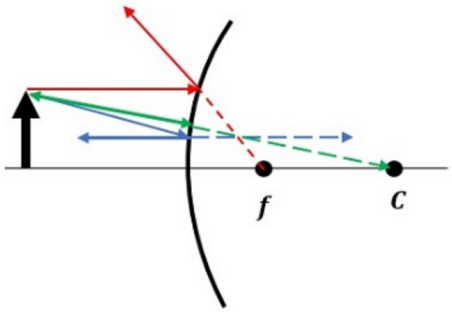
Online Lab:
Mirrors, Lenses and Image Formation

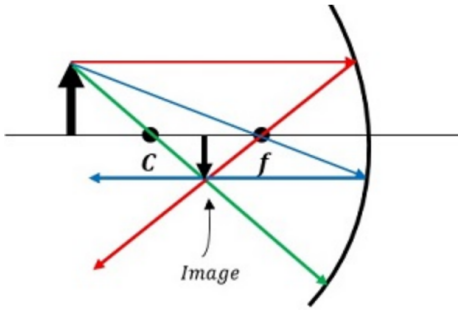
Name: Date:

Instructor: Section:

Ray Tracing for Mirrors



1. Is the diagram above a Concave or a Convex Mirror?
2. Which color is the Ray 1 in the ray diagram?
3. Which color is the Ray 3 in the ray diagram?



1. Is the diagram above a Concave or a Convex Mirror?
2. Which color is the Ray 2 in the ray diagram?
3. Based on the location of the object, is the **Image Type**: Real or Virtual?
4. Is the **Image Orientation**: Upright or Inverted?

Online Mirrors Experiment Setup Instructions.

1. Go to the following website:
   https://ophysics.com/l10.html

2. Figure 1 shows an example of what you should see on your screen.

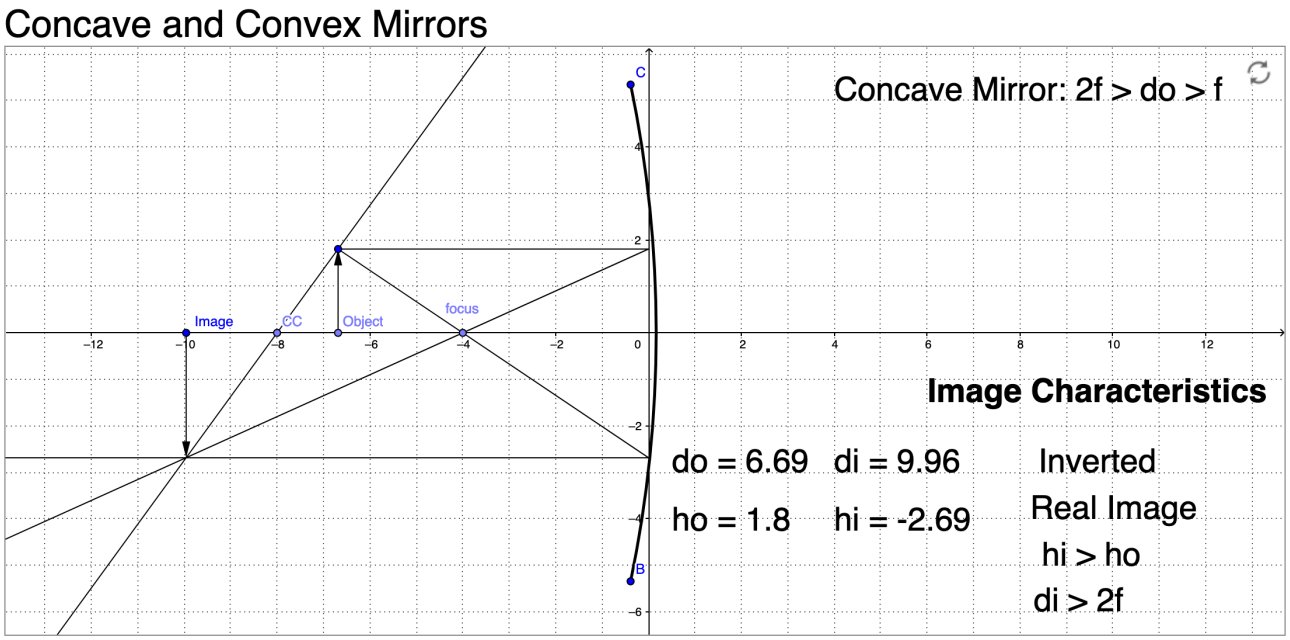


Figure 1: Initial Configuration after opening the Concave and Convex Mirrors Simulator

