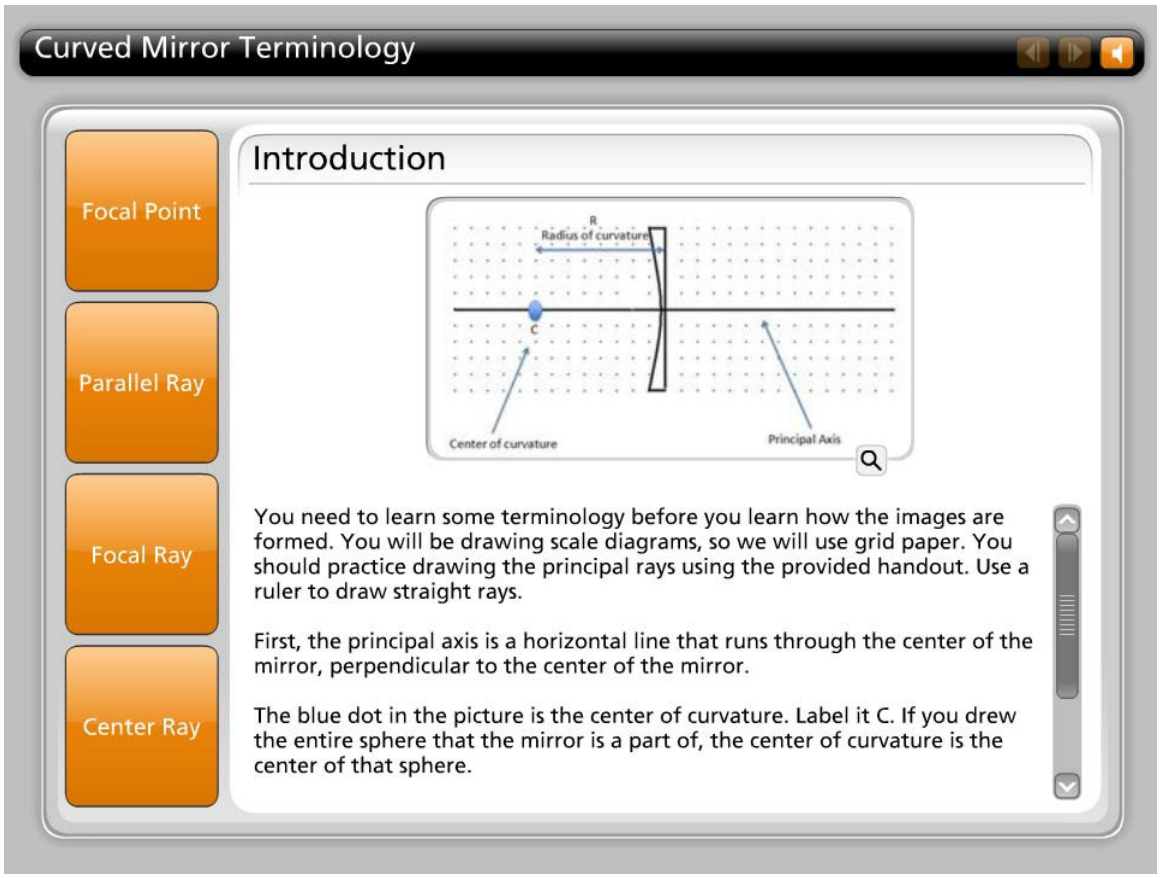
Module 10: Optics
Topic 2 Content: Curved Mirrors Notes Sheet



Introduction

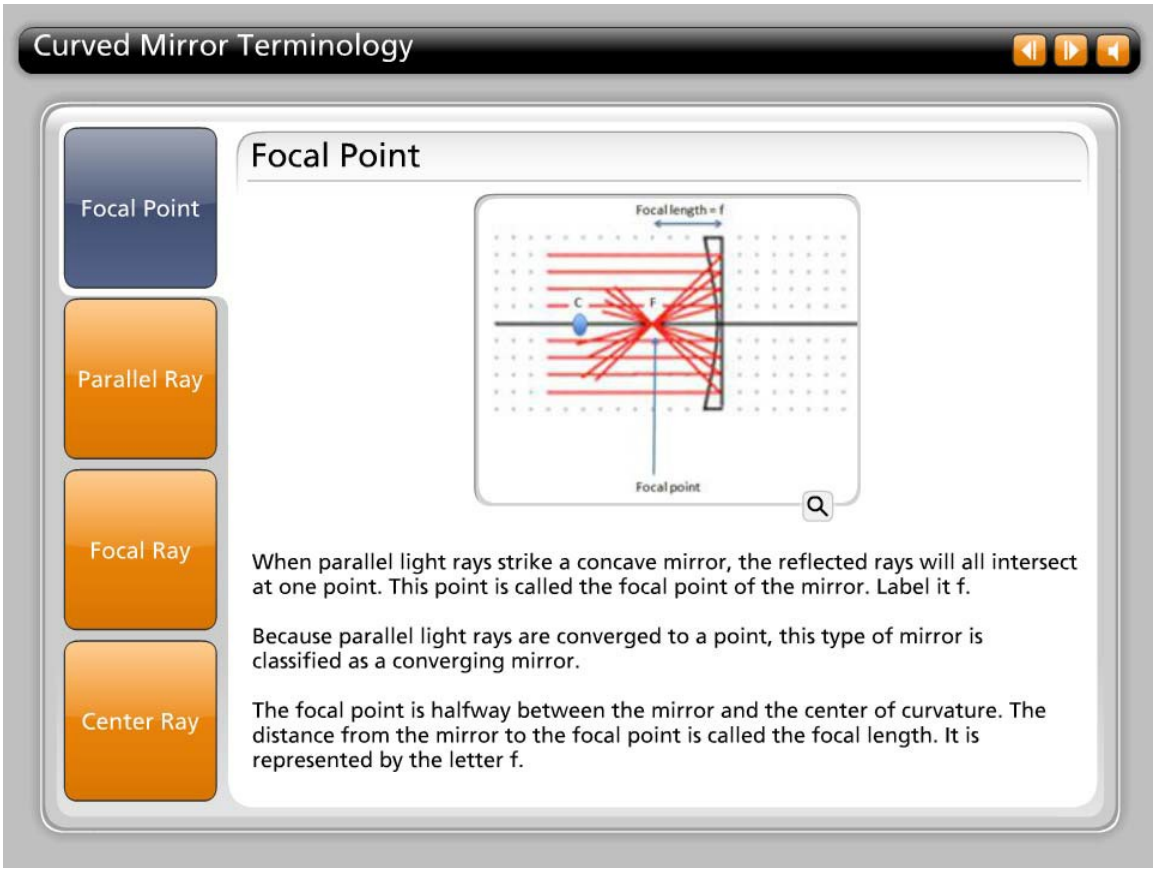
You need to learn some terminology before you learn how the images are formed. You will be drawing scale diagrams, so we will use grid paper. You should practice drawing the principal rays using the provided handout. Use a ruler to draw straight rays.

First, the principal axis is a horizontal line that runs through the center of the mirror, perpendicular to the center of the mirror.

The blue dot in the picture is the center of curvature. Label it C. If you drew the entire sphere that the mirror is a part of, the center of curvature is the center of that sphere.

The distance from the center of curvature to the mirror is called the radius of curvature. It is the radius of the sphere and is represented by the letter R.

Click the tabs to continue with curved mirror terminology. Click on the magnifying glass on each image to enlarge it.

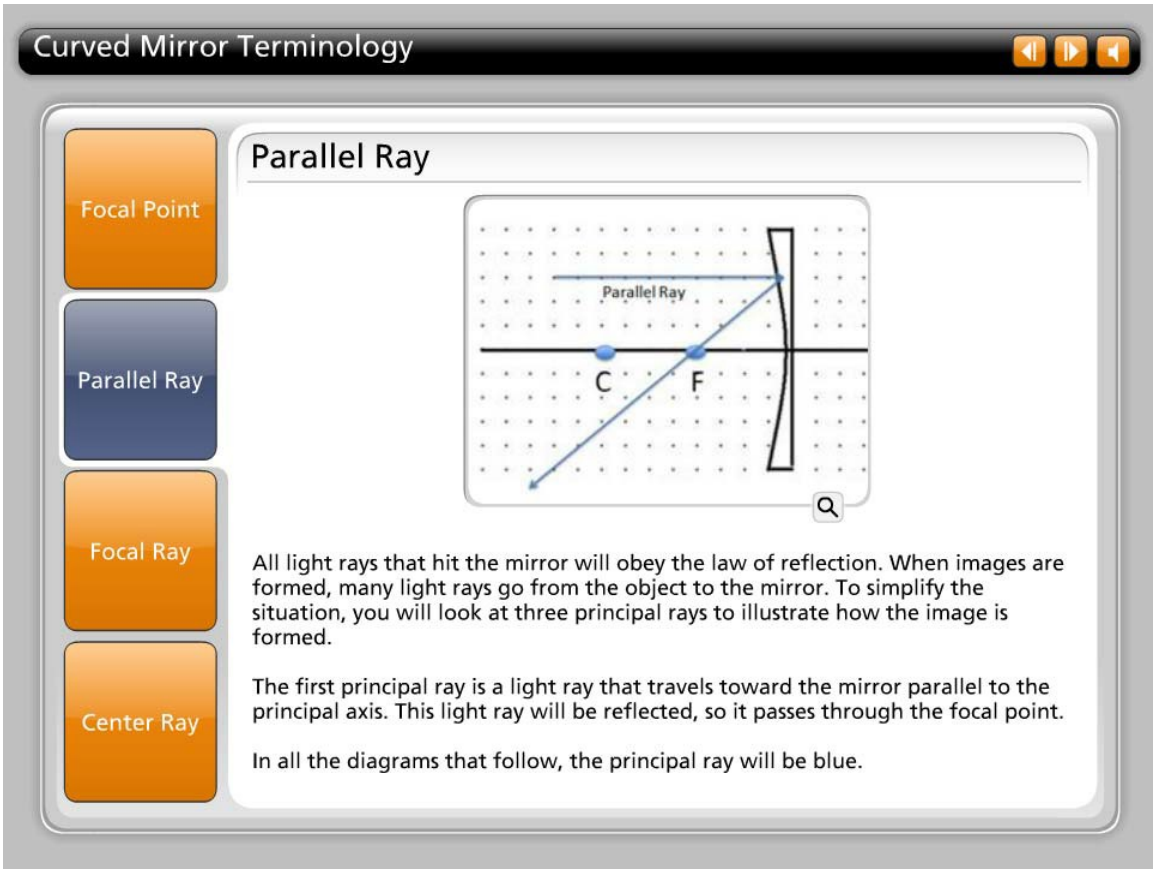


Focal Point

When parallel light rays strike a concave mirror, the reflected rays will all intersect at one point. This point is called the focal point of the mirror. Label it f.

Because parallel light rays are converged to a point, this type of mirror is classified as a converging mirror.

The focal point is halfway between the mirror and the center of curvature. The distance from the mirror to the focal point is called the focal length. It is represented by the letter f.

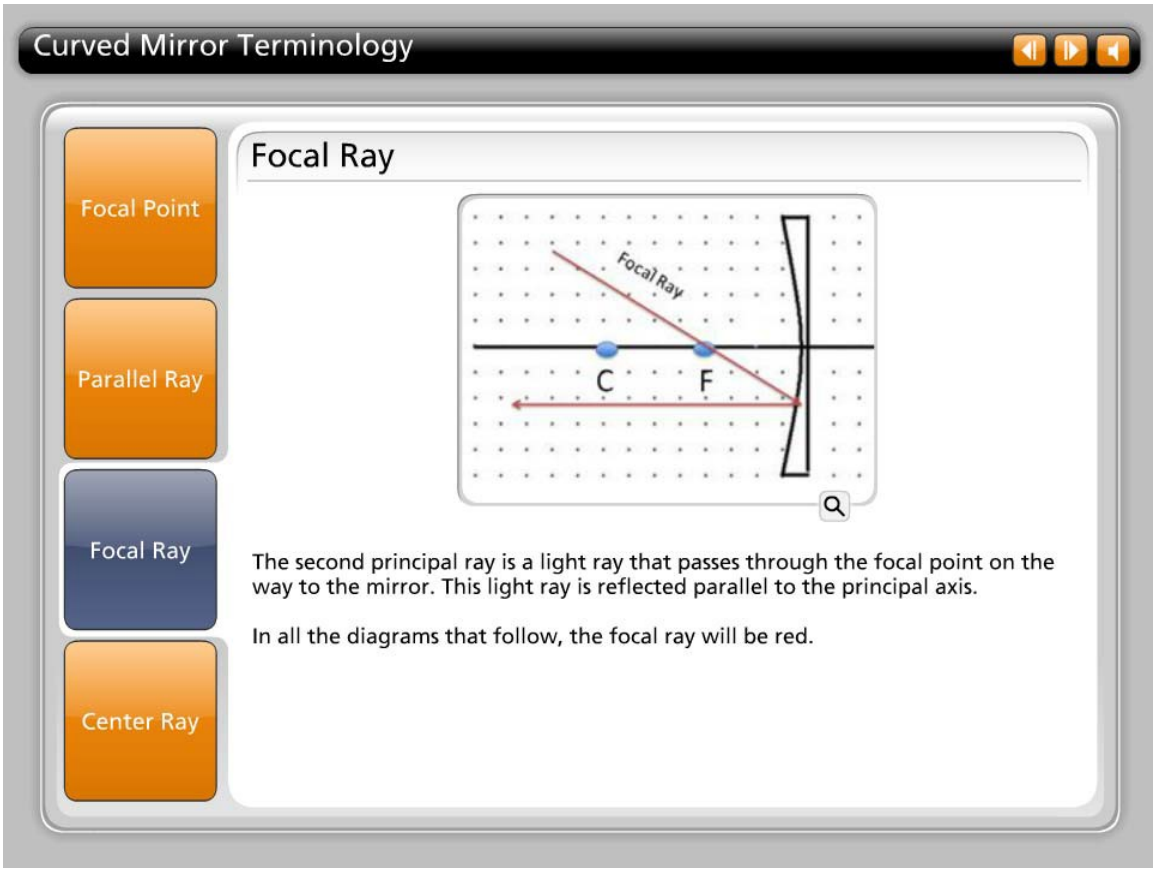


Parallel Ray

All light rays that hit the mirror will obey the law of reflection. When images are formed, many light rays go from the object to the mirror. To simplify the situation, you will look at three principal rays to illustrate how the image is formed.

The first principal ray is a light ray that travels toward the mirror parallel to the principal axis. This light ray will be reflected, so it passes through the focal point.

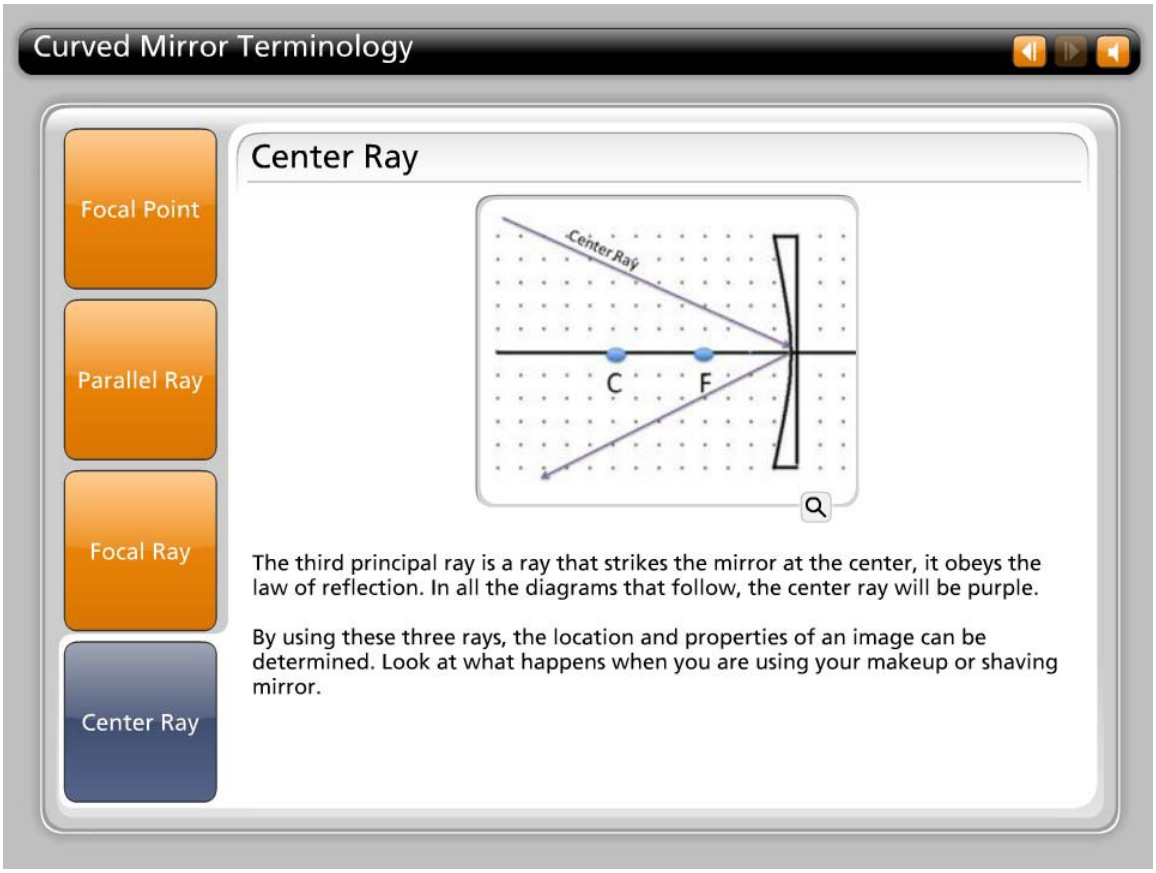
In all the diagrams that follow, the principal ray will be blue.



Focal Ray

The second principal ray is a light ray that passes through the focal point on the way to the mirror. This light ray is reflected parallel to the principal axis.

In all the diagrams that follow, the focal ray will be red.

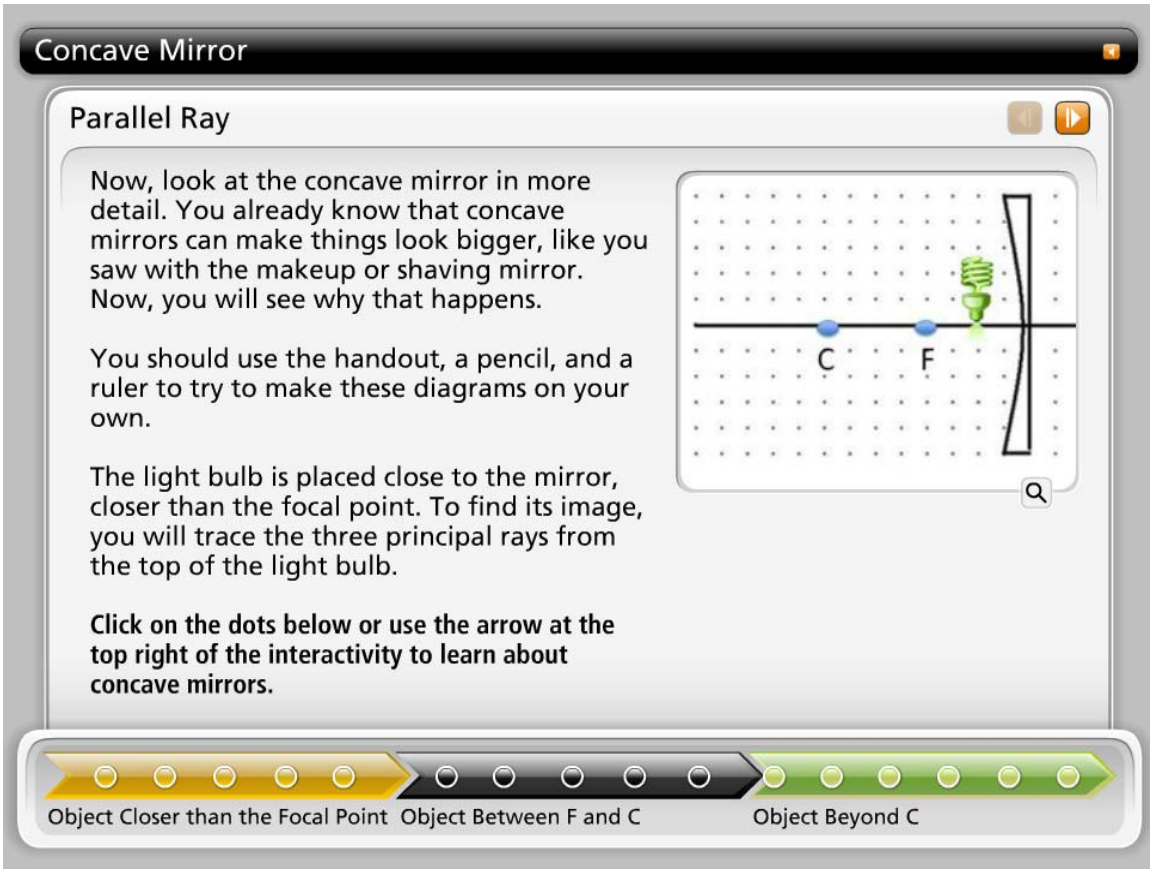


Center Ray

The third principal ray is a ray that strikes the mirror at the center, it obeys the law of reflection. In all the diagrams that follow, the center ray will be purple.

By using these three rays, the location and properties of an image can be determined. Look at what happens when you are using your makeup or shaving mirror.

Concave Mirror



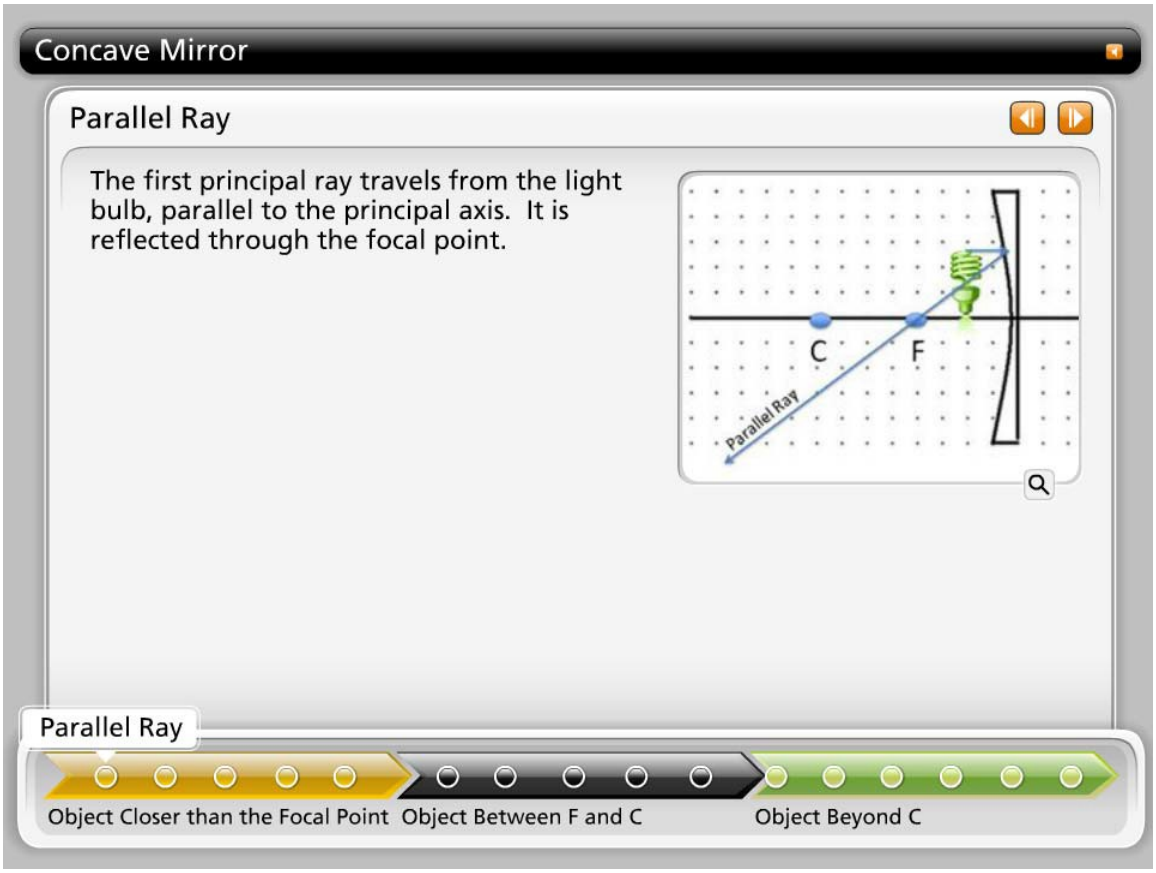
Parallel Ray

Now, look at the concave mirror in more detail. You already know that concave mirrors can make things look bigger, like you saw with the makeup or shaving mirror. Now, you will see why that happens.

You should use the handout, a pencil, and a ruler to try to make these diagrams on your own.

The light bulb is placed close to the mirror, closer than the focal point. To find its image, you will trace the three principal rays from the top of the light bulb.

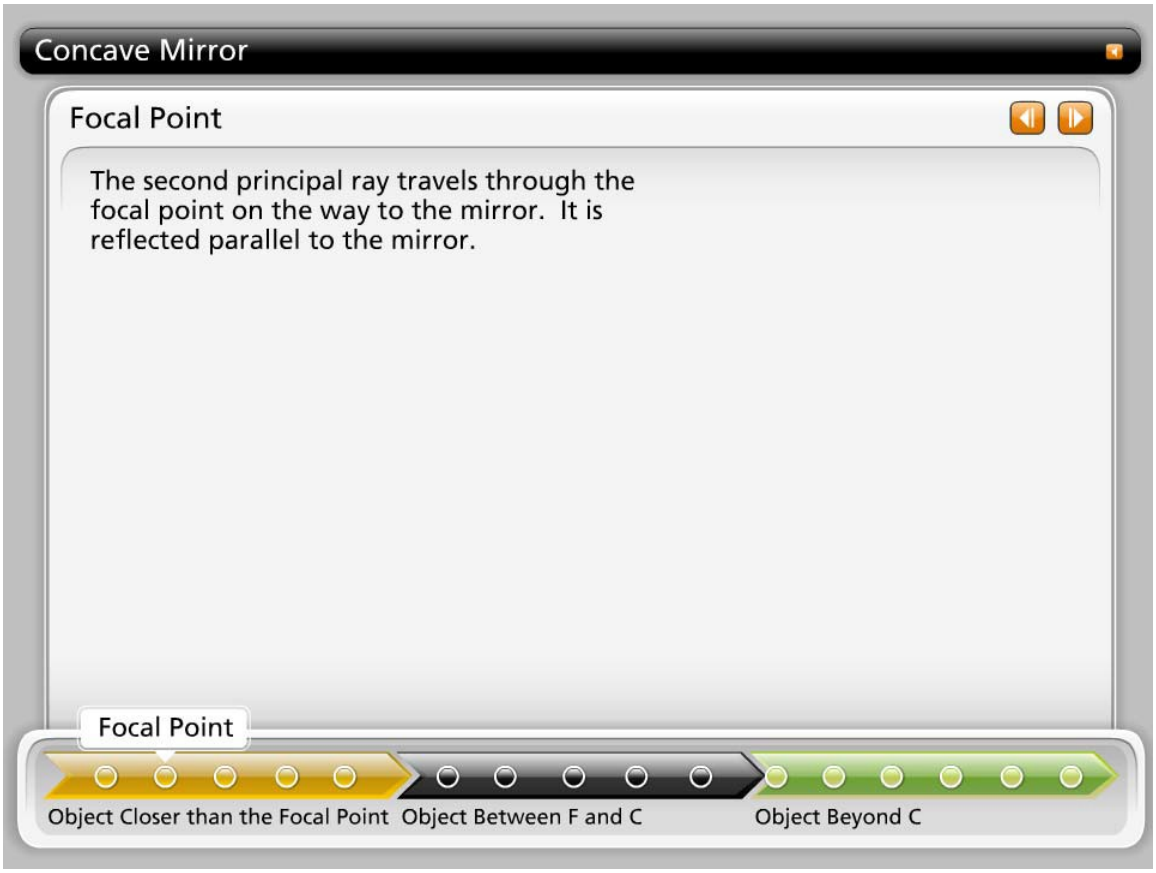
Click on the dots to learn about concave mirrors.



