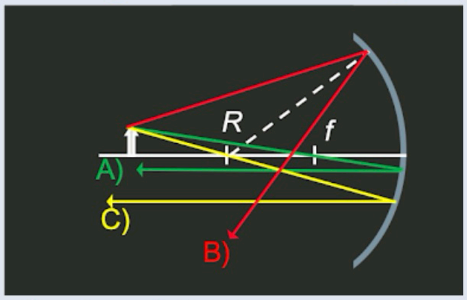
You wish to reflect sunlight from a mirror onto some paper under a pile of wood in order to start a fire. Which would be the best choice for the type of mirror?

In order to start a fire, it is necessary for real light rays to converge on the pile of wood. So the best choice for this is a converging mirror: a concave mirror. If you align the mirror such that the wood is at the mirror's focal point, then the intensity of the light will be a maximum and could be enough to start a fire.

The diagram shows three light rays reflected off of a concave mirror.



Which ray is NOT correct? → Ray C is NOT correct

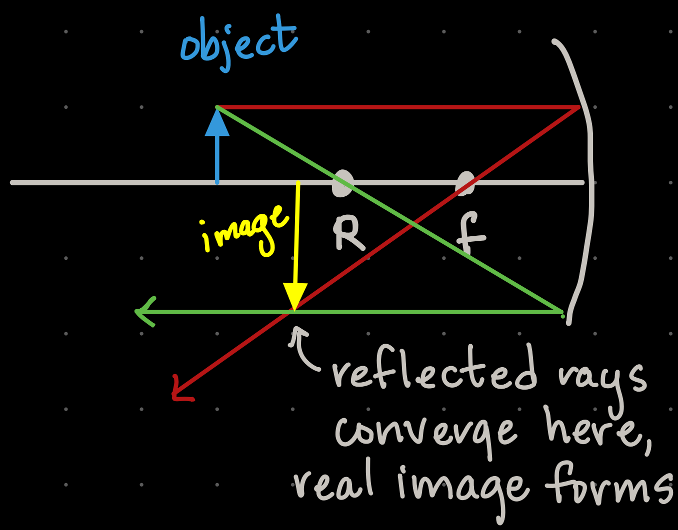
Ray A: incident ray goes through the focal point (f). Any ray that goes through f will reflect from the mirror with the reflected ray traveling parallel to the optical axis.

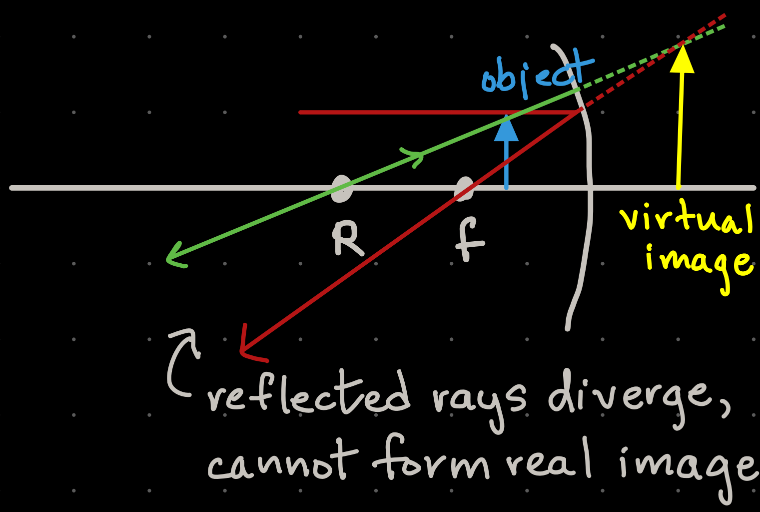
Ray B: this is not a principle light ray - it doesn't go through f or R - but it does obey the law of reflection. The dashed line is the normal and it shows how the incident angle is equal to the reflection angle. So Ray B is valid.

Ray C: The incident ray goes through R (the center of curvature) so it will travel normal to the mirror. This will reflect back along the same normal line - not parallel to the axis as shown.

The image produced by a concave mirror of a real object is...

A concave mirror usually causes real light rays to converge and form a real image. But if the object is very close to the mirror, then real light rays diverge and a virtual image is formed.



