

Compound Microscope

Purpose: To use a converging lens to make measurements to test the Thin Lens and Magnification Equations.

Equipment: Optics Bench, Light Source, 75 mm Focal Length Convex Lens, 150 mm Focal Length Convex Lens, Variable Aperture, Component Holders (2), Viewing Screen.

Introduction: A compound microscope uses two lenses to provide greater magnification of near objects than is possible using a single lens as a magnifier. The setup is shown in Figure 2. The objective lens, L_1 , functions as a projector. The object is placed just beyond the focal point of L_1 so a real, magnified, inverted image is formed. The eyepiece, L_2 , functions as a magnifier. It forms an enlarged, virtual image of the real image projected by L_1 .

The real image that is projected by L_1 is magnified by an amount $m_{objective} = -\frac{d_i}{d_o}$ Eq.1, as given by the Magnification Equation. That image is in turn magnified by the eyepiece by a factor of

$m_{eyepiece} = \frac{25cm}{f}$ Eq.2. The combined magnification is, therefore

$$M = m_{objective} m_{eyepiece} = -\frac{d_i}{d_o} \left(\frac{25cm}{f} \right) \quad Eq.3.$$

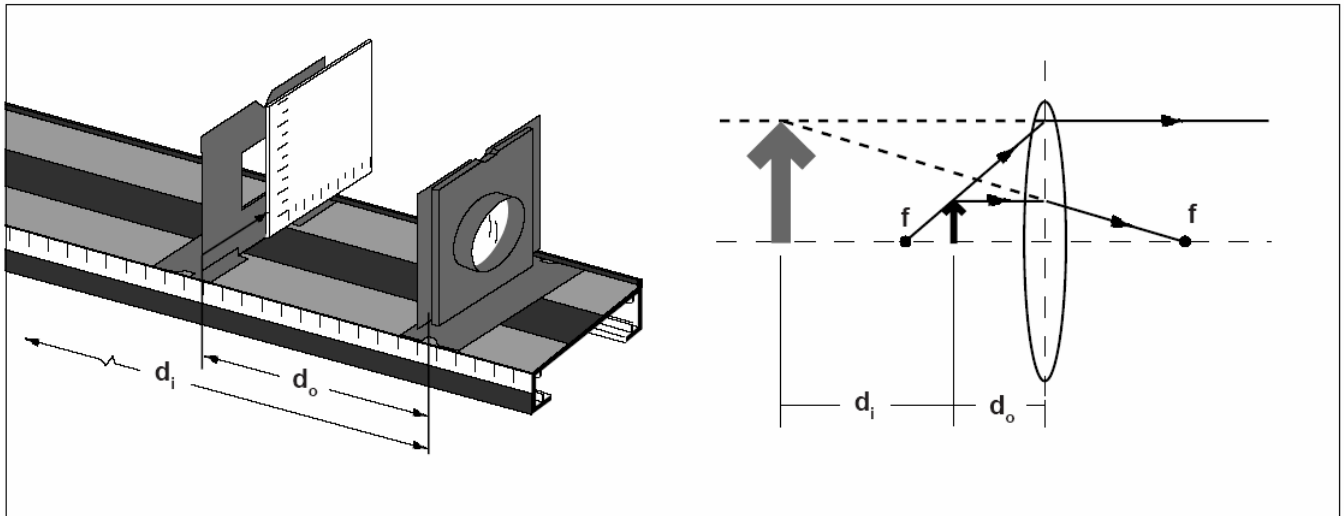


Figure 1 Experimental set-up for magnifier.

Procedure:

1. Begin by trying a single lens magnifier. Set up a magnifier as shown in Figure 1. First try it with the 75 mm focal length lens, and then with the 150 mm focal length lens. For each lens, adjust the distance between the object (the Viewing Screen) and the lens so the magnification is a maximum and the image is clearly focused. Is there a limit to the magnification that you can achieve while keeping the image in focus? Which lens seems to provide the greatest magnification? Does your observation agree with the expression above for the magnification provided by an eyepiece, Eq.2? The magnifier is essentially an eyepiece with no objective lens.

