Concave Mirrors

Equipment List

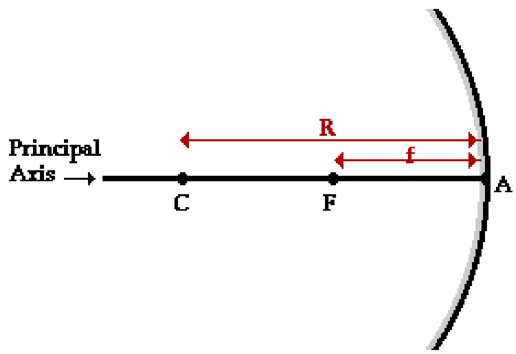
Qty	Items	Part Numbers
1	Light Source	OS-8517
1	Optics Bench	OS-8518
1	50 mm Concave Mirror, and Half Screen	OS-8519
1	Viewing Screen	OS-8460
1	Vernier Caliper	
1	White paper	
1	Metric ruler	

Purpose

The purpose of this activity is to exmaine some of the basic properties of a concave mirror by experimentally determining its focal length.

Background

Concave and convex mirrors are examples of spherical mirrors. Spherical mirrors can be thought of as a portion of a sphere which was sliced away and then silvered on one of the sides to form a reflecting surface. Concave mirrors are silvered on the inside of the sphere and convex mirrors are silvered on the outside of the sphere.

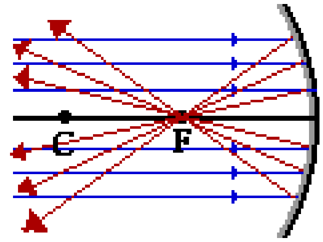


If a concave mirror is thought of as being a slice of a sphere, then there would be a line passing through the center of the sphere and attaching to the mirror in the exact center of the mirror. This line is known as the principal axis. The point in the center of sphere from which the mirror was sliced is known as the center of curvature and is denoted by the letter C in the diagram. The point on the mirror's surface where the principal axis meets the mirror is known as the vertex and is denoted by the letter A in the diagram. The vertex is the geometric center of the mirror. Midway between the vertex and the center of curvature is a point known as the focal point; the focal point is denoted by the letter F in the diagram. The distance from the vertex to the center of curvature is known as the radius of curvature (abbreviated by "R"). The radius of curvature is the radius of the sphere from which the mirror was cut. Finally, the distance from the mirror to the focal point is known as the focal length (abbreviated by "f").

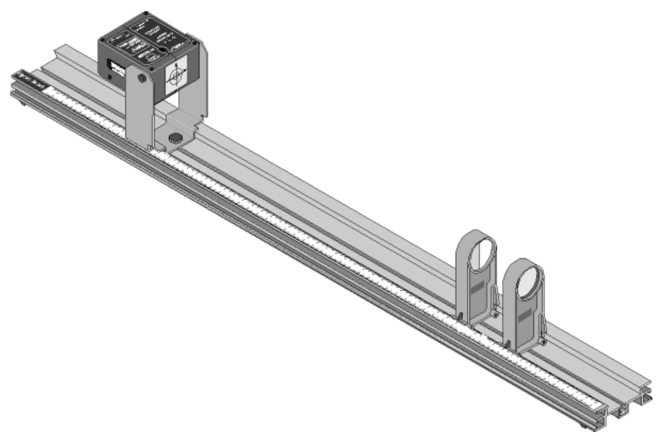
$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

$$M_{exp} = \frac{h'}{h} = -\frac{q}{p}$$

The focal point is the point in space at which light incident towards the mirror and traveling parallel to the principal axis will meet after reflection. The diagram at the right depicts this principle. In fact, if some light from the Sun was collected by a concave mirror, then it would converge at the focal point. Because the Sun is such a large distance from the Earth, any light rays from the Sun which strike the mirror will essentially be traveling parallel to the principal axis. As such, this light should reflect through the focal point.

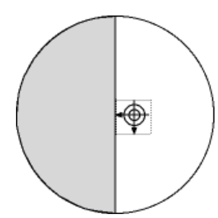


Setup



1. Mount the Light Source at one end of the Optics Bench so its front is at location 0.0 cm. Turn on the Object Source.
2. Place the Concave Mirror at the 100.0 cm mark of the Optics Bench, with the mirror facing the image source.
3. Make sure the crossed-arrow 'object' is illuminated and pointing toward the mirror.
4. Place the Half-Screen on the Optics Bench between the Object Source, and the mirror.
5. With the Vernier Caliper measure the size of the crossed-arrowed object, and record this as the *height of the object* in the Table.

Procedure



1. With the Object Source, and mirror in their current locations move the Half-Screen closer to or farther from the Concave Mirror until the reflected image of the crossed arrow target on the white screen is focused.
2. Determine the distance between the position indicators on the Half-Screen and the Concave Mirror, and record that distance in the Table for q for position 100 cm.
3. Using the Vernier Caliper, measure the size of the image and record it in the Table under h'.
4. Reposition the mirror to the next position listed in Table 3, and repeat procedure for all the listed object positions, p.
5. Preform calculations to complete Table 3. Show work in the space provided below the Table.

Analysis of Concave Mirrors Lab

Name____ Group#________
Course/Section____
Instructor____

Table
Object Height, h________ **Mirror Focus Length_________**

p(cm)	q(cm)	$f = \frac{q \cdot p}{q + p}$	h'(cm)	M = h'/h	M = -q/p
100					
75					
50					
40					
35					
30					
25					
20					
17.5					
15					
13					
Average f					

(30 points) Show Calculations.

1. Calculate the % Error between the given focus length of the mirror and your average experimental value. Show work. (5 points)

2. Using Excel, or some other graphing program, graph $\frac{1}{q}\, vs. \frac{1}{p}$ from the data from Table 3. (10 points)

3. What physical property of the mirror does the y-intercept represent? (10 points)

4. Were the images, compared to the object, upright or inverted? (5 points)

5. Would the image be upright or inverted if the object was placed 'inside' the focus length of the mirror? (5 points)

6. Using Excel, or some other graphing program, graph M vs. p. (10 points)

7. As the object position value gets larger, what value does the magnification go to? (5 points)

8. How does the radius of curvature, R, relate to the focal length, f, of a concave mirror? (6 points)

9. Very briefly explain what happens when light rays strike a concave mirror. (6 points)

10. Do the results of the experiment confirm the theory? Explain your answer. (8 points)