Reflections…
Plane Mirrors

Already know physics:

\[ \theta_R = \theta_I \]

Source: Object - emits rays in all directions.

Eye intercepts cone of rays.
Plane Mirrors

SIGN RULE convention for \( s \) and \( s' \):
- IF object & incoming ray same side, pos. \( s \), otherwise neg.
- IF image & outgoing ray same side, pos. \( s' \), otherwise neg.
- IF curv. cent. & outgoing ray same side, pos., otherwise neg.

For mirror example, we have \( s = -s' \).
Plane Mirrors

For a plane mirror, $PQV$ and $P'Q'V$ are congruent, so $y = y'$ and the object and image are the same size (the lateral magnification is 1).
**Spherical Mirror**

Point C, center of curvature. Suppose object at P, then outgoing ray passes through P′.

\[ \alpha + \theta = \phi ; \quad \phi + \theta = \beta \implies \alpha + \beta = 2\phi \]

\[ \tan \alpha = \frac{h}{s - \delta} ; \quad \tan \beta = \frac{h}{s' - \delta} ; \quad \tan \phi = \frac{h}{R - \delta} \]

Assume, angles small, \( \delta \approx 0 \), paraxial rays, approx. parallel to axis. Note s and s′ positive.

\[ \alpha \approx \frac{h}{s} ; \quad \beta \approx \frac{h}{s'} ; \quad \phi \approx \frac{h}{R} \]

\[ \frac{1}{s} + \frac{1}{s'} = \frac{2}{R} \]
Spherical Mirror

Infinite distance, \( s = \infty \), \( s' = R/2 \) image appears at \( \frac{1}{2} \) radius of curvature.

\[
\frac{1}{\infty} + \frac{1}{s'} = \frac{2}{R}
\]

Nomenclature; focal length, \( f = R/2 \), is image length when object is at infinity.

\[
\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}
\]

Real image – formed by converging rays. Can be viewed on screen. Virtual image – rays do not go through. Can not be shown on screen. Concave mirror: can have real or virtual image.
Lateral Magnification; spherical mirror

Magnification = \[
\frac{y'}{y} = -\frac{s'}{s}
\]

Remarks: note that \(y'=-|y'|\), since the arrow is upside down and that \(s, s',\) and \(y\) are positive. So the magnification by this definition is negative, since \(y'\) is upside down.
For a convex mirror, the radius of curvature is inside the mirror. We have another RULE, that when the curvature center $C$ is on the same side of the outgoing ray, then the radius is positive. For the convex mirror we have NEGATIVE radius. Also from our rule for $s'$, we observe this is negative in the above drawing. Using same recipe as we used for concave mirrors, we would find same formula:

$$\frac{1}{s} + \frac{1}{s'} = \frac{2}{R}$$

Again, note $s'$ and $R$ are negative

$$\frac{y'}{y} = -\frac{s'}{s}$$

Magnification = (this is positive)
Santa is 75cm from convex mirror of radius 3.6cm. What is image position and magnification?

\[
\frac{1}{s} + \frac{1}{s'} = \frac{2}{R} = \frac{1}{75} + \frac{1}{s'} = \frac{2}{-3.6}
\]

\[
s' = -1.76 \text{ cm}
\]

\[
m = -\frac{s'}{s} = -\frac{-1.76}{75} = .0234
\]
Ray Tracing or Graphical techniques

Useful to help describe image.

To find the image position in Practice we need to find the Intersection of at least two rays. Useful rays are

1) Focal point F, #2
2) Ray through C, #3
3) Vertex V, #4
4) Parallel ray reflects through F, #1
The diagram below shows three light rays reflected off of a concave mirror. Which ray is NOT correct?

A)  
B)  
C)  

Question 1
The diagram below shows three light rays reflected off of a concave mirror. Which ray is NOT correct?

A)  
B)  
C) The ray reflected from the concave mirror is not correct.
Ray A goes through focal pt and is reflected parallel to the axis.

Ray B has angle incidence = angle reflection

Ray C goes through center of sphere.
  • Therefore it has normal incidence
  • Should be reflected straight back
For next time

• Homework #12 posted → due Monday

• The home stretch: optics/optical phenomenon

• Last quiz (#6) Friday – E&M waves, refraction (1 note card)