Object Closer than the Focal Point

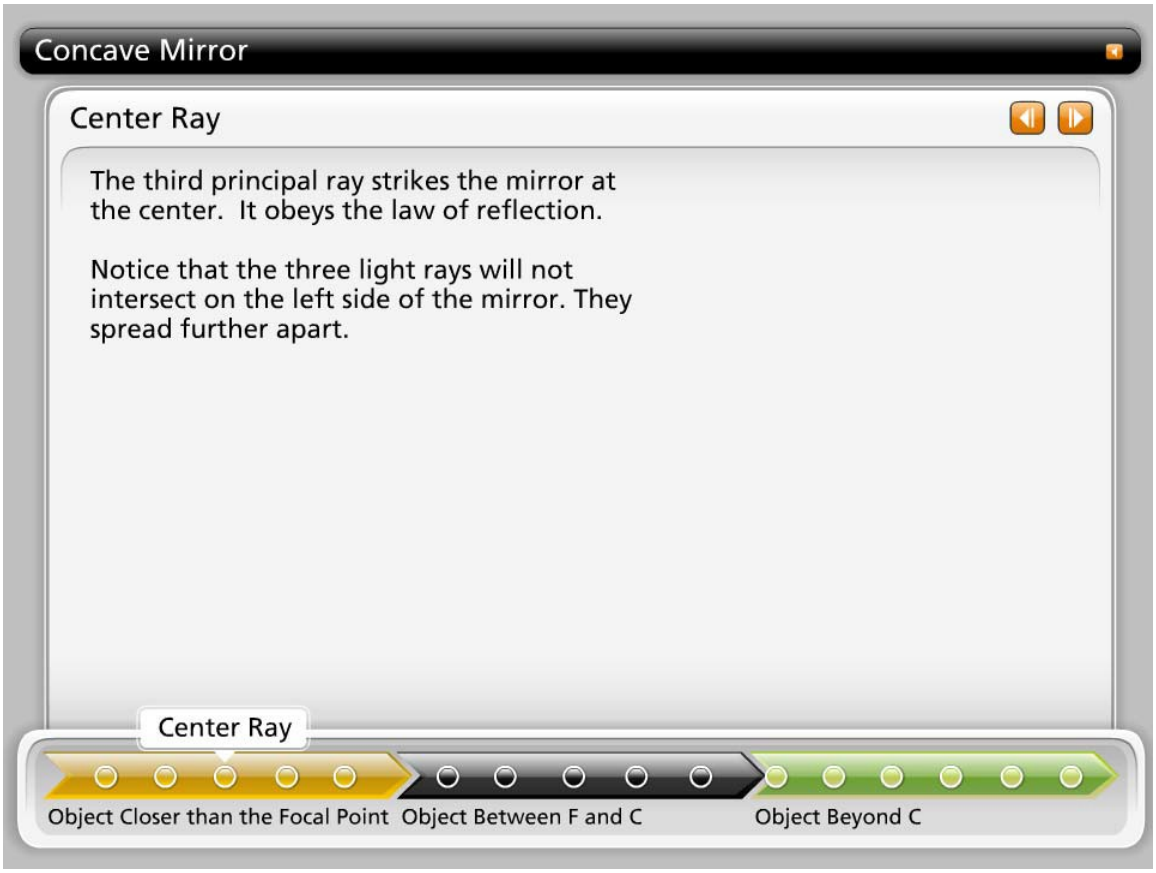
Parallel Ray

The first principal ray travels from the light bulb, parallel to the principal axis. It is reflected through the focal point.



Focal Point

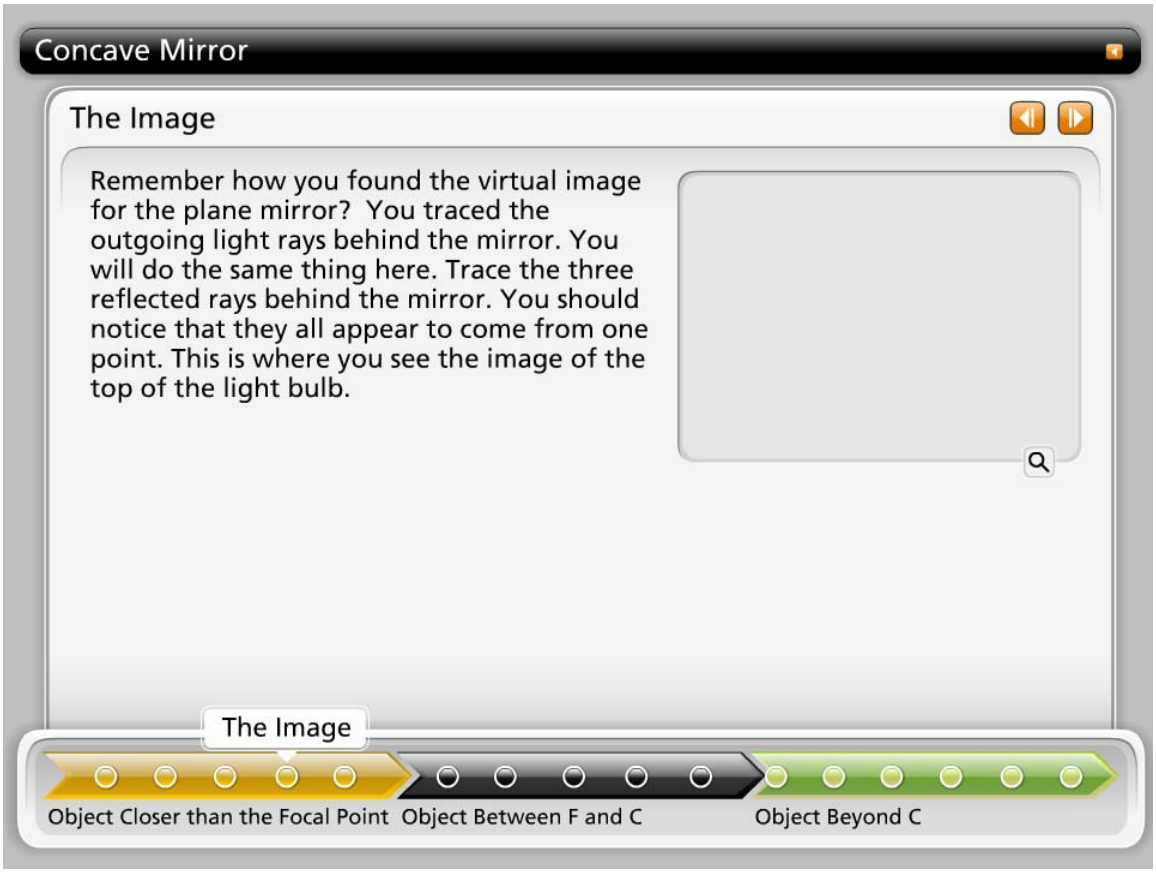
The second principal ray travels through the focal point on the way to the mirror. It is reflected parallel to the mirror.



Center Ray

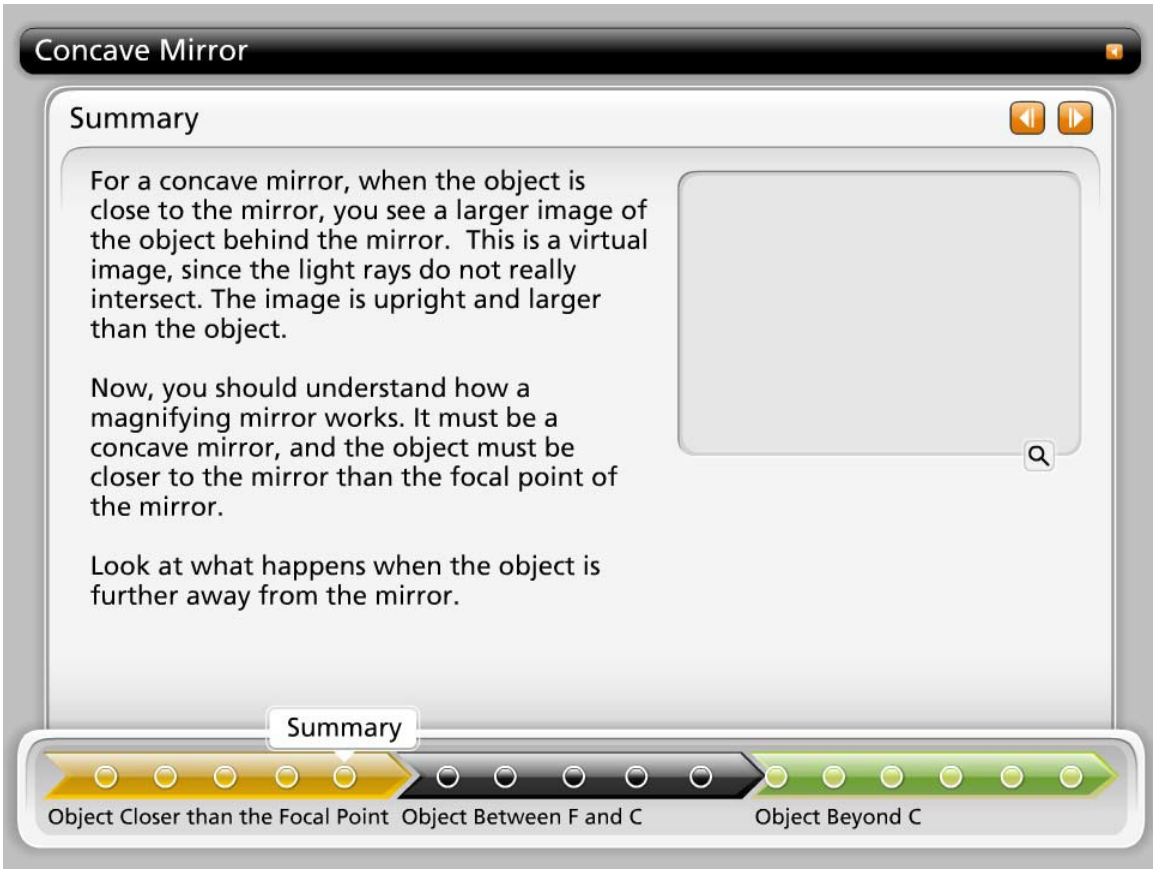
The third principal ray strikes the mirror at the center. It obeys the law of reflection.

Notice that the three light rays will not intersect on the left side of the mirror. They spread further apart.



The Image

Remember how you found the virtual image for the plane mirror? You traced the outgoing light rays behind the mirror. You will do the same thing here. Trace the three reflected rays behind the mirror. You should notice that they all appear to come from one point. This is where you see the image of the top of the light bulb.

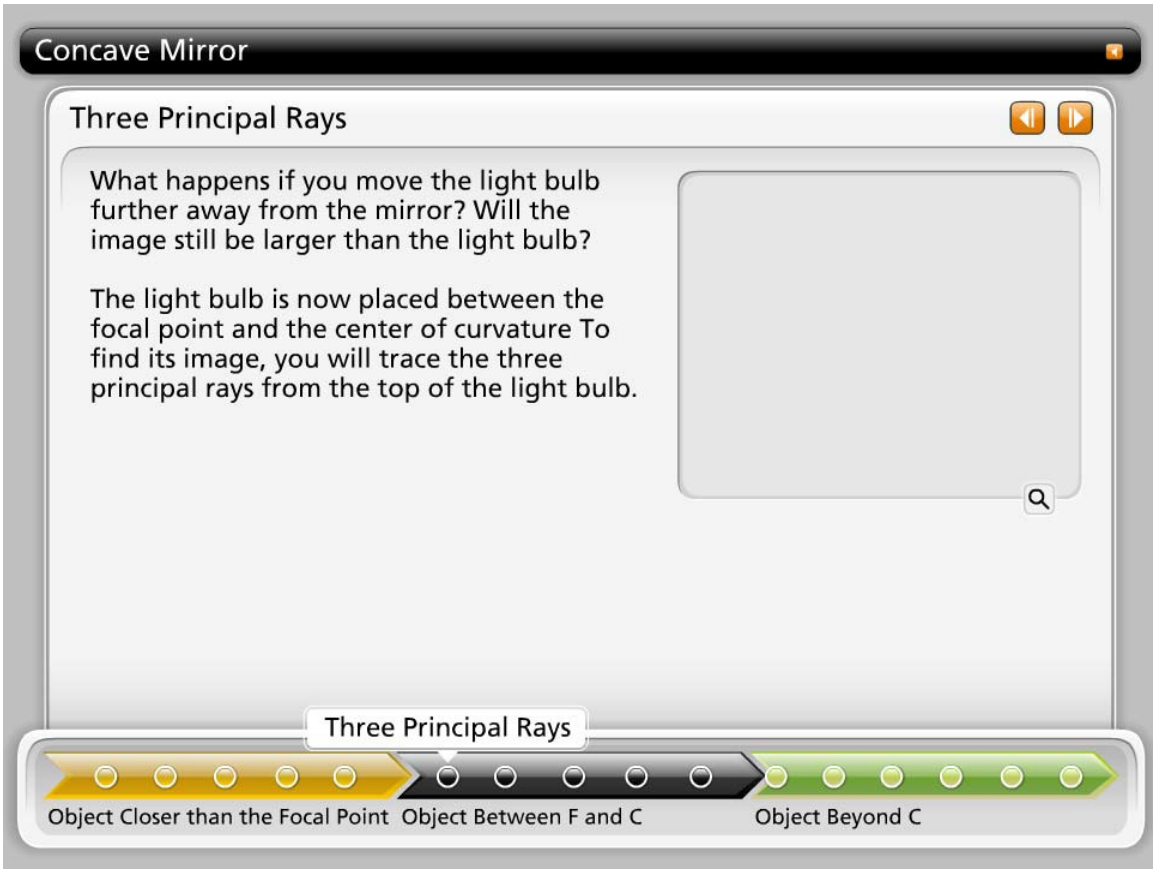


Summary

For a concave mirror, when the object is close to the mirror, you see a larger image of the object behind the mirror. This is a virtual image, since the light rays do not really intersect. The image is upright and larger than the object.

