

Thin Lenses

Saddleback College Physics Department

Purpose

- To practice drawing ray diagrams for converging & diverging lenses and examine the magnification relationship.
- To experimentally determine the focal length of a converging lens using two different methods.
 - Method #1:** View the image of a distant object through the converging lens and compare it to the focal length printed on the lens.
 - Method #2:** Use the thin lens equation to experimentally determine the focal length of a converging lens and compare it with the actual focal length.
- To view the virtual images produced by both converging and diverging lens.

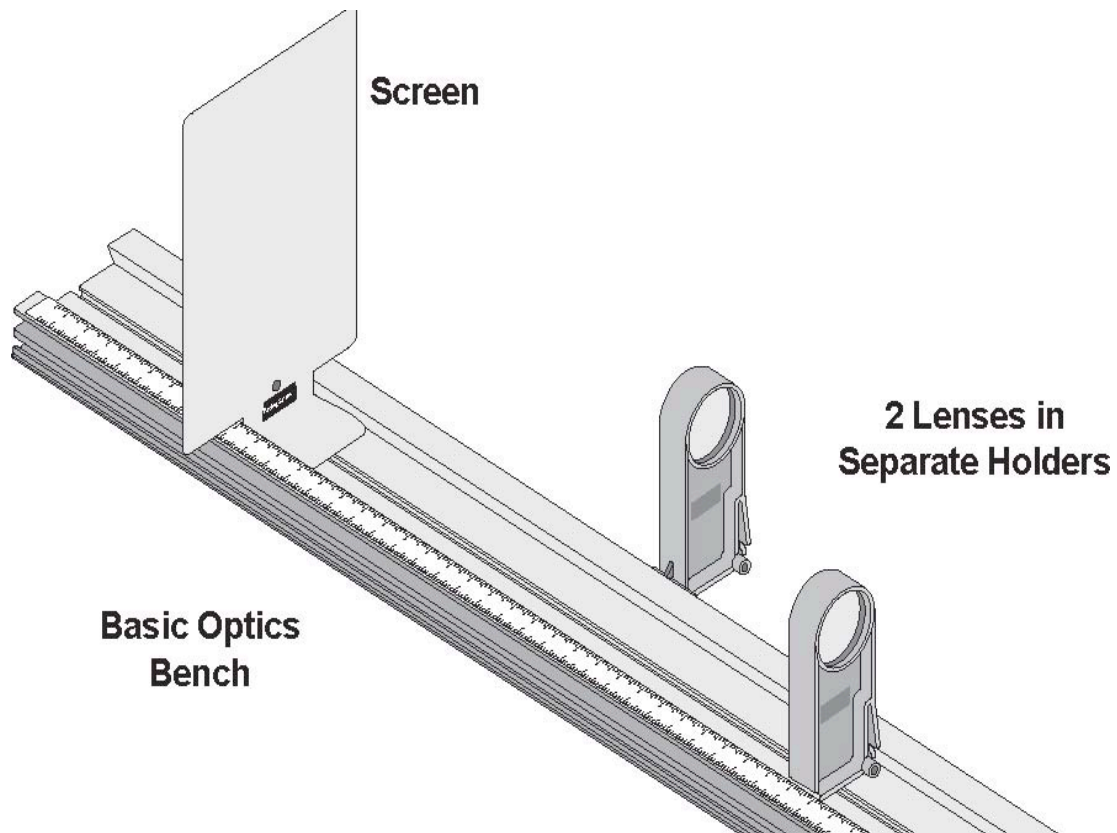


Figure 1: Geometric Optics equipment

Equipment

Optics Bench

Concave & convex mirrors

Converging & diverging lenses

PASCO Light Source OS-8470 (use the crossed arrows)

Adjustable lens holders (2)

Index card (for use as a screen when going outside to perform step 2 in the procedure)

