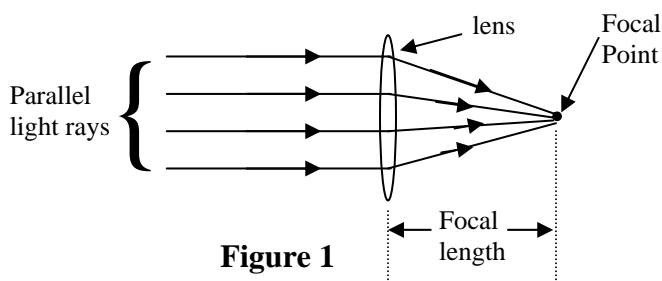


Applied Optics—The Slide Projector

Purpose: To investigate the properties of converging lenses by constructing a simple slide projector

Equipment: Pasco optics bench, two lens holders, +75 mm lens, object arrow, viewing screen, and light source

Introduction: A slide projector represents a well known and simple application of geometrical optics. The basic function of the projector is to take a small, well illuminated object (the slide) and, using a converging lens, form a larger, real image on a screen that is at a comfortable distance for viewing. The size and position of the image depends on the focal length of the lens. The focal length of a converging lens is defined to be the distance from the center of the lens to a point (called the focal point) where parallel light rays coming into the lens are focused. See Figure 1.



A converging lens will form a well focused image of the slide on the screen whenever the image and object distance are related to each other mathematically by the following equation (often called the thin lens equation):

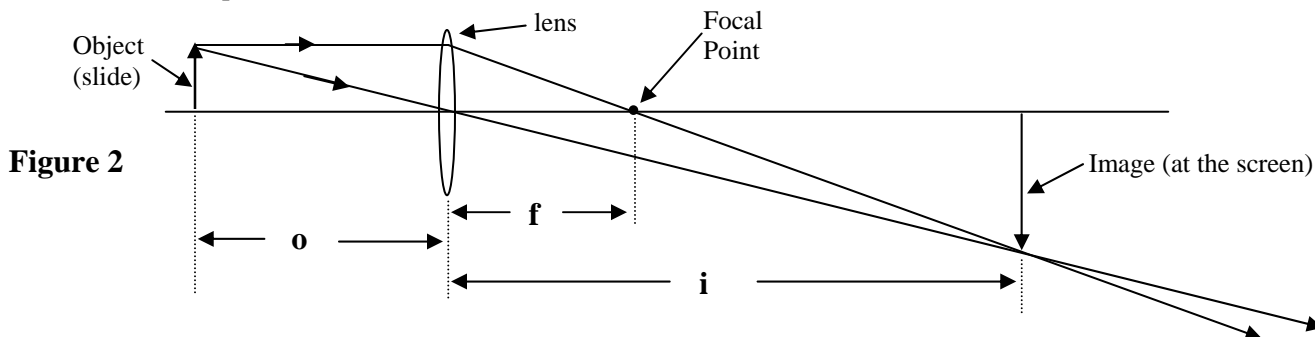
$$\frac{1}{i} + \frac{1}{o} = \frac{1}{f}$$

o = object distance

i = image distance

f = focal length

See Figure 2 below to see how two light rays leave the object (slide) and arrive at the image (screen). Take a moment and look at the above equation along with Figure 2 so you can see how the equation relates to the actual situation.



Procedure:

1. Mount your slide (the object arrow with the scale markings) on the front of the light source with the arrow pointing up. Position the light source so that the object arrow is at the 100 mm mark on the optics bench.
2. Mount the 75 mm lens on its holder and position it at 250 mm on the optics bench.
3. Place the viewing screen on its holder somewhere past 250 mm and slide it away from the lens until you see a clearly focused image of the arrow on the screen. Record the image and object distance (refer to Figure 2) in the table on the next page. Is the image upright or inverted relative to the object? Is the image smaller or larger than the object? Record your answers in this same table.

Image Data

i = Image Distance (mm)	o = Object Distance (mm)	f = focal length (mm)	Upright or inverted image?	Reduced or enlarged image?

4. Put the numbers for the various quantities that you just recorded into the thin lens equation and see how closely the right hand side of the equation agrees with the left hand side. What is the percent difference between the two?

Percent Difference =

5. Move the screen out to the 700 mm position on the optics bench and form a sharply focused enlarged image of the arrow on the screen by moving the lens to a new location. This setup is more typical of an actual slide projector. What is different about the image you see now compared to the image in part 4? In the table below, record the data for this situation.

Image Data for Slide Projector

i = Image Distance (mm)	o = Object Distance (mm)	f = focal length (mm)	Upright or inverted image?	Reduced or enlarged image?

6. Finally, let's determine the magnification of our slide projector. Using the scale on the viewing screen, measure the distance, in mm, between five of the vertical marks on the image arrow. You may have to slide the viewing screen over a bit in order to have the scale overlap with the image. Each of these same marks on the object arrow is actually separated by 1 mm so that this same distance on the object is 5 mm. The magnification is calculated by dividing your distance for the five marks on the image by the corresponding distance (5 mm) on the object.

Magnification = $\frac{\text{Image height (mm)}}{\text{Object height (mm)}}$ = _____ =

7. The theoretical calculation for magnification is image *distance* divided by object *distance*. Calculate the theoretical magnification of your slide projector using your data from part 5 and compare with the experimental value for magnification in part 6.

Theoretical Magnification = $\frac{\text{Image distance (mm)}}{\text{Object distance (mm)}}$ = _____ =

8. Find the percent difference between the two values of magnification.

Percent Difference =

9. What are possible sources of error in the experiment?