Now, you should understand how a magnifying mirror works. It must be a concave mirror, and the object must be closer to the mirror than the focal point of the mirror.

Look at what happens when the object is further away from the mirror.

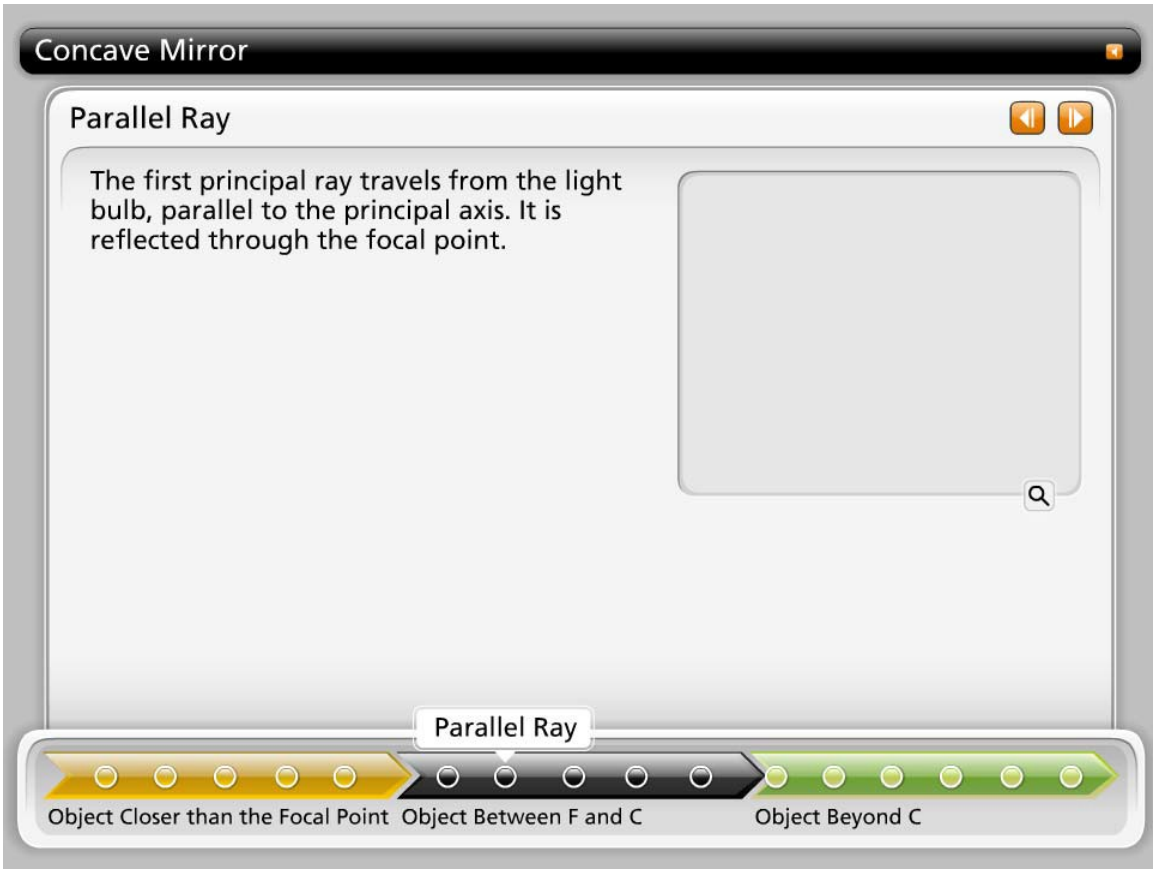


Object Between F and C

Three Principal Rays

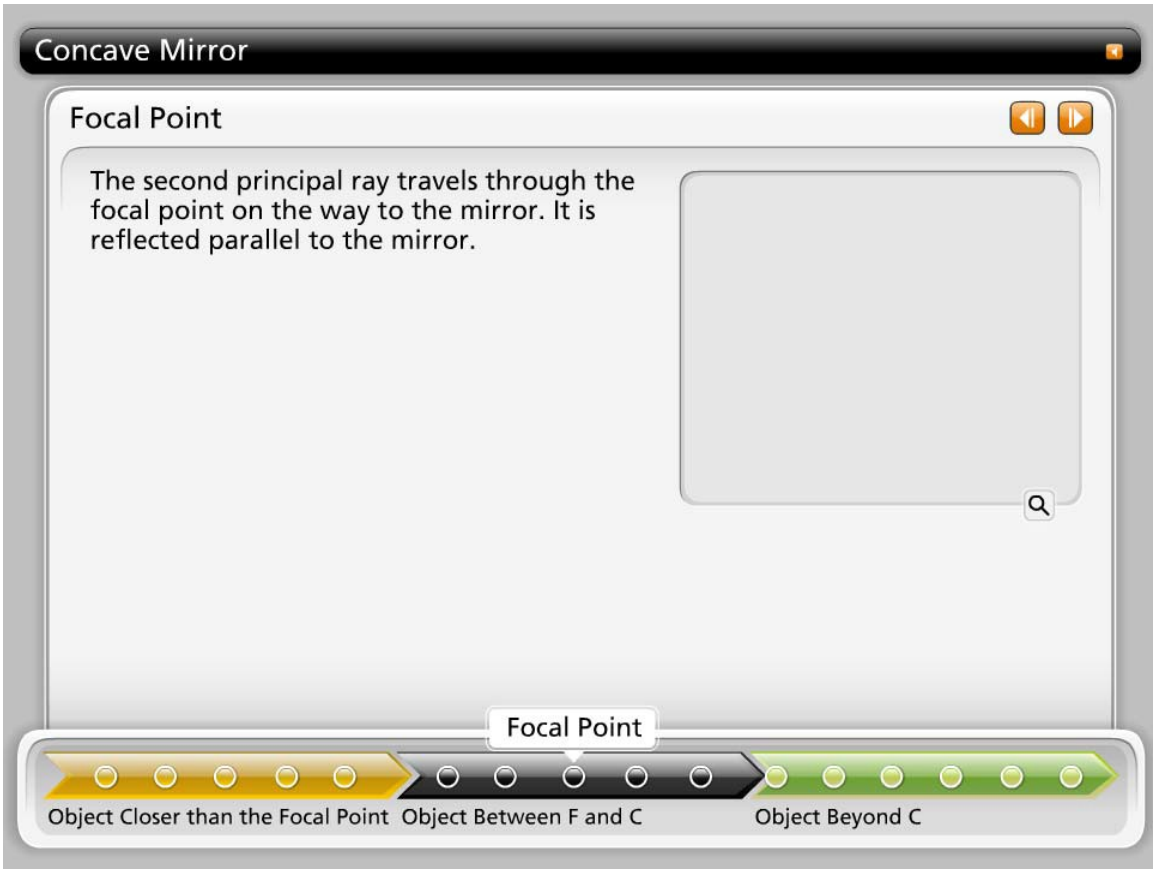
What happens if you move the light bulb further away from the mirror? Will the image still be larger than the light bulb?

The light bulb is now placed between the focal point and the center of curvature To find its image, you will trace the three principal rays from the top of the light bulb.



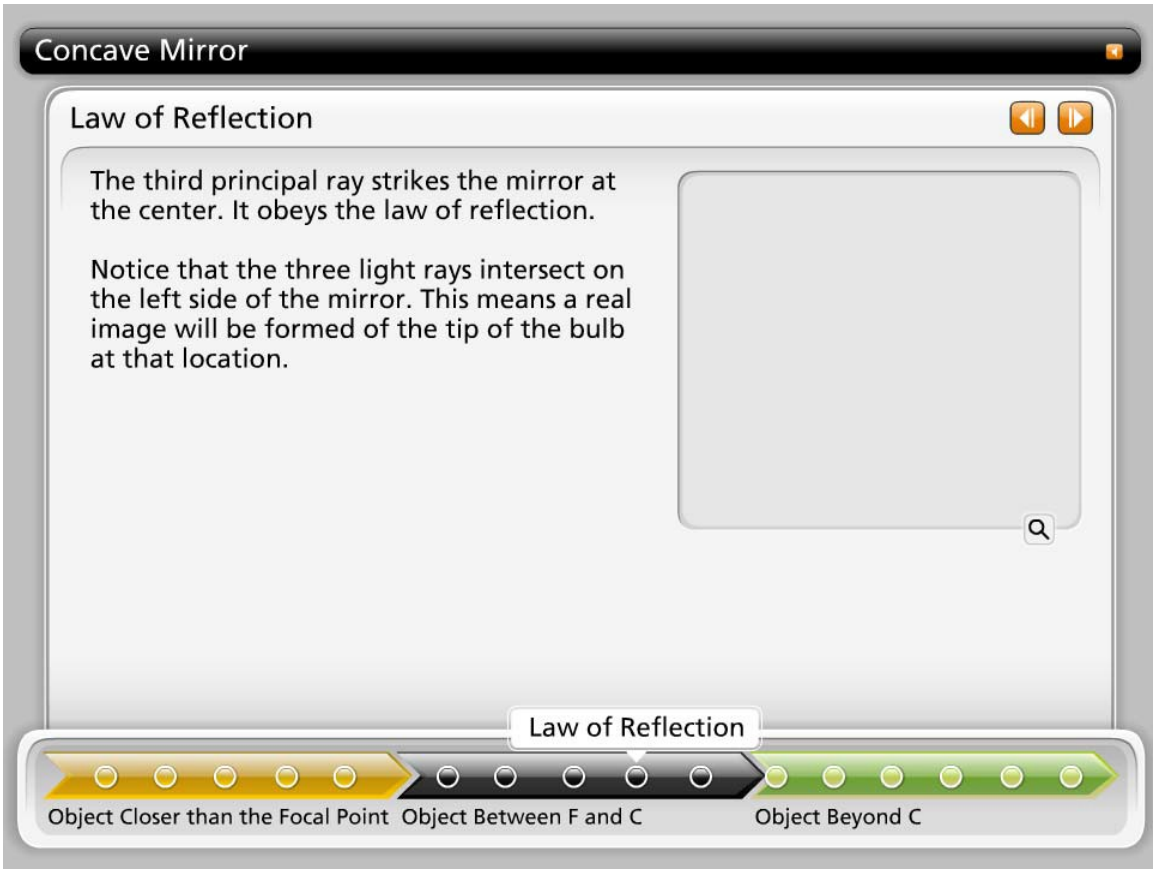
Parallel Ray

The first principal ray travels from the light bulb, parallel to the principal axis. It is reflected through the focal point.



Focal Point

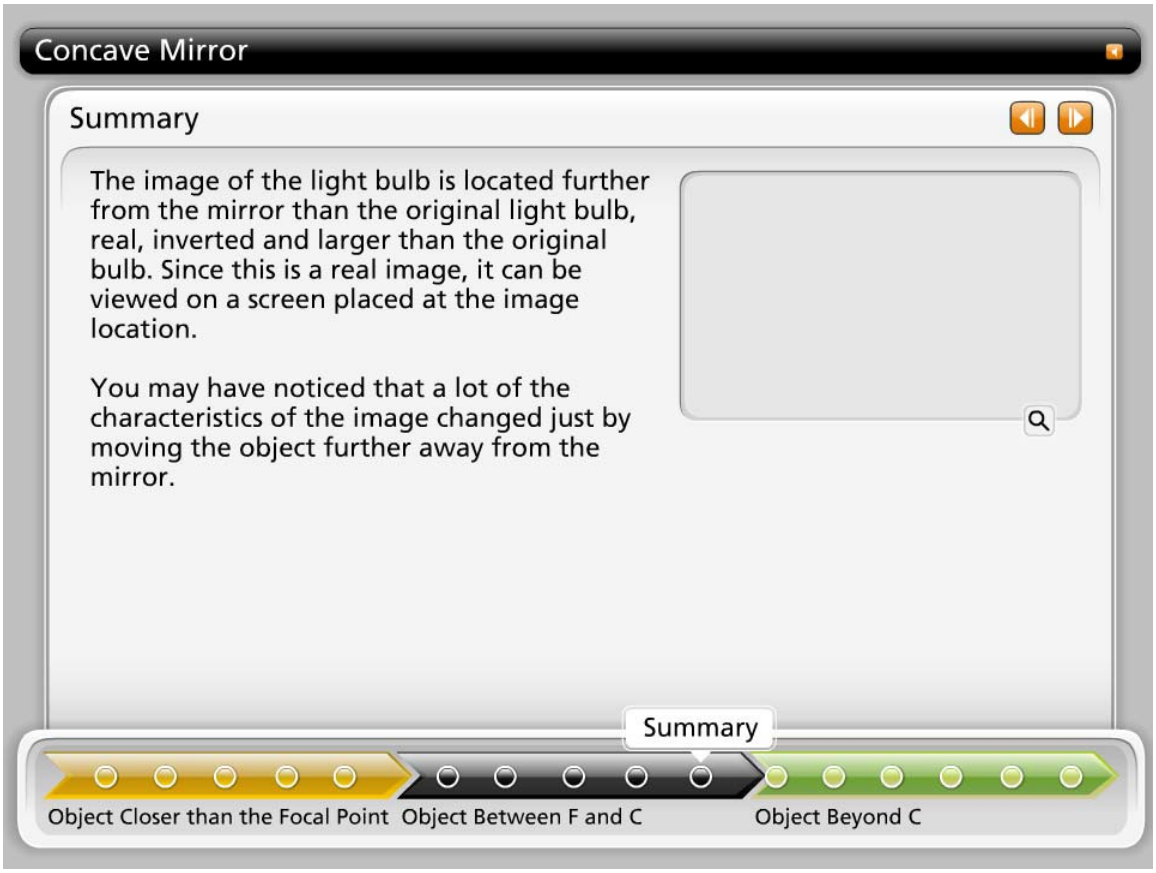
The second principal ray travels through the focal point on the way to the mirror. It is reflected parallel to the mirror.