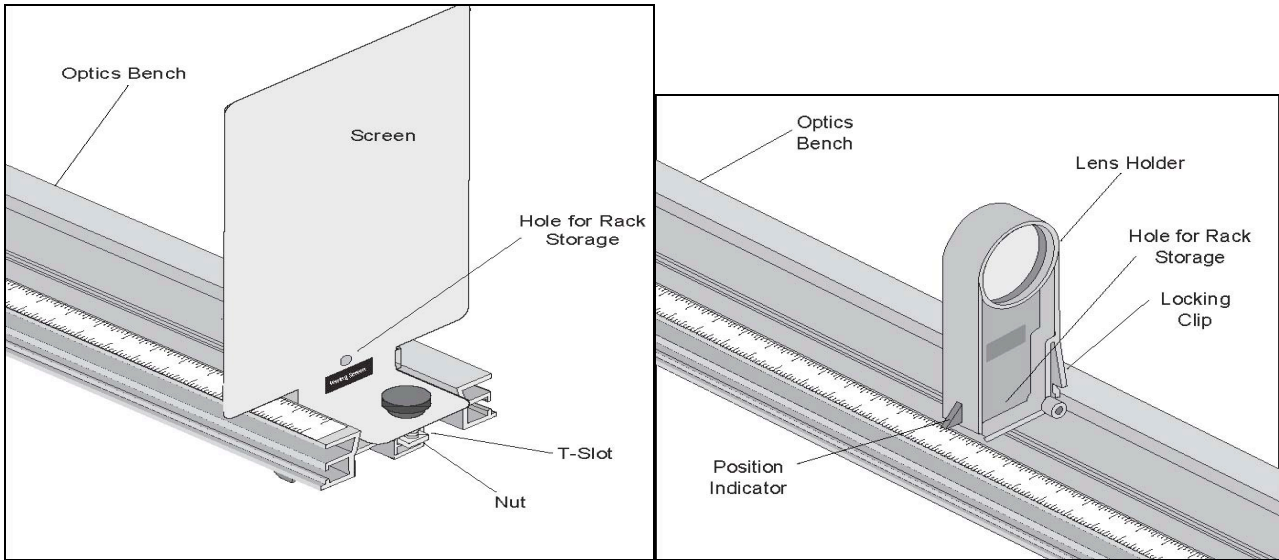


Figure 2: Mounting Screen and Lens Holder on Bench

The lens holders simply snap into place on the bench. See Figure 2, Mounting Lens Holders on Bench. To slide the lens holder along the bench, grasp the lens holder at its base and squeeze the locking clip on the side of the holder. Continue to squeeze the locking clip while the lens is slid along or removed from the bench. When the locking clip is released the lens is held firmly in place.

Theory

Parallel rays of light pass through a converging lens and converge at the focal point of the lens.

The magnification of an image is described by the equations below.

$$(1) \quad m = -\frac{i}{p} \quad \text{where } p = \text{object distance}$$
$$m = \text{magnification of lens}$$

$$(2) \quad m = \frac{h'}{h}$$

The thin lens equation describes the relationship between image distance, object distance and focal length of optical systems containing spherical mirrors and thin lenses.

$$(3) \quad \frac{1}{f} = \frac{1}{p} + \frac{1}{i} \quad \text{where } p = \text{object distance}$$

$f = \text{focal length of lens}$
 $i = \text{image distance}$

Procedure

1. Construct four large (accurate, scaled down) ray diagrams for a CONVERGING LENS for $p > 2f$, $f < p < 2f$, $p < f$ and $p \rightarrow \infty$. Measure all distances in *cm*.
2. Experimentally determine the focal length of a converging lens by producing an image of a distant object. (Try using the hill across the large parking lot outside and a 3 x 5 index card as the image screen.) Compare the experimental focal length to the actual focal length.
3. Select a converging lens and set up each of the three cases $p > 2f$, $f < p < 2f$ and $p < f$. A light source or a candle may be used for the object.
 - For the case(s) with a REAL image, record your actual focal length, object distance, image distance, image height and object height.
 - a) Calculate the experimental focal length from equation (3) and compare it to the actual focal length of the lens.
 - b) Measure & record the image height and object height, then calculate the magnification using equations (1) and (2). Compare these magnifications.
 - For the case(s) with VIRTUAL images, view the virtual image. Ask your Professor to make sure you are doing this correctly.
4. Construct a large (accurate, scaled down) ray diagram for a DIVERGING LENS with either $p > 2f$, $f < p < 2f$ or $p < f$.
5. Select a diverging lens and set up one of the three cases listed in step 4. View the virtual image using the same technique used in step 3.