3. Click on the top of the Object arrow.

   - Move Up or down to adjust the object height, *ho*.
   - Move Left or Right to adjust the object distance, *do*.
   - For purposes of this lab, each grid square  is 1 cm height and 1 cm wide.
   - Place the Object arrow Left of the Mirror for a Concave Mirror.
   - Place the Object arrow Right of the Mirror for a Convex Mirror.

Concave Mirrors

1. Place the object to the left of the Mirror at -6 cm.
2. Click on the Object arrow and set the height, to 3 cm.
3. Get the object distance, do. Record this as your object distance, p.
4. Get the image distance, di. Record this as your image distance, q.
5. Get the object height, ho. Record this as your object height, h.
6. Get the image height, hi. Record this as your image height, h'.
7. Record the **Image Type** (Real or Virtual):
8. Record the **Image Orientation** (Upright or Inverted):
9. Place the object to the left of the Mirror at -12 cm.
10. **Repeat Steps 2-6**.

Table 1: Data Results - Concave Mirrors

Trial	p	q	h	h'
-6 (cm)				
-12 (cm)				

11. For each trial, Calculate the focal length f using the equation:
Record your answers in the Table below.

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f} \tag{1}$$

12. For each trial Calculate the magnification of the image M using the ratio: $\frac{h'}{h}$.
Record your answers in the Table below.
13. For each trial Calculate the magnification of the image M using the ratio: $-\frac{q}{p}$.
Record your answers in the Table below.

Table 2: Data Analysis - Concave Mirrors

Trial	f	$M = \frac{h'}{h}$	$M = -\frac{q}{p}$
-6 (cm)			
-12 (cm)			

Convex Mirrors

1. Place the Object arrow Right of the Mirror at 6 cm for a Convex Mirror
2. Click on the Object arrow and set the height, to 3 cm.
3. Get the object distance, do. Record this as your object distance, p.
4. Get the image distance, di. Record this as your image distance, q.
5. Get the object height, ho. Record this as your object height, h.
6. Get the image height, hi. Record this as your image height, h'.
7. Record the **Image Type** (Real or Virtual):
8. Record the **Image Orientation** (Upright or Inverted):
9. Place the object to the right of the mirror at 12 cm.
10. **Repeat Steps 2-6**.

Table 3: Data Results - Convex Mirrors

Trial	p	q	h	h'
6 (cm)				
12 (cm)				

11. For each trial, Calculate the focal length f using the equation:
Record your answers in the Table below.

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f} \tag{2}$$

12. For each trial Calculate the magnification of the image M using the ratio: $\frac{h'}{h}$.
Record your answers in the Table below.
13. For each trial Calculate the magnification of the image M using the ratio: $-\frac{q}{p}$.
Record your answers in the Table below.

Table 4: Data Analysis - Convex Mirrors

Trial	f	$M = \frac{h'}{h}$	$M = -\frac{q}{p}$
6 (cm)			
12 (cm)			

Online Lenses Experiment Setup Instructions.

1. Click on the **Light** menu at the top of the screen and Select the Concave and Convex Lenses simulator as shown in Figure 2.

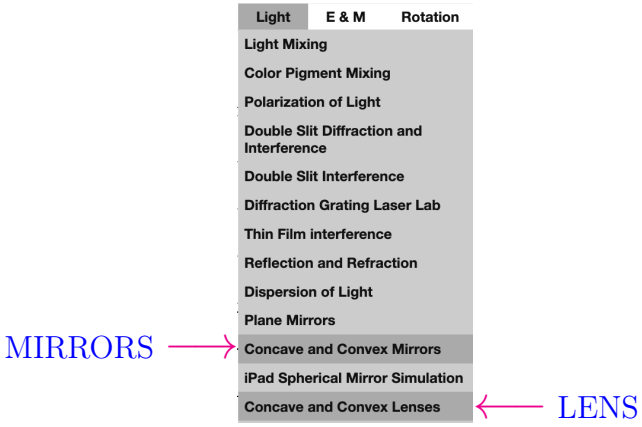


Figure 2: Simulator Selection Menu

2. Figure 3 shows an example of what you should see on your screen.

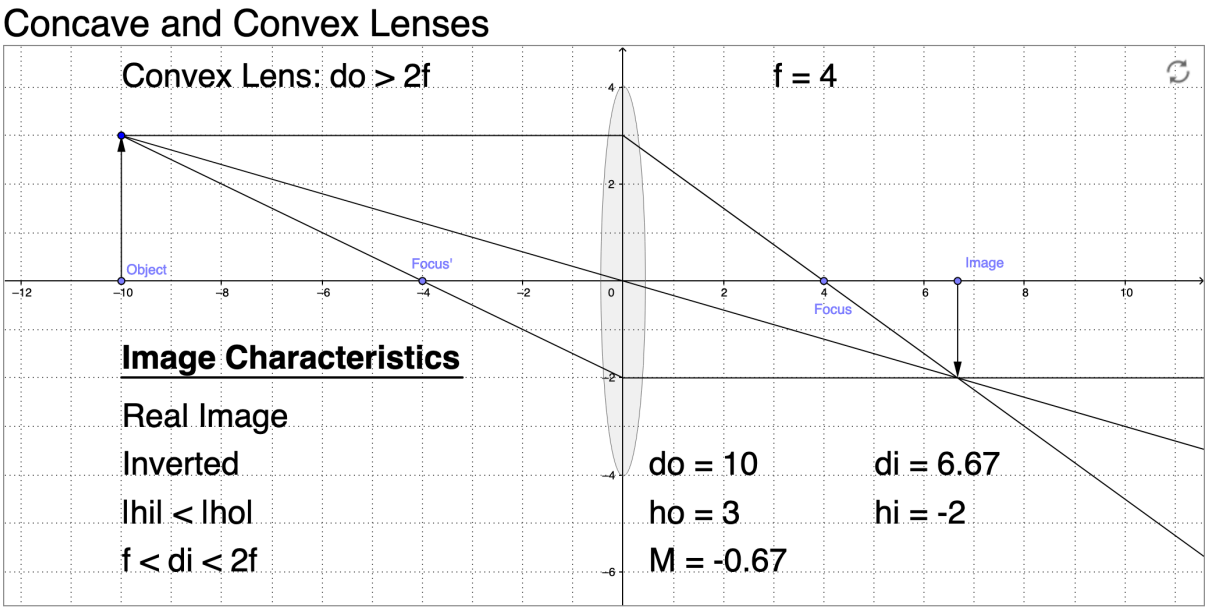
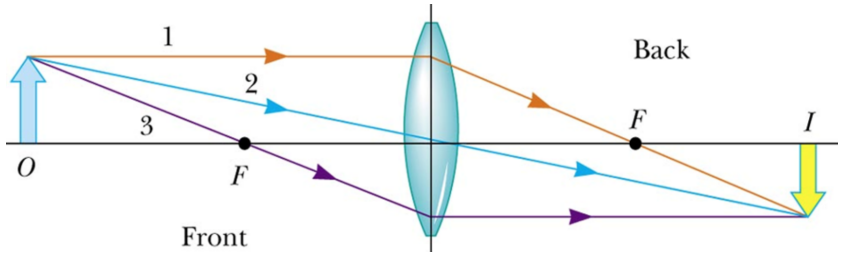


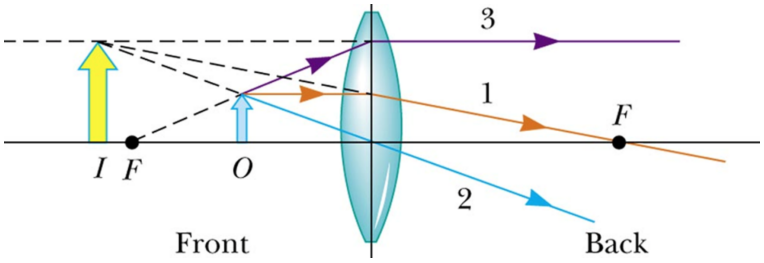
Figure 3: Initial Configuration after opening the Concave and Convex Mirrors Simulator

- Move the tip of the "Object" arrow Up or Down to adjust the object height, *ho*.
- Move the tip of the "Object" arrow Left or Right to adjust the object distance, *do*.
- Move the point named Focus′ to change the focal length
- Move the point named Focus′ to the right side of the lens to change to a concave lens.