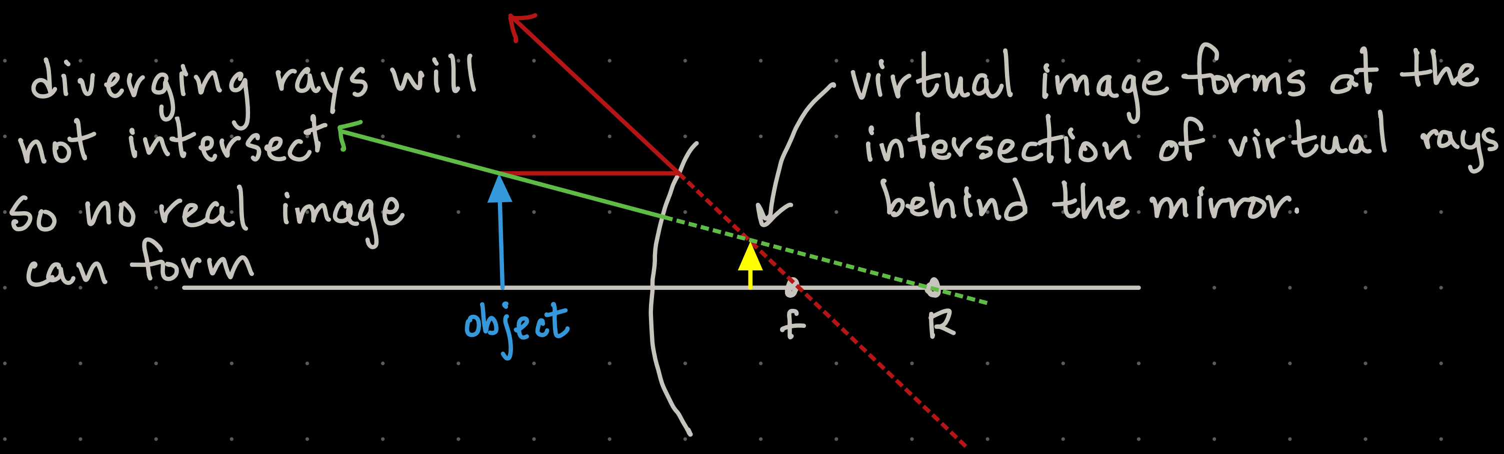


Conclusion: a concave mirror can produce real and virtual images. If the object distance is longer than the mirror's focal length, the image is real. If the object distance is shorter than the focal length, the image is virtual.

The real image is always inverted and the virtual image is always upright.

The image produced by a convex mirror of a real object is...

A convex mirror is a diverging mirror - always. There is no situation where a convex mirror will cause reflected rays to converge. So a convex mirror always produces a virtual image.

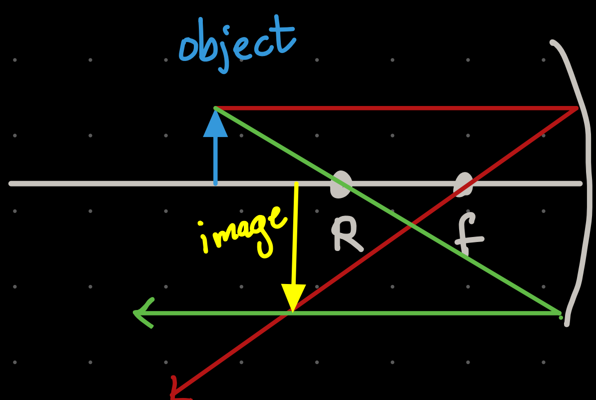


Conclusion: A convex mirror always produces a virtual, upright image. This does not depend on the object distance.

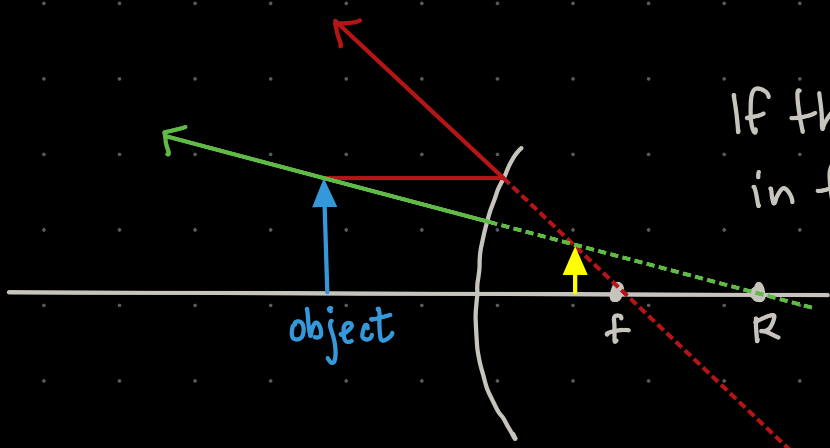
Take a look at this picture of some NASA scientists working on a mirror for a large telescope.

Based on the appearance of this image, you would conclude which of the following?

