16.2.6: Convex Mirrors

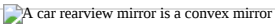

Figure 14.6.1

Convex mirrors provide a wide angle view and they provide an upright image. Wide angle images have benefits in rearview mirrors, in-store customer monitors, and for viewing large areas like intersections and parking lots.

Images in a Convex Mirror

In **convex mirrors**, the reflecting surface is on the outside of the sphere, making the center of curvature and the focal point on the opposite side of the mirror from the object. Since the focal point is on the opposite side of the mirror from the object, the focal length is assigned a negative number.

Light rays that come to the mirror aimed at the focal point on the back side will be reflected parallel to the principal axis. In the sketch, blue rays approach the mirror as if they would continue through the mirror toward the focal point (dotted blue lines). They reflect along the purple lines parallel to the principal axis.

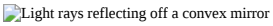

Figure 14.6.2

Similarly, light rays that approach the mirror parallel to the principal axis reflect as if they came from the focal point.

Example 14.6.1

A convex mirror has a radius of curvature of 40.0 cm. If the object distance is 1000.0 cm, find the image distance and the magnification.

Solution

$(1/d_o)+(1/d_i)=(1/f)$ *so* $(1/1000)+(1/x)=(1/-20.0)$

Multiplying both sides by 1000x yields $x+1000=-50x$ and $51x=-1000$ and $x=-19.6$ cm.

Since the image distance is negative, it means the image is behind the mirror and is virtual. The image will be upright.

$m=-d_i/d_o=-(-19.6)/1000=0.0196$ or 1/51

The image is reduced by a factor of 51.

For a convex mirror, if the object is at infinity, the image will be a dot on the focal point. As the object moves from infinity toward the mirror, the image moves along the principal axis toward the mirror. When the object right next to the mirror, the image will be right next to the mirror on the other side.

All ray diagrams for convex mirrors look essentially like the image below, with the placement of the image somewhere between the mirror and the focal point.

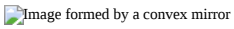

Figure 14.6.3

The ray tracing for convex mirrors follow this general sketch. Two rays leave the tip of the object, one approaches the mirror parallel and reflects as if it came from the focal point. The top blue dotted line shows this imaginary route. The second ray leaves the object tip and approaches the mirror toward the focal point but reflects parallel at the mirror. The green solid line shows the reflected ray and the dotted green line shows the imaginary route behind the mirror. Where the two dotted lines intersect is the tip of the image. All images in convex mirrors are upright, virtual, and diminished. As the object moves toward the mirror, the image also moves toward the mirror and increases in size. This can be determined using the mirror and magnification equations.

When light enters a Cassegrain telescope from a distant planet, first it bounces off a concave primary mirror and then off a secondary convex mirror. Play around with a Cassegrain telescope in the simulation below and see if you can until you get a clear view of Jupiter in the eyepiece:

Summary

- For convex mirrors, the reflecting surface is on the outside of the sphere, placing the center of curvature and the focal point on the opposite side of the mirror from the object.
- Light rays that approach the mirror aimed at the focal point will be reflected parallel to the principal axis.
- Light rays that come to the mirror parallel to the principal axis reflect as if they came from the focal point.
- Since the focal point is on the opposite side of the mirror from the object, the focal length is assigned a negative number.
- Both the mirror equation and the magnification equation are true with convex mirrors.

Review

1. Find the image distance of an object placed 5.00 cm in front of a convex mirror whose focal length is 8.00 cm.
2. Find the image distance of an object placed 3.00 cm in front of a convex mirror whose focal length is 8.00 cm.
3. A 4.0 cm tall light bulb is placed a distance 35.5 cm from a convex mirror with a focal length of -12.2 cm.
    1. Find the image distance.
    2. Find the image size.

Explore More

Use this resource to answer the questions that follow.

1. Images in a convex mirror are always _____ and always _____.
2. The image in a convex mirror will always be on the _____ (same or opposite) side of the mirror from the object.

Additional Resources

Study Guide: Geometric Optics Study Guide

Real World Application: Closer than They Appear

Videos: