4. Image Formation in a Plane Mirror

4.1. Purpose

1. Determine the location of a mirror's virtual image by ray tracing.
2. Compare image and object distances for a mirror.

4.2. Equipment

Ray Light box[1], ray Optics Mirror, 11x17 inch paper, ruler (15" or longer if available), diverging lens (double concave) from Pasco Optics kit.

4.3. Introduction

Looking into a mirror and seeing a nearly exact image of yourself hardly seems like the result of simple physical principles, but it is. The nature of the image you see in a mirror is understandable in terms of the principles you have already learned: the Law of Reflection and the straight-line propagation of light.

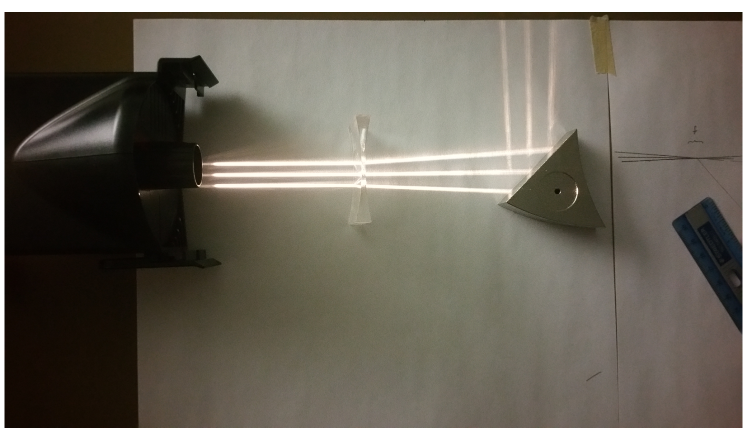
In this experiment you will investigate how the apparent location of an image reflected from a plane mirror relates to the location of the object, and how this relationship is a direct result of the basic principles you have already studied. Additionally a virtual object will be utilized.

4.4. Procedure

1. Use electrical tape to block the light emitted upward from the filament if you desire.
2. Tape together two sheets of 11x17 inch paper along the long side as shown. Place the light ray box in the upper left of the paper.
3. Set up the equipment as shown in Figure 4.1. Positioning of the ray box, lens and mirror is important. The location of both the virtual object and virtual image must be on the paper. Estimate where your rays will intersect.
   a) Additional paper can be added later if needed
   b) Attempt to have the lens center and the center ray coincide, along with the center of the mirror.
   c) Attempt to have the lens's axis purpendicular to the central ray.
4. Set the ray box to provide three rays.
5. Place a diverging lens from the Pasco kit in the path of the rays. This will generate diverging rays and a virtual object. The meeting point for these rays will serve as a virtual object: the filament's apparent location.
6. Mark the centers or edges of all three rays in two locations. This could possibly be done before putting the mirror on. Make these marks far apart to improve ray direction accuracy.
7. Position the mirror so that all three light rays are reflected from its flat surface as shown in Figure 4.1b.

[1] Leave collimator in, removal often damages the plastic case unfortunately.

(a) Light Ray box on upper left of paper



(b) Position for the mirror: the diverging rays between the lens and mirror must meet somewhere on the paper to locate the virtual object.

Figure 4.1.: Mirror Image equipment configuration

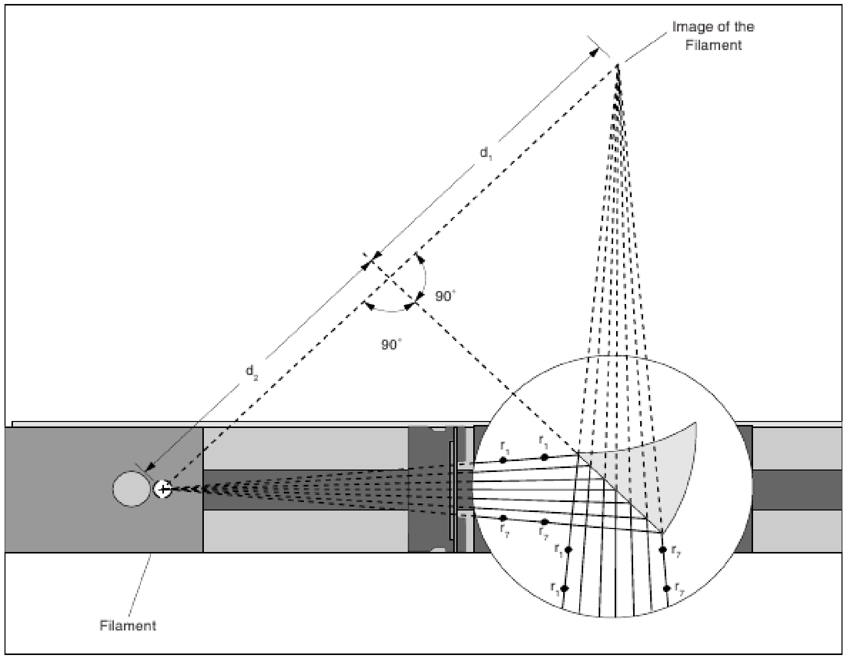


Figure 4.2.: Mirror image ray tracing and analysis. Note that the diverging lens is not present, the light ray box has had the collimating lens removed. In this case the object is real: the actual filament position can be used.

8. Without moving the mirror, trace a line on the paper to mark the position of the flat surface of the mirror.
9. With a pencil, mark two points along the reflected rays. If necessary, label the points so you know which points belong to which ray.
10. Remove the mirror and reconstruct the rays using a pencil and straight-edge. Draw dotted lines to extend the incident and reflected rays to where they intersect.
11. Estimate the center of the various intersecting rays if the back-traced lines do not meet at a single location.
12. On your drawing, label the position of the virtual object and the apparent position of its reflected image. Draw a line joining these points or locations similar to what is shown in Figure 4.2.
13. Extend the line of the mirror's surface up to the line drawn in step 12. Consult Figure 4.2.
14. Measure d_1 and d_2 as shown in Figure 4.2 and calculate their ratio. See questions below.

4.5. Questions

1. What is the perpendicular distance from the filament to the plane of the mirror? This corresponds to distance d_1 in Figure 4.2.

2. What is the perpendicular distance from the image of the filament to the plane of the mirror? This corresponds to distance d_2 in Figure 4.2.

3. What is the relationship between object and image location for reflection in a plane mirror?

4. If one wall of a room consists of a large, flat mirror, how much larger does the room appear to be than it actually is?

5. A mirror reverses what image property with respect to the object?
   a) right/left
   b) depth

6. How does the size of the image reflected from a plane mirror relate to the size of the object?