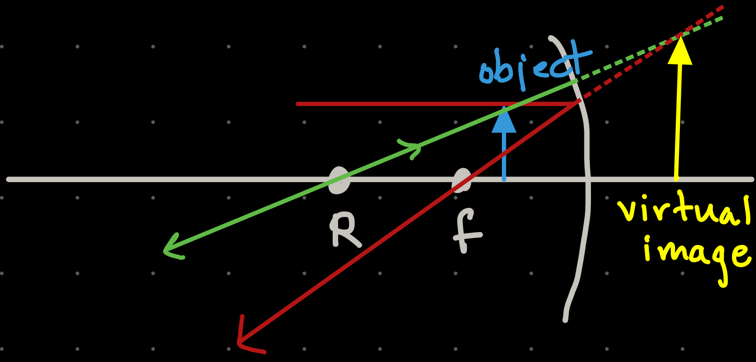
We see an image of 4 scientists. The image is upright since the 4 scientists in the image are not upside down. The image is magnified since the 4 scientists are larger than the 2 scientists working on the mirror. The mirror is either concave or convex. Let's look at ray diagrams for each to see what matches our observations.



If the 4 scientists were standing far away ($d_o > f$) from the concave mirror, the image would be real and inverted. So this is not correct.



If the scientists were standing in front of a convex mirror, the image would be upright, but smaller. That's not what we see so this is not correct.



If the 4 scientists are standing close ($d_o < f$) to the concave mirror, then the image will be upright and magnified.

So this NASA mirror must be a concave mirror and the 4 scientists seen in the image must be standing between the mirror's focal point and the mirror.

Because we cannot see these 4 scientists in the photo, we can assume the mirror's focal length is pretty long. It's long enough that these scientists can still be between f and the mirror without being in the photo.

When you hold a spherical concave mirror with a 48.2-cm radius of curvature in front of your face, you see an image of your face that is 61.8 cm in front of the mirror. What is the distance between the mirror and your face?

Concave (converging) mirror, $R = 48.2$ cm
Image forms in front of the mirror → real image
Image distance : $d_i = 61.8$ cm
Your face is the object. We are looking for the distance between the mirror and your face, which is the object distance : d_o.

We can use the mirror equation: $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$

Since this is a spherical mirror : $f = R/2 = 24.1$ cm

$$\frac{1}{24.1} = \frac{1}{d_o} + \frac{1}{61.8} \rightarrow \frac{1}{d_o} = \frac{1}{24.1} - \frac{1}{61.8} = 0.0253\ \text{cm}^{-1}$$

$$d_o = 39.5\ \text{cm}$$

When you hold a spherical concave mirror with a 48.2-cm radius of curvature 39.5 cm in front of your face, you see an image of your face that is 61.8 cm in front of the mirror. What is the magnification of this image?

$R = 48.2\text{cm} \rightarrow f = R/2 = 24.1$ cm
$d_o = 39.5$ cm $d_i = 61.8$ cm

magnification : $m = -\frac{d_i}{d_o} = -\frac{61.8\ \text{cm}}{39.5\ \text{cm}} = -1.56$ ← image is inverted

When you hold a spherical concave mirror with a 48.2-cm radius of curvature 19.4 cm in front of your face, you see an image of your face in the mirror. Where is this image located, with respect to the mirror?

Concave mirror, $R = 48.2\,cm \rightarrow f = R/2 = 24.1\,cm$

$d_o = 19.4\,cm$ (your face is the object)

$d_i = ?$ looking for image distance

mirror equation: $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \rightarrow \frac{1}{d_i} = \frac{1}{24.1} - \frac{1}{19.4}$

$d_i = -99.5\,cm$

↑ image located behind mirror

virtual image

An automobile rear-view mirror shows an image of a truck at a time when the truck is 3.0 m from the mirror. The focal length of the mirror is -0.58 m.

(a) Find the position of the image of the truck.

(b) Find the magnification of the image.

The truck is the object. At this time, the truck is 3 m from the mirror : $d_o = 3$ m

Focal length: $f = -0.58$ m.
↑ diverging (convex) mirror

(a) Need to calculate image distance : d_i

Use mirror equation: $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \rightarrow \frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o}$

$$\frac{1}{d_i} = \frac{1}{-0.58} - \frac{1}{3} = -2.06 \text{ cm}^{-1}$$

$d_i = -0.49$ cm → negative = behind mirror, virtual

(b) magnification: $m = -\frac{d_i}{d_o} = \frac{-(-0.49\text{cm})}{3\text{cm}} = +0.163$
↑ upright

The image is upright and smaller than the object.