Experiment: Image Formation from Spherical Mirrors

EQUIPMENT NEEDED:
- Optics Bench, Light Source
- 50 mm F. L. Spherical Mirror
- Crossed Arrow Target.
- Component Holder (3)
- Viewing Screen

Introduction

If you cut a thin strip along any diameter of a spherical mirror, the result is a close approximation to a thin cylindrical mirror. With this in mind, it's not surprising that images formed with spherical mirrors exhibit many of the same properties as those formed with cylindrical mirrors. In this experiment, you will investigate some of these properties.

Procedure

Focal Length

Set up the equipment as shown in Figure 12.1, with the concave side of the mirror facing the Light Source. The Viewing Screen should cover only half the hole in the Component Holder so that light from the filament reaches the mirror.

To verify the focal length of the mirror, position the mirror on the optical bench as far from the Crossed Arrow Target as possible. Vary the position of the Viewing Screen to find where the image of the target is focused.

CD What is your measured focal length for the concave spherical mirror?

F.L. =

CV How might you determine the focal length more accurately?

Image Location, Magnification, and Inversion

In Experiment 7, you tested the validity of the Fundamental Lens Equation: \( \frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \), for which the magnification of the image is given by the equation: \( m = \frac{-d_i}{d_o} \).

In this experiment you will test the validity of this same equation for image formation in a spherical mirror.

Set the distance between the concave mirror and the Crossed Arrow Target to the values shown in Table 12.1. At each position, place the Viewing Screen so the image of the target is in sharp focus. Use your data to fill in Table 12.1. Perform the calculations shown in the table to determine if the Fundamental Lens Equation is also valid for real images formed from a spherical mirror.

CD Are your results in complete agreement with the Fundamental Lens Equation? If not, to what do you attribute the discrepancies?
Virtual Images

In the previous part of this experiment, you tested the Fundamental Lens Equation only for the concave mirror, and only for those cases in which a real image was focused between the object and the mirror. However, when an object is placed between a concave mirror and its focal point, a virtual image is formed. Virtual images can also be formed using a convex spherical mirror.

In the Appendix of this manual, read the section titled "Locating Virtual Images". Construct a table similar to Table 12.1 and use the Image Locators to collect your data. Remember, for a virtual image, $d_i$ is negative.

<table>
<thead>
<tr>
<th>$d_o$ (mm)</th>
<th>$d_i$</th>
<th>$h_i$</th>
<th>$1/d_i + 1/d_o$</th>
<th>$1/f$</th>
<th>$h_i/h_o$</th>
<th>$-d_i/d_o$</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>450</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>350</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>250</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Are your results compatible with the Fundamental Lens Equation? If not, to what do you attribute the difference?

Repeat the procedure with the convex side of the Spherical Mirror.

2. Does the Fundamental Lens Equation hold for images formed by convex spherical mirrors?

Spherical Aberration

Adjust the position of the Light Source and Crossed Arrow Target so the image of the target on the screen is reasonably large and as sharp as possible.

1. Is the focus of the image sharpest at its center or at its edges? (This is a subtle effect which is easier to observe in a darkened room.)

Place the Variable Aperture on the Component Holder as shown in Figure 12.2. The bottom of the V formed by the Aperture plates should be aligned with the notch in the top of the Component Holder.

2. Vary the size of the aperture. How does this affect the focus of the image?

3. Explain your observations in terms of spherical aberration.

4. What aperture size would give the best possible focus of the image? Why is this size aperture impractical?