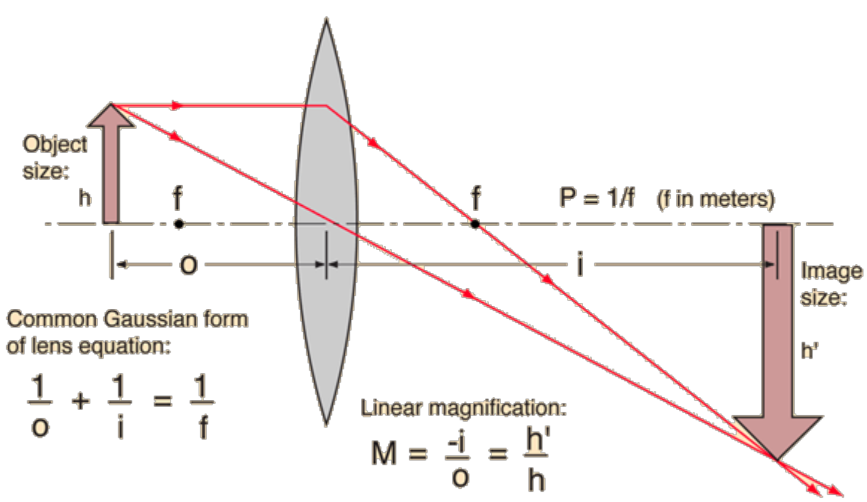


The distance between the object and the lens (***O***) together with the focal length of the lens (***f***), determine the distance from the lens to the image (***i***) and the magnification (***M***). The relation between this variables is given by the thin lens equation, which states that

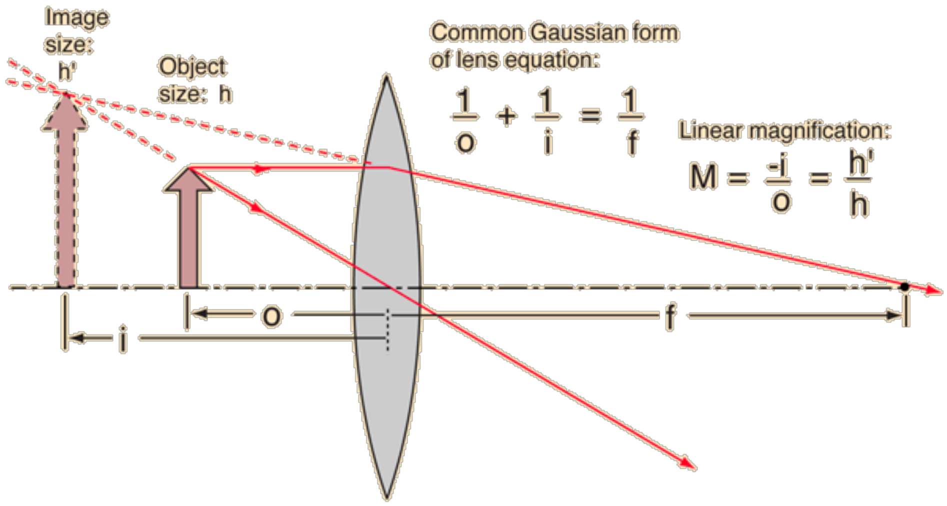
$$\frac{1}{o} + \frac{1}{i} = \frac{1}{f} \qquad \text{and} \qquad M = \frac{-i}{O} = \frac{h'}{h}$$

$$\frac{1}{\text{object distance}} + \frac{1}{\text{image distance}} = \frac{1}{\text{focal length}}$$

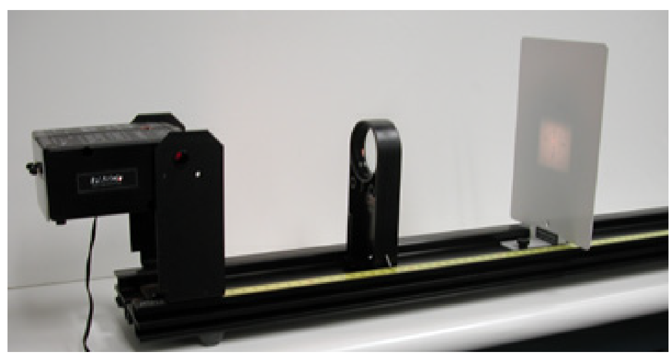
If the **object distance** is **larger than the focal length (*O* > *f*)**, the **image** forming will be **real** (on the other side of the lens) and **inverted** (negative magnification).



If the **object distance** is **less than the focal length (*O* < *f*)**, the **image** forming will be **virtual and negative** (on the same side of the lens as the object) and **upright** (positive magnification).



Setup



1. Mount the Light Source at the zero point (left end) of the Optics Bench. Connect the power supply.
2. Mount the Viewing Screen at the other end of the bench.
3. Adjust the light source in its bracket so the crossed-arrow object is illuminated and pointing toward the viewing screen.
4. Place the Convex Lens on the optics bench 500 mm from the light source.

Image Distance/Magnification v.s. Object distance

1. Position the viewing screen so the image of the crossed arrow is in sharp focus.
2. Record the distance from the *lens to the viewing screen* as the image distance (***i***).
3. Measure and record the *height of the image* on the viewing screen (***h'***).

4. Repeat the experiment setting the object distance (***O***) to the values shown in the table provided in the Data Collection section and record the corresponding image distance and image height. *The object distance* (***O***) *is measured from the lens to the illuminated crossed arrows on the light box.*

Data Collection

Object Height (***h***) = _______. The size of the cross in the light source.

Object Distance ***O*** (mm)	Image Distance ***i*** (mm)	Image Height ***h'*** (mm)	Object Distance ***O*** (mm)	Image Distance ***i*** (mm)	Image Height ***h'*** (mm)
800			500		
750			450		
700			400		
650			350		
600					
550					

Analysis

1. Using the lens equation calculate the focal length of the lens for a least 3 of your data points, then take the average and write down the result below.

Avg. Focal Length (***f***) = _________

2. Explore what happens if you place the lens closer than one focal length from the light source (so that ***O*** < ***f***). Can you see an image on the screen? Can you see an image when you look through the lens? Is the image inverted or upright?

3. Now use the desmos.com online calculator to plot the image distance (***i***) v.s. the object distance (***O***), and the the magnification (***h'/h***) v.s. object distance (***O***). Note that the object distance (***O***) is your independent variable (horizontal axis). **SAVE THE SHARE LINK WHEN YOU ARE DONE you will need it for the quiz.**

4. Complete the Lab 17 quiz on Canvas/iLearn.