Law of Reflection

The third principal ray strikes the mirror at the center. It obeys the law of reflection.

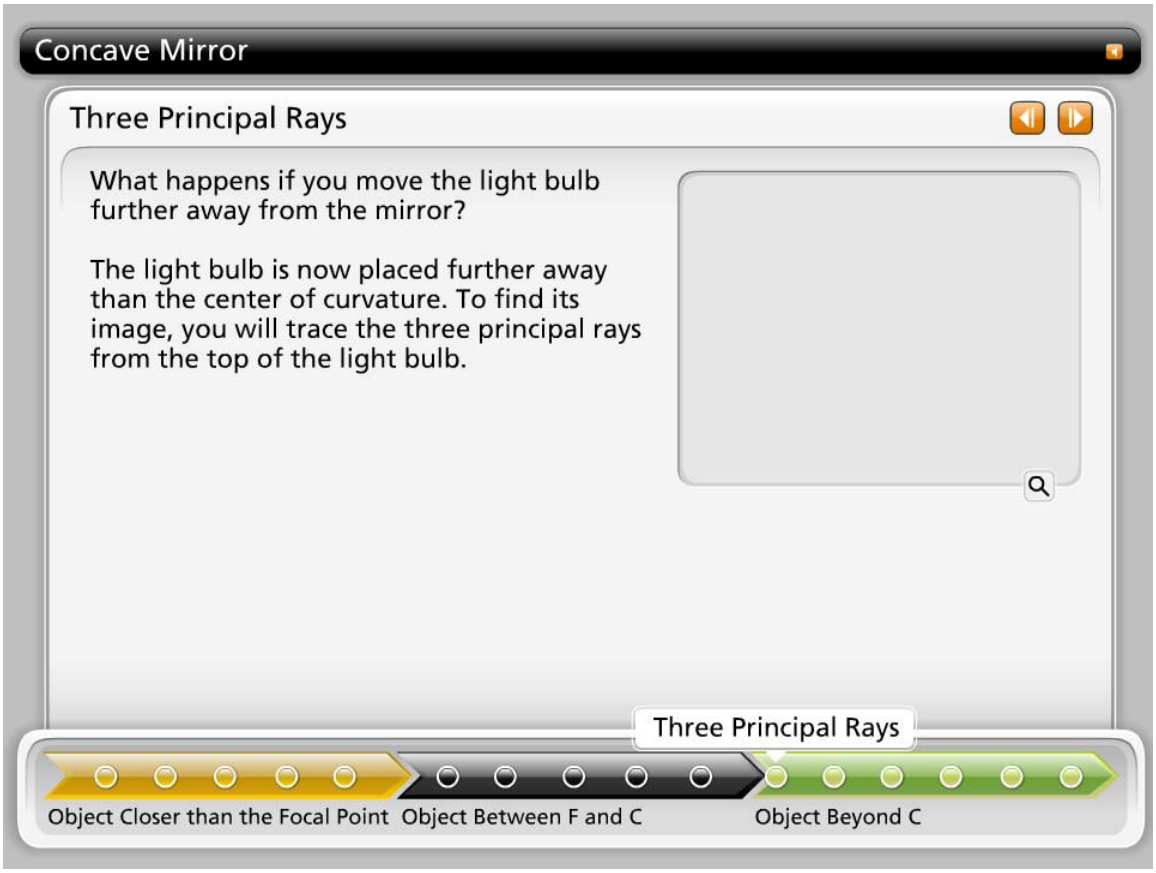
Notice that the three light rays intersect on the left side of the mirror. This means a real image will be formed of the tip of the bulb at that location.



Summary

The image of the light bulb is located further from the mirror than the original light bulb, real, inverted and larger than the original bulb. Since this is a real image, it can be viewed on a screen placed at the image location.

You may have noticed that a lot of the characteristics of the image changed just by moving the object further away from the mirror.

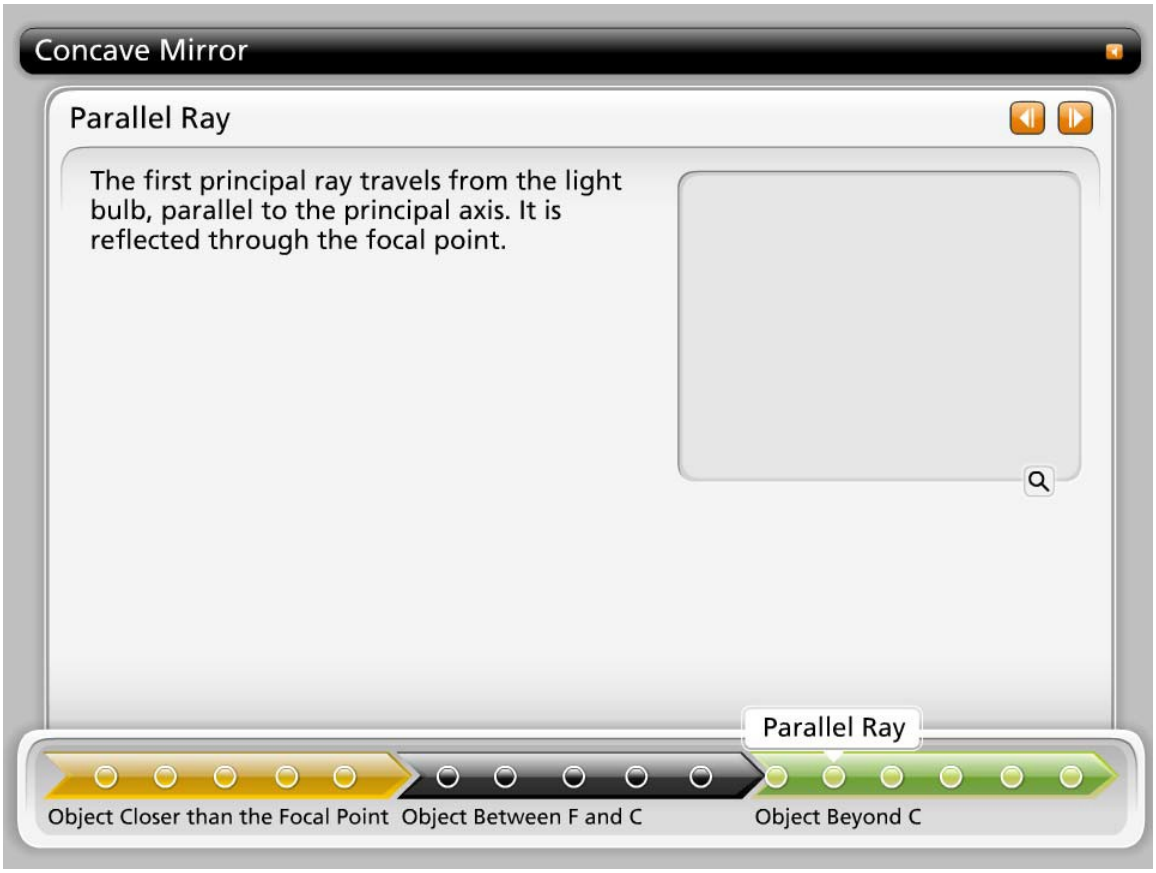


Object Beyond C

Three Principal Rays

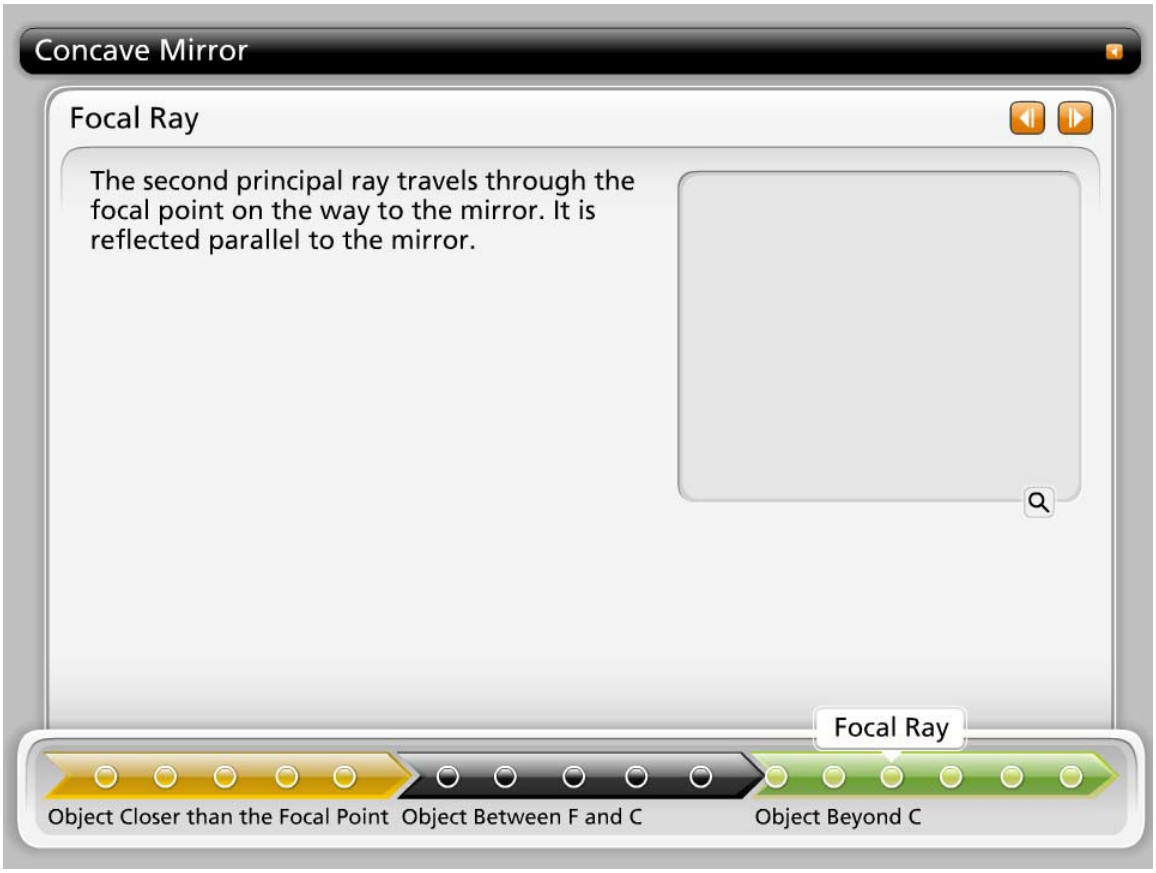
What happens if you move the light bulb further away from the mirror?

The light bulb is now placed further away than the center of curvature. To find its image, you will trace the three principal rays from the top of the light bulb.



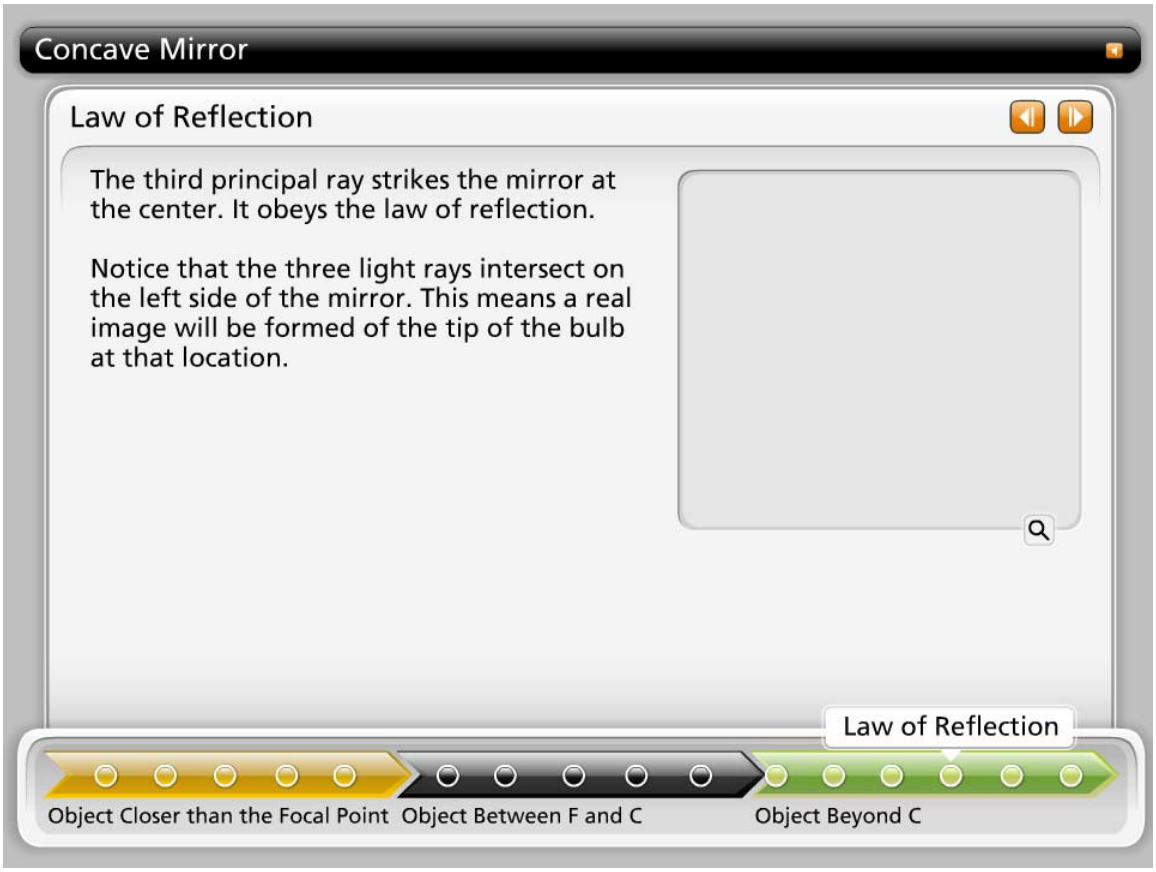
Parallel Ray

The first principal ray travels from the light bulb, parallel to the principal axis. It is reflected through the focal point.



