CONVEX SPHERICAL MIRRORS

On recent models of automobiles, there is a side-view mirror on the passenger's side of the car. Unlike the flat mirror on the driver's side, which produces unmagnified images, the passenger's mirror bulges outward at the center. Images in this mirror are distorted near the mirror's edges, and the image is smaller than the object. This type of mirror is called a **convex spherical mirror.**

convex spherical mirror

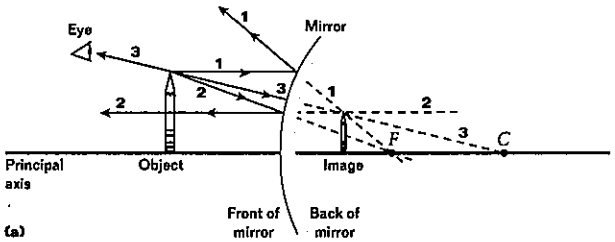
a mirror whose reflecting surface is an outward-curved segment of a sphere

A convex spherical mirror is a segment of a sphere that is silvered so that light is reflected from the sphere's outer, convex surface. This type of mirror is also called a diverging mirror because the incoming rays diverge after reflection as though they were coming from some point behind the mirror. The resulting image is therefore always virtual, and the image distance is always negative. Because the mirrored surface is on the side opposite the radius of curvature, a convex spherical mirror also has a negative focal length. The sign conventions for all mirrors are summarized in **Table 5.**

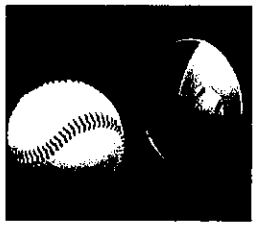
The technique for drawing ray diagrams for a convex mirror differs slightly from that for concave mirrors. The focal point and center of curvature are situated behind the mirror's surface. Dotted lines are extended along the reflected reference rays to points behind the mirror, as shown in **Figure 13(a).** A virtual, upright image forms where the three rays apparently intersect. Magnification for convex mirrors is always less than 1, as shown in **Figure 13(b).**

Convex spherical mirrors take the objects in a large field of view and produce a small image, so they are well suited for providing a fixed observer with a complete view of a large area. Convex mirrors are often placed in stores to help employees monitor customers and at the intersections of busy hallways so that people in both hallways can tell when others are approaching.

The side-view mirror on the passenger's side of a car is another application of the convex mirror. This mirror usually carries the warning, "objects are closer than they appear." Without this warning, a driver might think that he or she is looking into a flat mirror, which does not alter the size of the image. The driver could therefore be fooled into believing that a vehicle is farther away than it is because the image is smaller than the actual object.



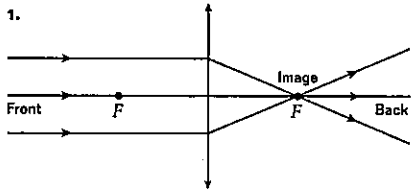
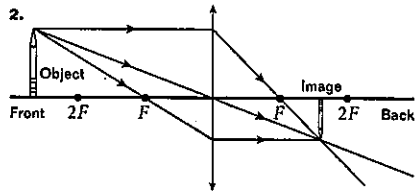
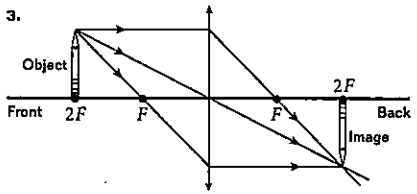
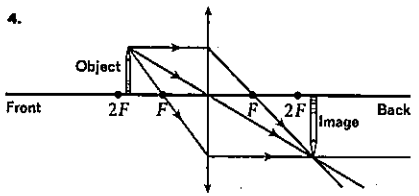
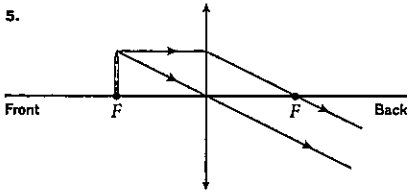
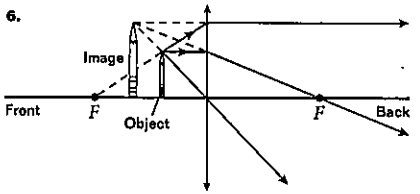
(a)



(b)

Figure 13
Light rays diverge upon reflection from a convex mirror (a), forming a virtual image that is always smaller than the object (b).

