80 Funland

Purpose

To investigate the nature, position, and size of images formed by a concave mirror

Required Equipment/Supplies

concave spherical mirror
cardboard
night-light with clear 7-watt bulb
small amount of modeling clay
meterstick

Optional Equipment/Supplies

computer
data plotting software

Discussion

The law of reflection states that the angle of reflection equals the angle of incidence. Parallel light rays that strike a plane mirror head on bounce directly backward and are still parallel. If the parallel rays strike that mirror at another angle, each bounces off at the same angle and the rays are again parallel. A plane mirror cannot bring light rays to a focus because the reflected light rays are still parallel and do not converge. Images observed in a plane mirror are always *virtual* images because *real* images are made only by converging light.

A parabolic mirror is able to focus parallel rays of light to a single point (the *focal point*) because of its variable curvature. A small spherical mirror has a curvature that deviates only a little from that of a parabolic curve and is cheaper and easier to make. Spherical mirrors can, therefore, be used to make real images, as you will do in this experiment.

Procedure

Measure focal length of mirror.

Step 1: The distance from the center of a spherical mirror surface to the focal point is called the *focal length*. Measure the focal length of your mirror by having it convert a parallel beam of light into a converging beam that comes to a point on a screen. Use the filament of a lit, clear 7-watt bulb as a source of approximately parallel light and a piece of cardboard as a screen. Record your measurement below to the nearest 0.1 cm. Also, record the number of your mirror.

focal length = _________ cm

mirror number = _______

Step 2: The rays of light striking your mirror from the bulb may not be exactly parallel. What effect, if any, would this have on your measured value for the focal length? What effect would moving the light source farther away from the mirror have? Increase the distance between the mirror and the light source to see if the focal length changes. (If a better source of parallel light is available, use it to find the focal point of your mirror). Record your measurement to the nearest 0.1 cm.

focal length f = ________ cm

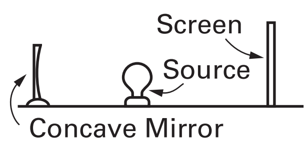

Fig. A

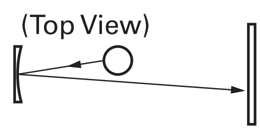

Fig. B

Find a real image with mirror.

Step 3: Use a small amount of modeling clay at the bottom of the mirror to act as a mirror holder. Arrange a screen and a light source as shown in Figure A. Position your screen so that the image is slightly off to one side of the object, as shown in Figure B. Move the mirror so that it is farther than one focal length f from the nightlight. Move the screen to form a sharp image of the filament on the screen. Can a real image be formed on the screen? Is it magnified or reduced, compared with the object? Is the image erect (right-side up) or inverted (upside down)? Record your findings in Data Table A.

Data Table A

Position of Object	Nature of Image		
	Real or Virtual?	Magnified?	Inverted or Erect?
Beyond f			
At f			
Within f			

d_o (cm)	d_i (cm)

Data Table B

Step 4: Where, in relation to one focal length from the mirror, is the object when the image appears right-side up (erect)? What is the relative size of the image (magnified or reduced) compared with the object? Is the image real or virtual? Record your findings in Data Table A.

Step 5: Is there a spacing between object and mirror for which no image appears at all? Where is the object in relation to the focal length? Record this position in Data Table A.

Step 6: Position the mirror two focal lengths away from the light source. The mirror will then form an image of the filament on a screen placed slightly to one side of the light source. The distance between the *focal point* and the object is the object distance d_o and the distance between the focal point and the image is the image distance d_i. Record the distances d_o and d_i in Data Table B. Move the mirror 5 cm farther away from the light source, and reposition the screen until the image comes back into focus. Progressively extend d_o by repeating these 5-cm movements five more times. Record d_o and d_i each time.

Step 7: Plot d_i (vertical axis) vs. d_o (horizontal axis), then different powers of each to discover the mathematical relation between d_i and d_o. Is there any combination that makes a linear graph through the origin and thus a direct proportion? If available, use data plotting software to plot your data.

1. What mathematical relationship exists between d_i and d_o?

Step 8: You can locate the position of the image of the object in Figure C using the ray-diagram method. Draw the path of the light rays that leaves the tip of the arrow parallel to the principal axis.

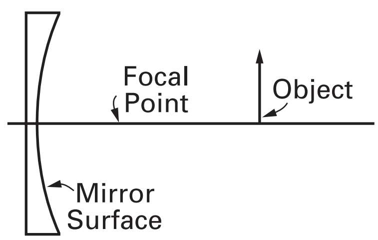

Fig. C

2. Where does this ray go after it is reflected?

Draw the light ray that leaves the tip of the arrow and passes through the focal point.

3. Where does this light ray go after it is reflected?

Now draw the paths of these two light rays after they are reflected. At the point where they cross, an image of the tip of the arrow is formed.

Step 9: Use the ray-diagram method to locate the image of the object in Figure D. Draw the path of the ray that leaves the tip of the arrow parallel to the principal axis and is reflected by the mirror. Trace another ray that heads toward the mirror in the same direction as if it *originated* from the focal point and is reflected by the mirror.

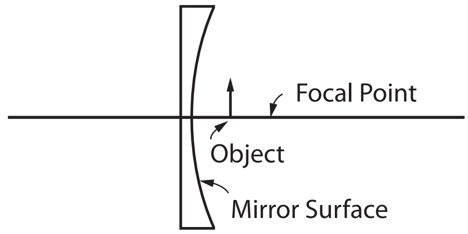

Fig. D

4. Where do the two reflected rays *appear* to cross?

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5. Could the image be projected onto a screen? Explain.

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