Focal Ray

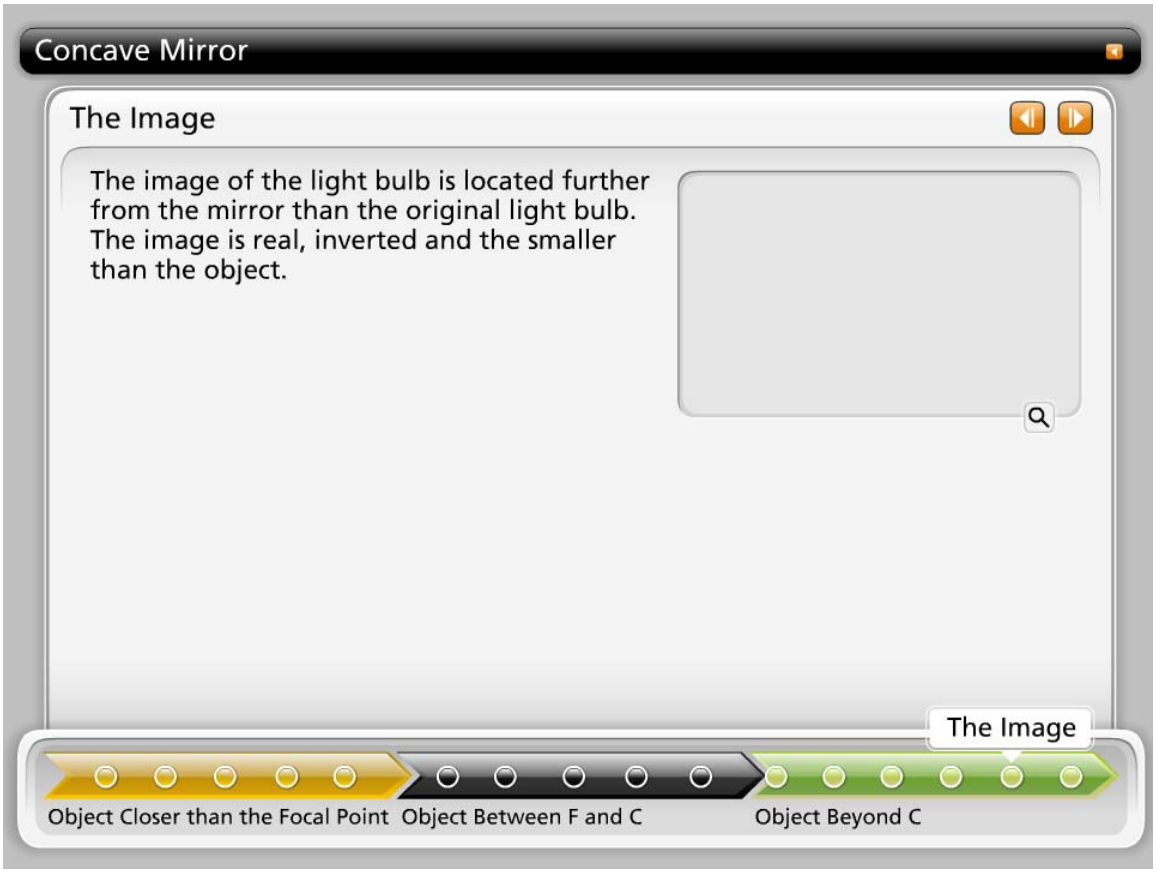
The second principal ray travels through the focal point on the way to the mirror. It is reflected parallel to the mirror.



Law of Reflection

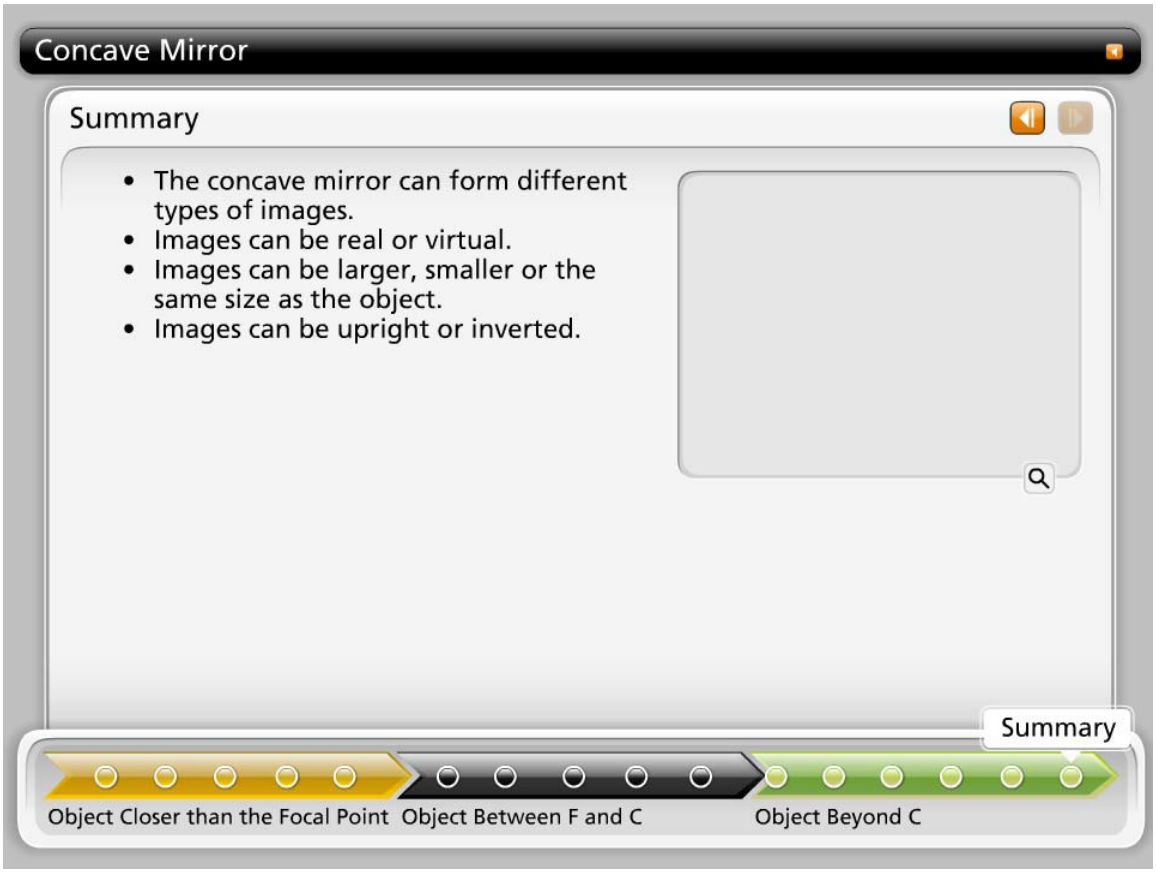
The third principal ray strikes the mirror at the center. It obeys the law of reflection.

Notice that the three light rays intersect on the left side of the mirror. This means a real image will be formed of the tip of the bulb at that location.



The Image

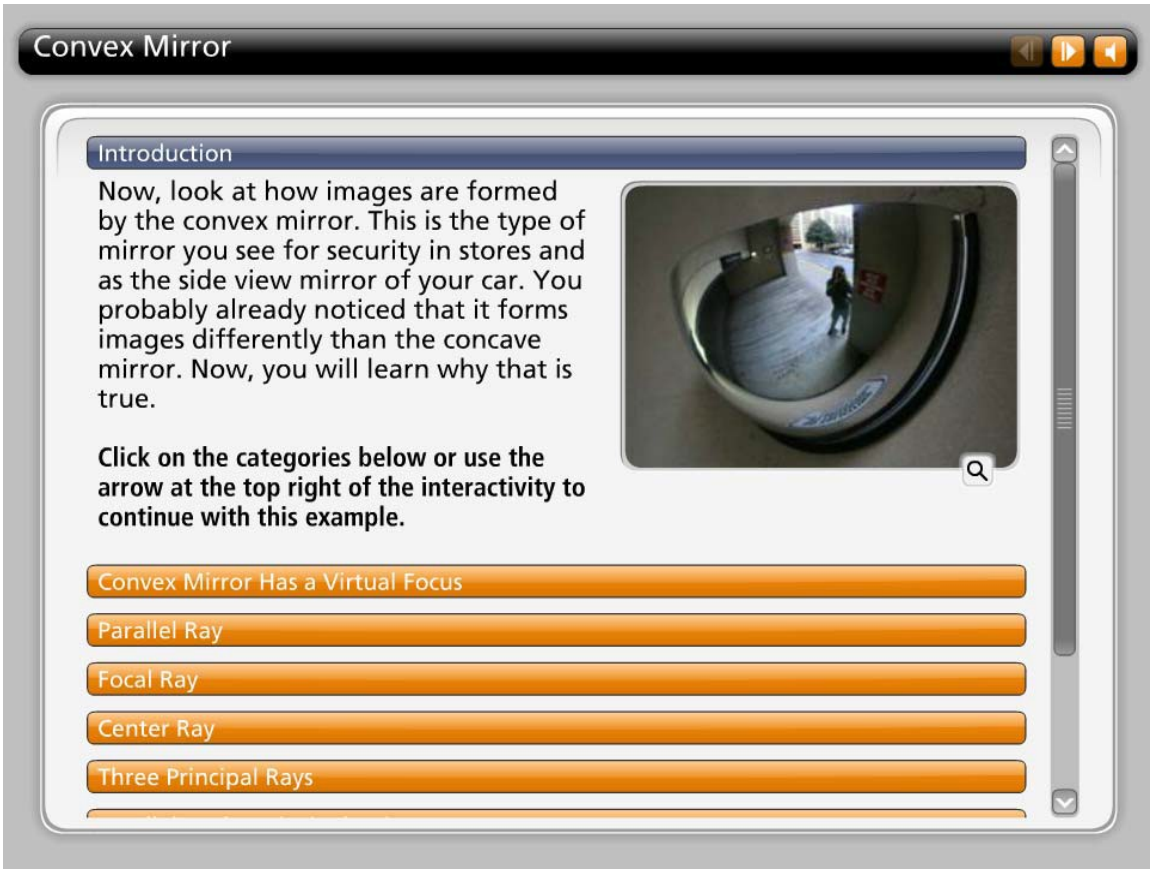
The image of the light bulb is located further from the mirror than the original light bulb. The image is real, inverted and the smaller than the object.



Summary

- The concave mirror can form different types of images.
- Images can be real or virtual.
- Images can be larger, smaller or the same size as the object.
- Images can be upright or inverted.

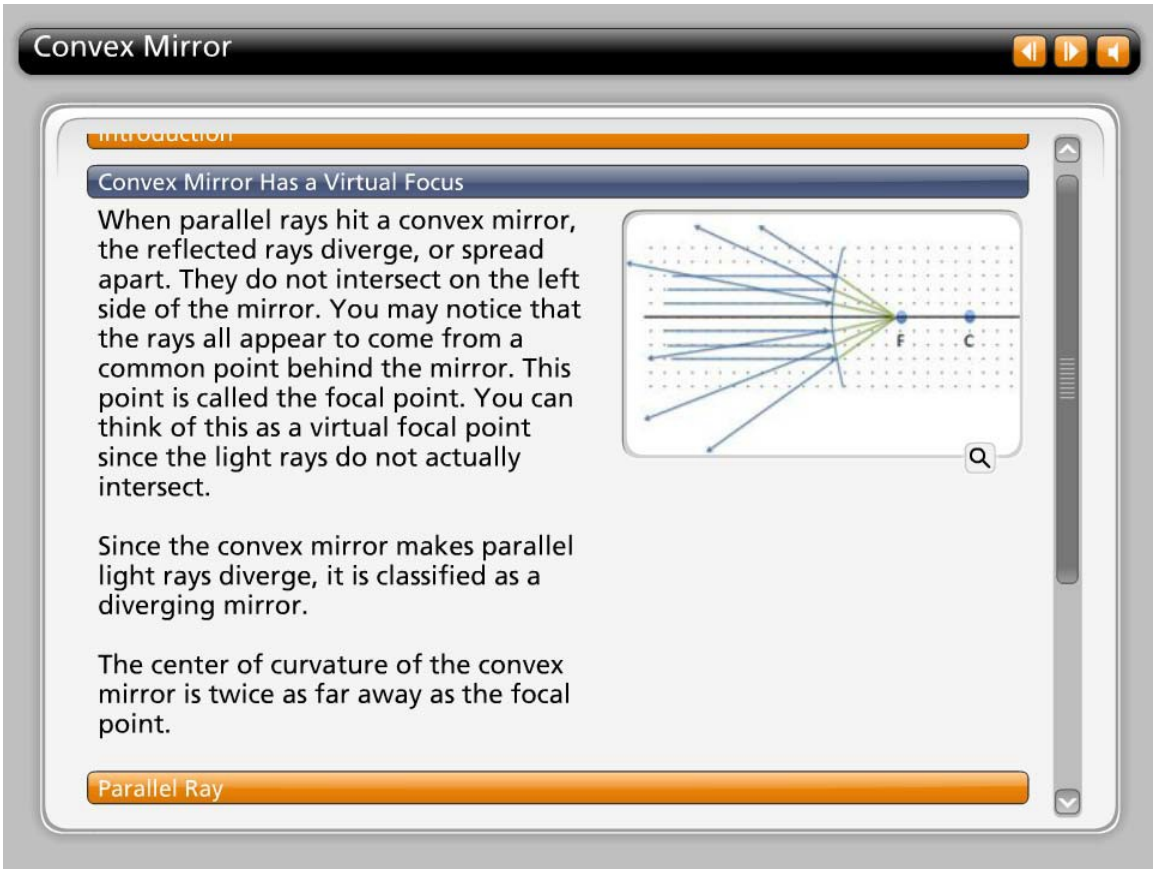
Convex Mirror



Introduction

Now, look at how images are formed by the convex mirror. This is the type of mirror you see for security in stores and as the side view mirror of your car. You probably already noticed that it forms images differently than the concave mirror. Now, you will learn why that is true.

Click each category to continue with this example.