- The **25cm** in the numerator of *Eq.2* corresponds with the *near point* of a normal eye. This is the nearest distance that an object can be placed in front of an eye, while still forming a sharp image on the retina. Working with your partner, measure your near point. Cover one eye, and hold your arm out in front of you with your thumb extended upward. Slowly bring your thumb closer to your eye until the image becomes blurry. Move your thumb away from your eye until it looks sharp again. Have your partner use a meter stick to estimate the distance between your thumb and the lens of your eye. If you wear corrective lenses, try it with and without them.
- Set up the microscope as shown in Figure 2. Use the 75 mm focal length lens as the objective lens and the 150 mm focal length lens as the eyepiece. Begin with the objective lens approximately 150 mm away from the object (the Viewing Screen). Adjust the position of the eyepiece until you see a clearly focused image of the Viewing Screen scale. Is the image magnified? How does the magnification compare to using the 75 mm focal length lens alone, as a simple magnifier?
- While looking through the eyepiece, slowly move the objective lens closer to the Viewing Screen. Adjust the position of the eyepiece as needed to retain the best possible focus. Why does the magnification increase as the objective lens is moved closer to the object? What focusing problems develop as the magnification increases?
- Use the Variable Aperture to restrict the path of light to the central regions of the objective lens. Vary the size of the aperture and observe the effects on focusing. What effect does the aperture have on focusing? What effect does the aperture have on the brightness of the image?
- What advantage would there be in using a 75 mm focal length lens as the eyepiece compared to using the 150 mm focal length lens as the eyepiece?

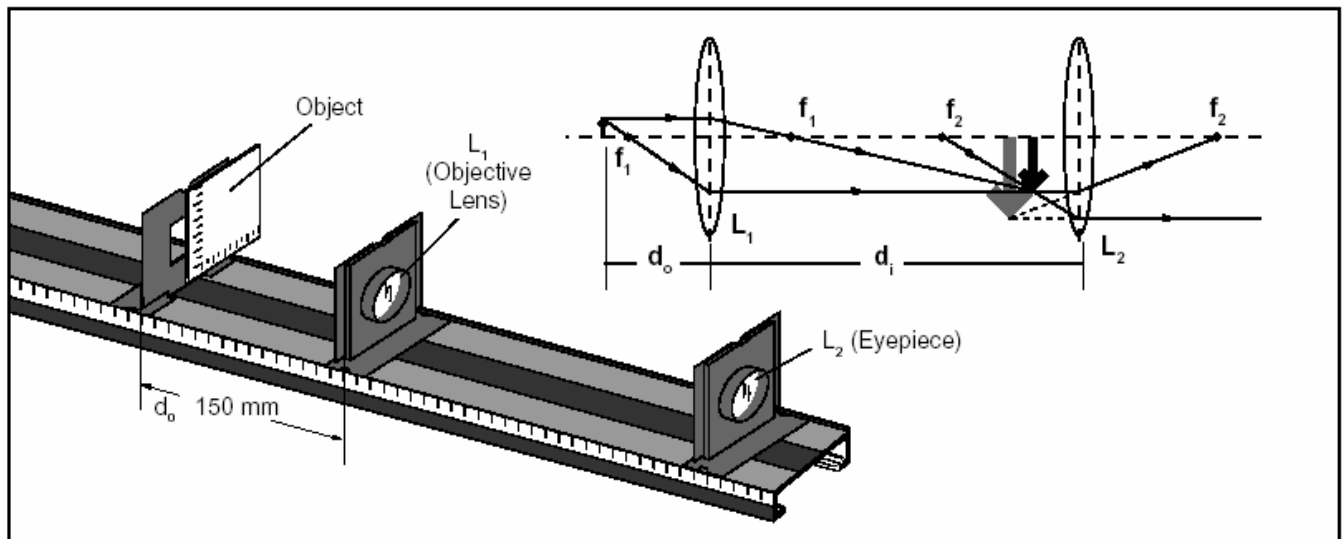


Figure 2 Experimental set-up for compound microscope.