

Focal Length of a Concave Mirror

Optics: Concave mirror

Equipment List

Qty	Items	Part Numbers
1	Light Source, Basic Optics	OS-8517
1	Concave Mirror Accessory	OS-8532
1	Optics Bench, Basic Optics	OS-8518
1	Vernier Caliper	

Introduction

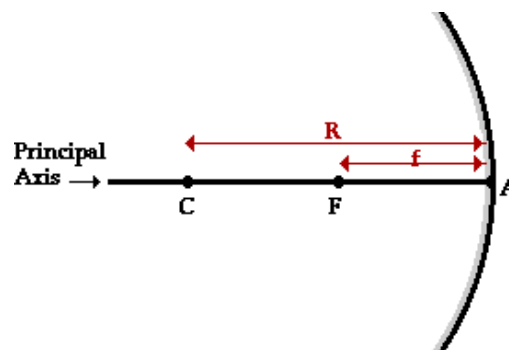
The purpose of this activity is to measure the focal length of a concave mirror. Use a light source, concave mirror, and half screen accessory on an optics bench to measure the focal length of the concave mirror.

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.

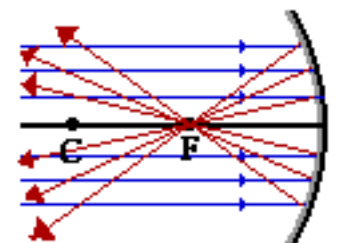
If a concave mirror is thought of as being a slice of a sphere, then there would be a line passing through the center of the sphere and attaching to the mirror in the exact center of the mirror. This line is known as the principal axis. The point in the center of sphere from which the mirror was sliced 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"). The straight line distance from the object to the surface of the mirror along the principal axis is 'p'. While the straight line distance along the principle axis from the surface of the mirror to the location the image forms is 'q'. To look at the magnification, the original size of the object is 'h', while the size of the image is 'h'.



$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q} \qquad \text{Magnification} = \frac{h'}{h} = -\frac{q}{p}$$

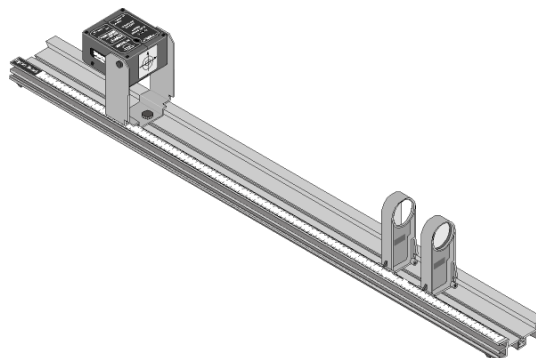
The focal point is the point in space at which light incident towards the mirror and traveling parallel to the principal axis will meet after reflection. The diagram at the right depicts this principle. In fact, if some light from the Sun was collected by a concave mirror, then it



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.

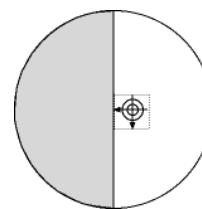
Setup

1. Mount the Light Source at one end of the Optics Bench. Place the Concave Mirror 1m from the light source.
2. Position the Light Source so the crossed arrow target is aimed at the Concave Mirror and the concave surface of the mirror faces the light source.
3. Place the Half-Screen a few centimeters in front of the Concave Mirror (between the mirror and the Light Source).



Procedure

1. 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. Measure the distance between the position indicators on the Half-Screen and the Concave Mirror.
3. Repeat for the given distances in the table below and measure the height of the image on the half-screen and record the data below.



Position, p	Image, q	Focal, $f = \frac{qp}{q+p}$	Height, h'	Magnification, h'/h	Magnification, $-q/p$
100 cm					
75 cm					
50 cm					
40 cm					
35 cm					
30 cm					
25 cm					
20 cm					
17.5 cm					
15 cm					
12 cm					
Average f:			Height, h:		

Lab Report: Focal Length of a Concave Mirror**Name:** _____**Analysis****Data**Experimental focal length = _____ (mm) Accepted focal length = 50 (mm)

1. On a separate sheet of paper, plot $1/\text{image}$ vs. $1/\text{position}$ (in cm.) by hand. What the intercept represents?
2. What is the percent error between the accepted and experimental focal length?
3. How might you determine the focal length more accurately?
4. What is the orientation of the image of the crossed arrow target compared to the target itself?
5. What would happen to the orientation of the image if the object was placed inside of the focal length of the mirror?
6. What is the relationship between the object position and the size of the image formed?
7. As the position value becomes larger, the image value should approach a specific value. What is the significance of that value for this lens?