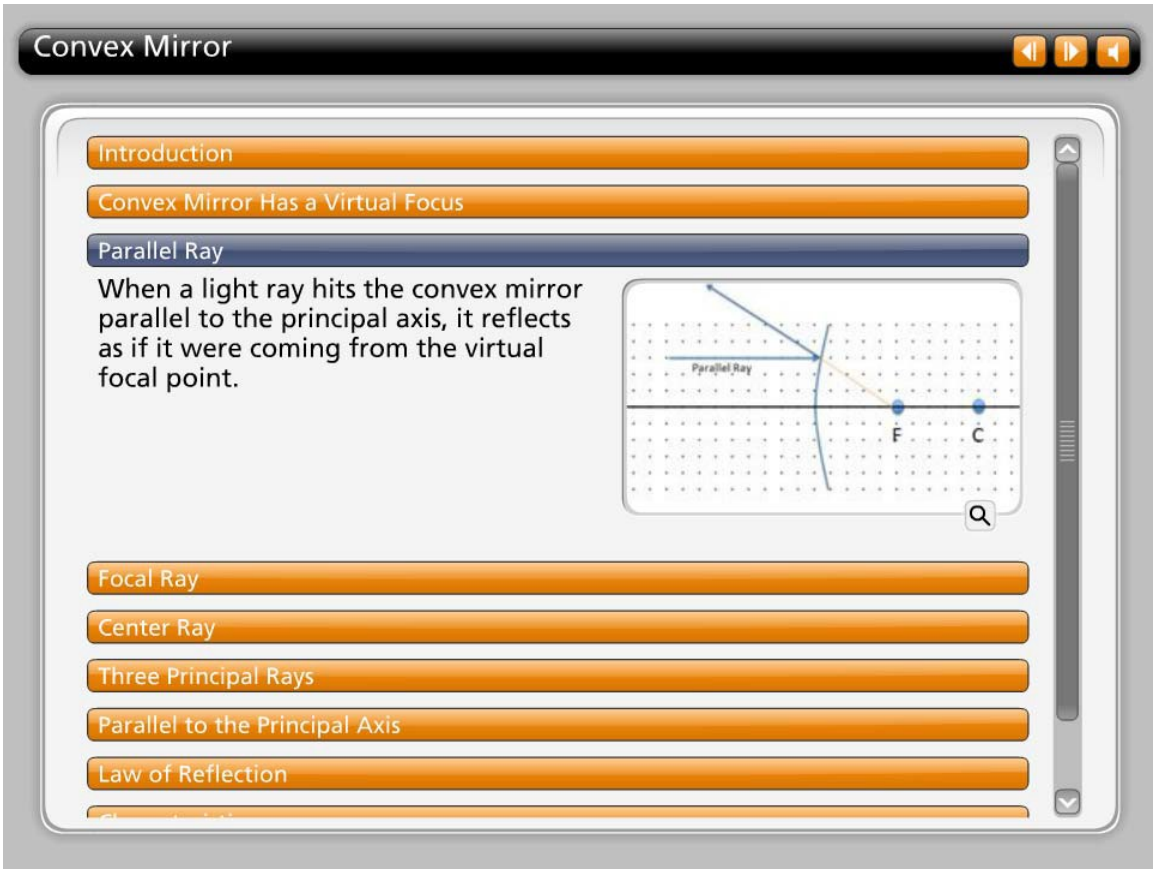


Convex Mirror Has a Virtual Focus

When parallel rays hit a convex mirror, the reflected rays diverge, or spread apart. They do not intersect on the left side of the mirror. You may notice that the rays all appear to come from a common point behind the mirror. This point is called the focal point. You can think of this as a virtual focal point since the light rays do not actually intersect.

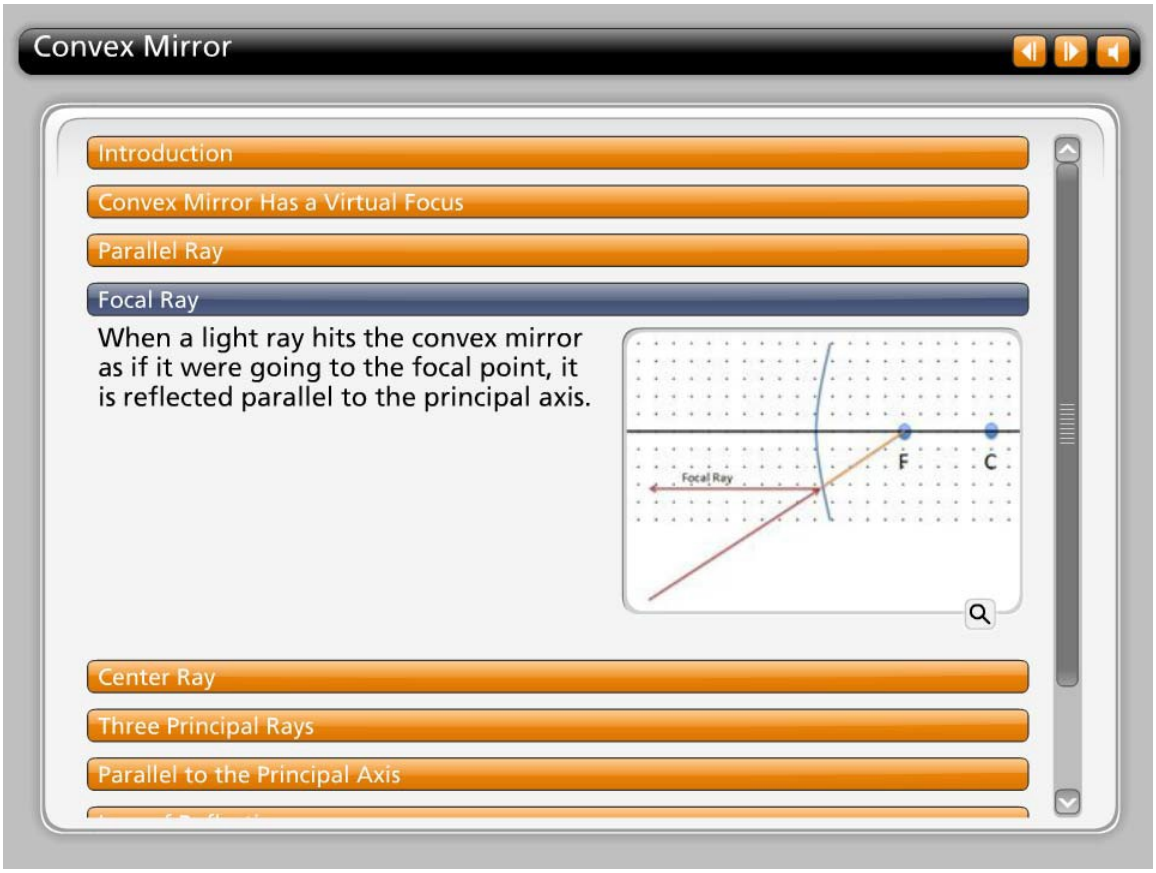
Since the convex mirror makes parallel light rays diverge, it is classified as a diverging mirror.

The center of curvature of the convex mirror is twice as far away as the focal point.



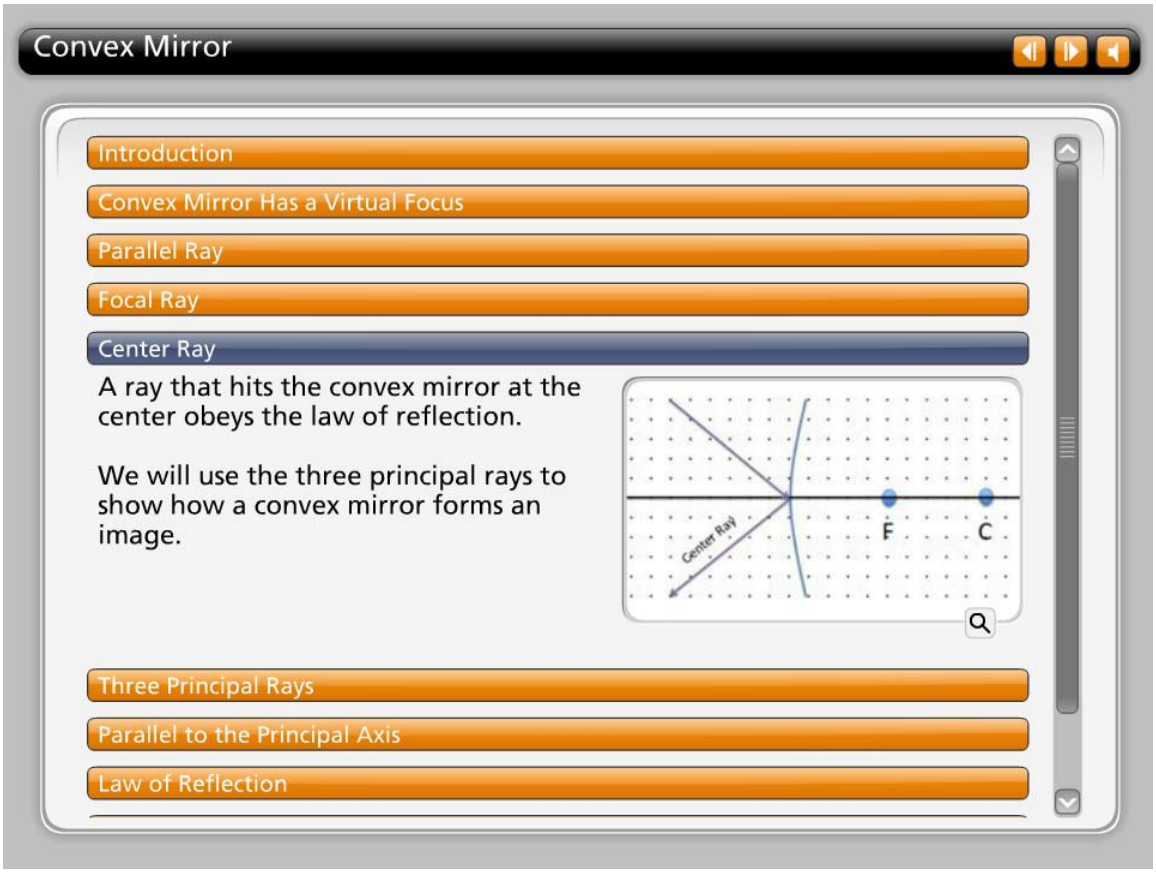
Parallel Ray

When a light ray hits the convex mirror parallel to the principal axis, it reflects as if it were coming from the virtual focal point.



Focal Ray

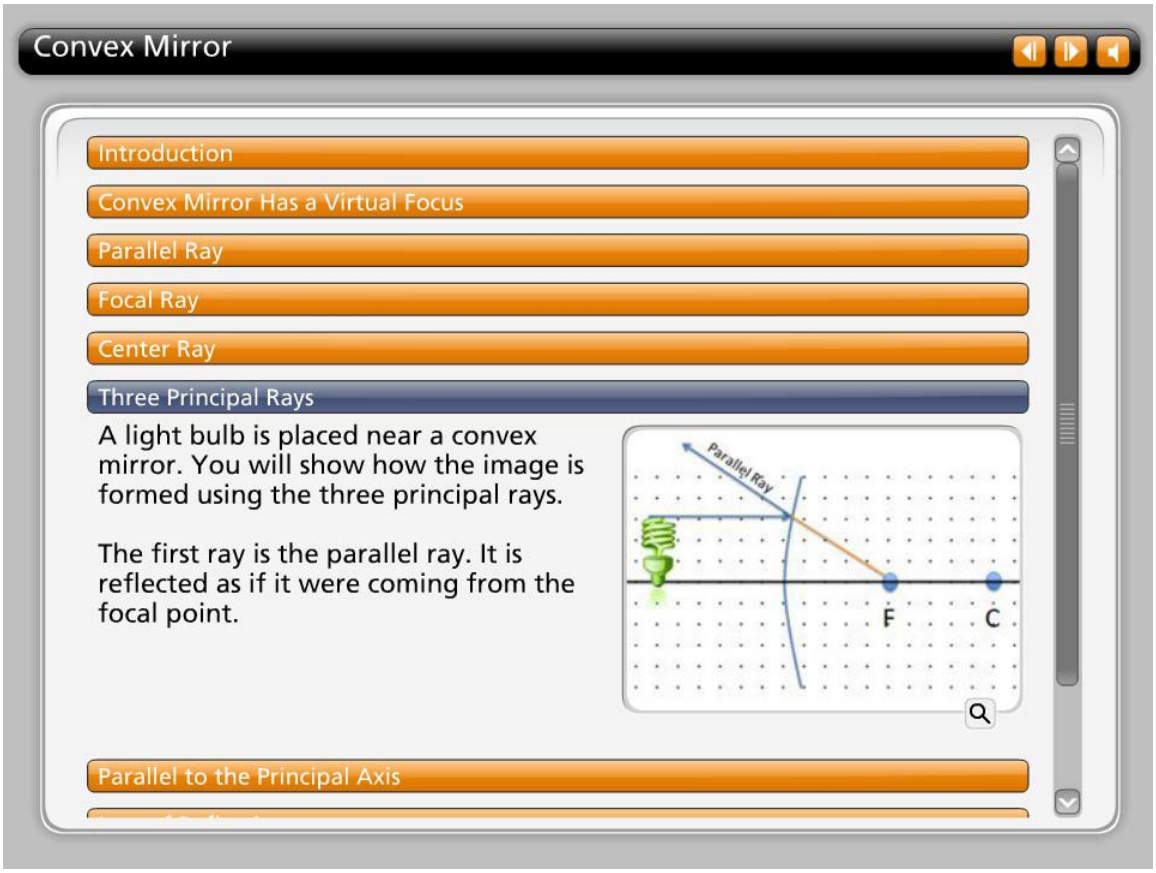
When a light ray hits the convex mirror as if it were going to the focal point, it is reflected parallel to the principal axis.



Center Ray

A ray that hits the convex mirror at the center obeys the law of reflection.