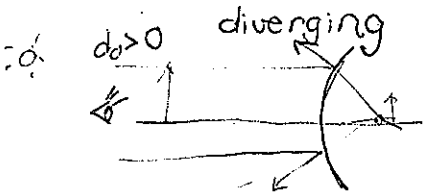
Table 3 Images Created by Converging Lenses

Ray diagrams	
1.  **Configuration:** object at infinity; point image at *F* **Applications:** burning a hole with a magnifying glass	2.  **Configuration:** object outside 2*F*; real, smaller image between *F* and 2*F* **Applications:** lens of a camera, human eyeball lens, and objective lens of a refracting telescope
3.  **Configuration:** object at 2*F*; real image at 2*F* same size as object **Applications:** inverting lens of a field telescope	4.  **Configuration:** object between *F* and 2*F*; magnified real image outside 2*F* **Applications:** motion-picture or slide projector and objective lens in a compound microscope
5.  **Configuration:** object at *F*; image at infinity **Applications:** lenses used in lighthouses and searchlights	6.  **Configuration:** object inside *F*; magnified virtual image on the same side of the lens as the object **Applications:** magnifying with a magnifying glass; eyepiece lens of microscope, binoculars, and telescope

#48
FRQ 2008 B #5

mirror
$d_o > 0$
d_i +
f +
converging

$m > 1$ bigger



d_i −
f −

~store, corners, rearview ~ WARNING: objects are closer than they appear

always upright
smaller
virtual

$$m = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

Table 5 Sign Conventions for Mirrors

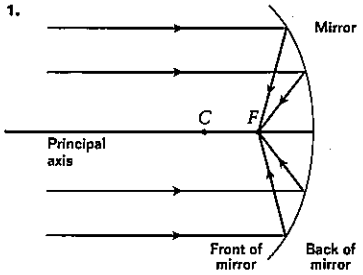
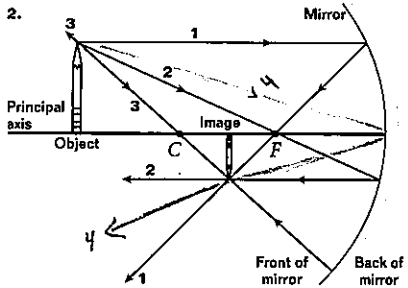
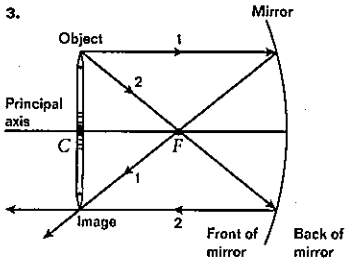
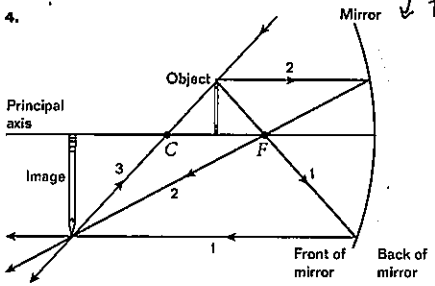
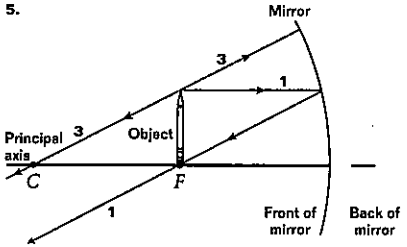
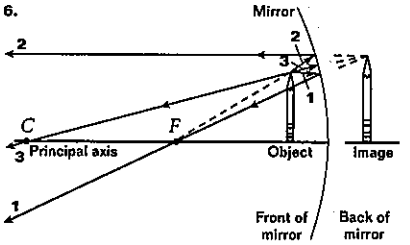
Symbol	Situation	Sign	
p	object is in front of the mirror (real object)	+	$p > 0$
q	image is in front of the mirror (real image)	+	$q > 0$
q	image is behind the mirror (virtual image)	−	$q < 0$
R, f	center of curvature is in front of the mirror (concave spherical mirror)	+	$R > 0$, $f > 0$
R, f	center of curvature is behind the mirror (convex spherical mirror)	−	$R < 0$, $f < 0$
R, f	mirror has no curvature (flat mirror)	∞	$R, f \to \infty$
h'	image is above the principal axis	+	$h, h' > 0$
h'	image is below the principal axis	−	$h > 0, h' < 0$

Did you know?

There are certain circumstances in which the object for one mirror is the image that appears behind another mirror. In these cases, the object is virtual and has a negative object distance. Because of the rarity of these situations, virtual object distance ($p < 0$) has not been listed in **Table 5**.

Diverging mirror
Ch23 #11

Table 4 Images Created by Concave Mirrors

Ray diagrams	
1.  **Configuration:** object at infinity **Image:** real image at F solar cooker	2.  **Configuration:** object outside C **Image:** real image between C and F, inverted with magnification < 1 spoon ↕ #22
3.  **Configuration:** object at C **Image:** real image at C, inverted with magnification = 1	4.  **Configuration:** object between C and F **Image:** real image at C, inverted with magnification > 1
5.  **Configuration:** object at F **Image:** image at infinity (no image)	6.  **Configuration:** object inside F **Image:** virtual, upright image at C with magnification >1

car headlights

make-up mirror