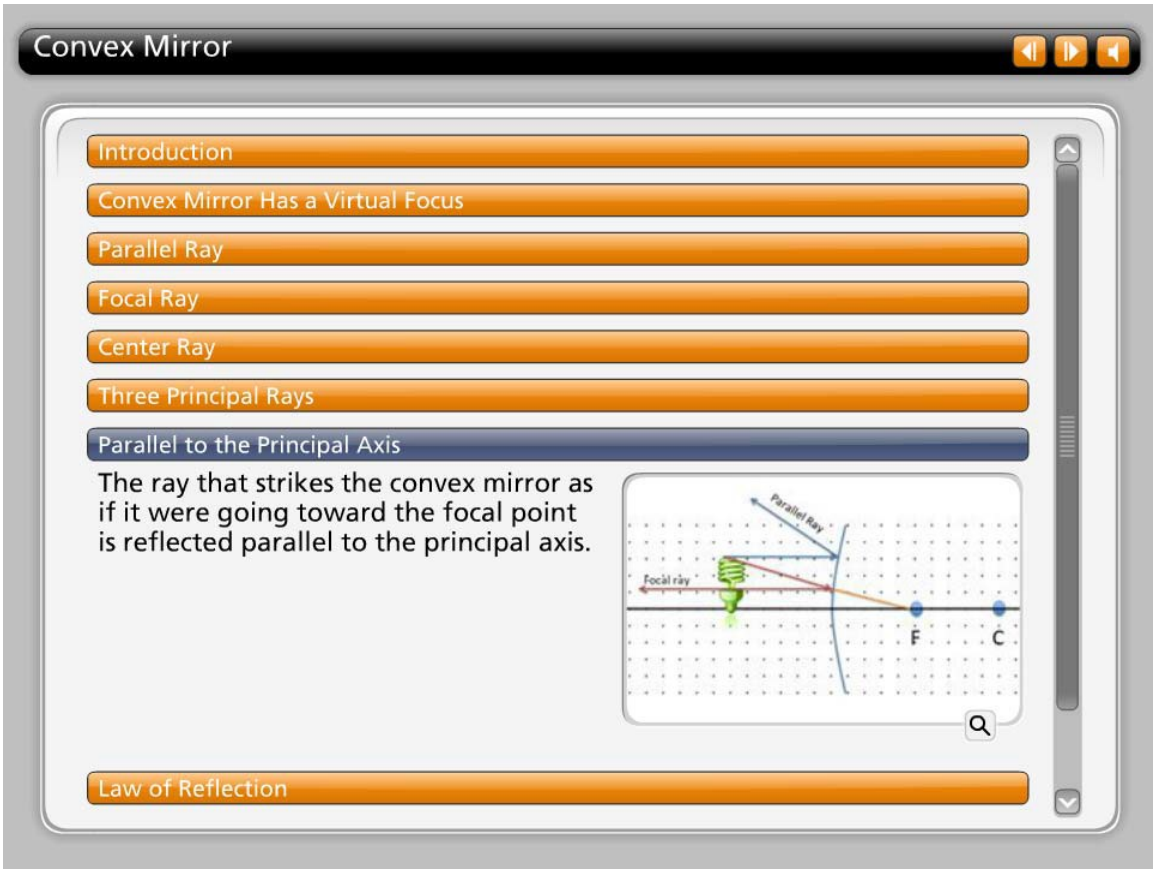
We will use the three principal rays to show how a convex mirror forms an image.



Three Principal Rays

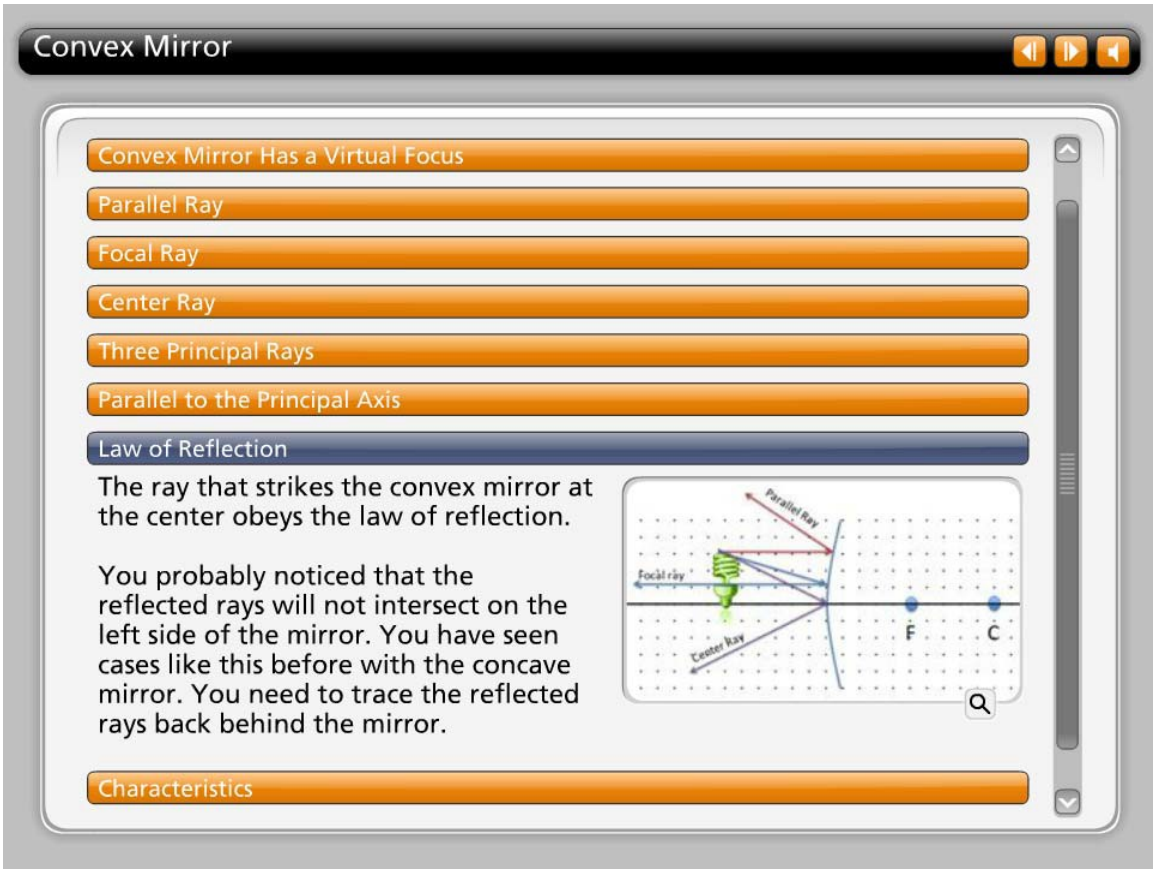
A light bulb is placed near a convex mirror. You will show how the image is formed using the three principal rays.

The first ray is the parallel ray. It is reflected as if it were coming from the focal point.



Parallel to the Principal Axis

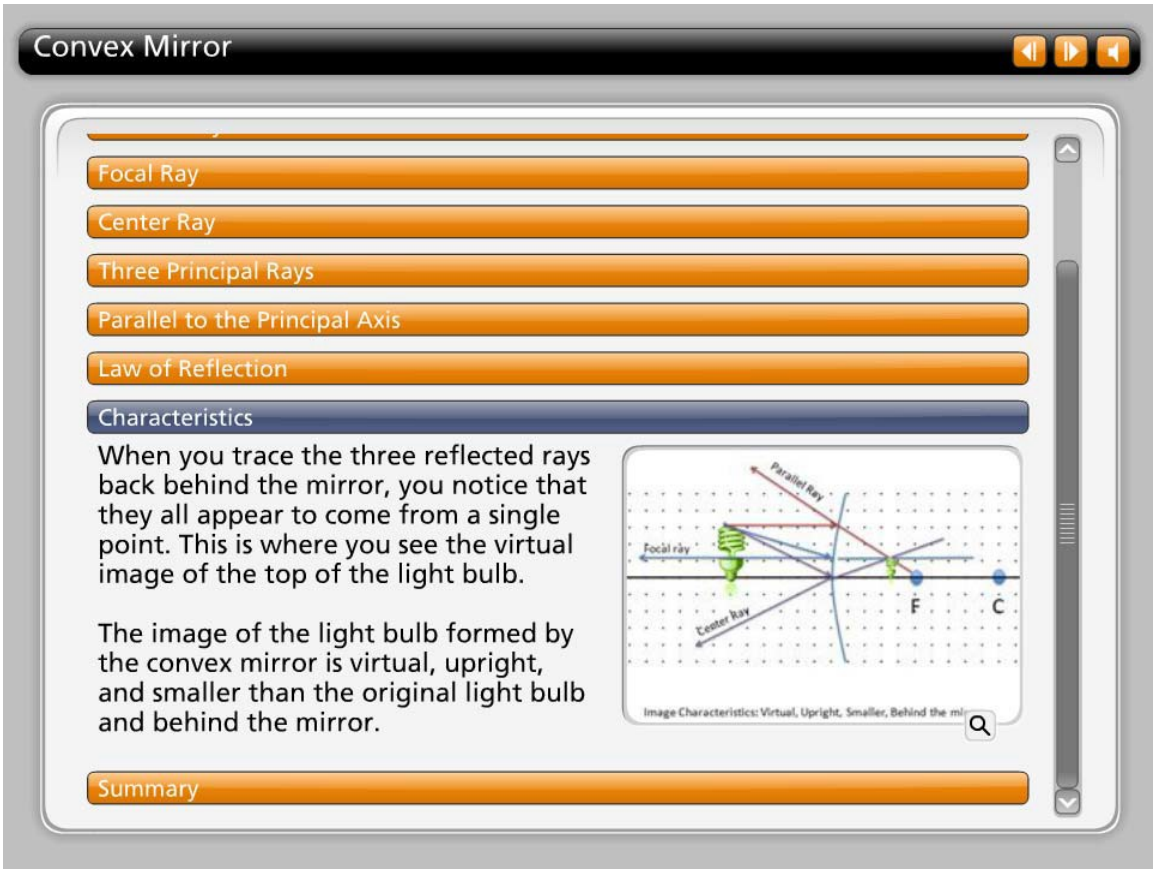
The ray that strikes the convex mirror as if it were going toward the focal point is reflected parallel to the principal axis.



Law of Reflection

The ray that strikes the convex mirror at the center obeys the law of reflection.

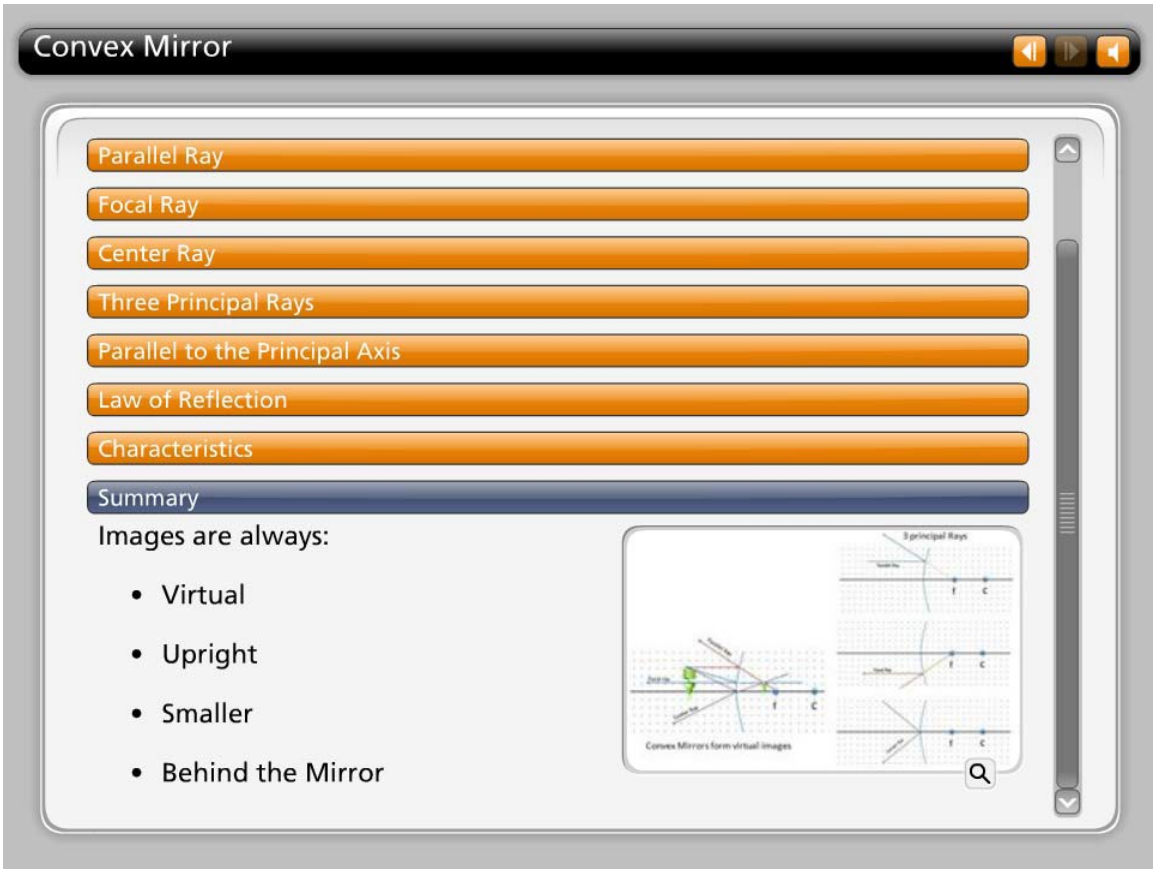
You probably noticed that the reflected rays will not intersect on the left side of the mirror. You have seen cases like this before with the concave mirror. You need to trace the reflected rays back behind the mirror.



Characteristics

When you trace the three reflected rays back behind the mirror, you notice that they all appear to come from a single point. This is where you see the virtual image of the top of the light bulb.

The image of the light bulb formed by the convex mirror is virtual, upright, and smaller than the original light bulb and behind the mirror.



Summary

Images are always:

- Virtual
- Upright
- Smaller
- Behind the Mirror

Images can be located using three principal rays. The parallel ray reflects from the mirror as if it were coming from the focal point. The focal ray is reflected parallel. The center ray obeys the law of reflection. Drawing these three rays from one point on the object locates the image of that part of the object.