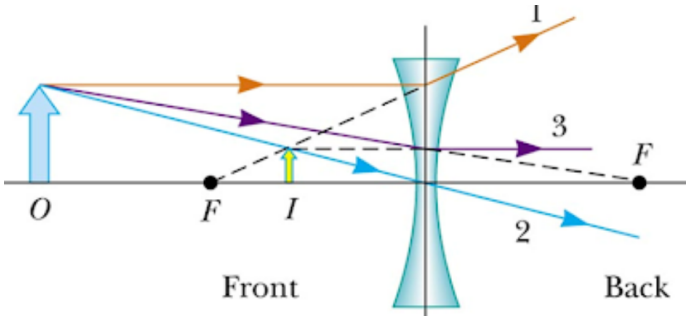
Ray Tracing for Lenses



1. Is the diagram above a Concave (Diverging) or a Convex (Converging) Lens?
2. Based on the location of the object, is the **Image Type**: Real or Virtual?
3. Is the **Image Orientation**: Upright or Inverted?



1. Is the diagram above a Concave (Diverging) or a Convex (Converging) Lens?
2. Based on the location of the object, is the **Image Type**: Real or Virtual?
3. Is the **Image Orientation**: Upright or Inverted?



1. Is the diagram above a Concave (Diverging) or a Convex (Converging) Lens?
2. Based on the location of the object, is the **Image Type**: Real or Virtual?
3. Is the **Image Orientation**: Upright or Inverted?

Convex Lens - (Converging)

1. Place the object to the left of the lens at -7 cm.
2. Click on the Object arrow and set the height, to 3 cm.
3. Get the object distance, do. Record this as your object distance, p.
4. Get the image distance, di. Record this as your image distance, q.
5. Get the object height, ho. Record this as your object height, h.
6. Get the image height, hi. Record this as your image height, h'.
7. Record the **Image Type** (Real or Virtual):
8. Record the **Image Orientation** (Upright or Inverted):
9. Place the object to the left of the lens at -12 cm.
10. **Repeat Steps 3-7**.

Table 5: Data Results - Converging Lens

Trial	p	q	h	h'
-7 (cm)				
-12 (cm)				

11. For each trial, Calculate the focal length f using the equation:
Record your answers in the Table below.

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f} \tag{3}$$

12. For each trial Calculate the magnification of the image M using the ratio: $\frac{h'}{h}$.
Record your answers in the Table below.
13. For each trial Calculate the magnification of the image M using the ratio: $-\frac{q}{p}$.
Record your answers in the Table below.

Table 6: Data Analysis - Converging Lens

Trial	f	$M = \frac{h'}{h}$	$M = -\frac{q}{p}$
-7 (cm)			
-12 (cm)			

Concave Lens - (Diverging)

1. Place the Focus′ to the right of the lens near 4.0 cm to switch to a concave lens.
2. Place the object to the left of the lens at -7 cm.
3. Click on the Object arrow and set the height, to 3 cm.
4. Get the object distance, do. Record this as your object distance, p.
5. Get the image distance, di. Record this as your image distance, q.
6. Get the object height, ho. Record this as your object height, h.
7. Get the image height, hi. Record this as your image height, h'.
8. Record the **Image Type** (Real or Virtual):
9. Record the **Image Orientation** (Upright or Inverted):
10. Place the object to the left of the lens at -12 cm.
11. **Repeat Steps 3-7**.

Table 7: Data Results - Diverging Lens

Trial	p	q	h	h'
-7 (cm)				
-12 (cm)				

12. For each trial, Calculate the focal length f using the equation:
Record your answers in the Table below.

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f} \tag{4}$$

13. For each trial Calculate the magnification of the image M using the ratio: $\frac{h'}{h}$.
Record your answers in the Table below.
14. For each trial Calculate the magnification of the image M using the ratio: $-\frac{q}{p}$.
Record your answers in the Table below.

Table 8: Data Analysis - Diverging Lens

Trial	f	$M = \frac{h'}{h}$	$M = -\frac{q}{p}$
-7 (cm)			
-12 (cm)			

Analytical Exercises

For each of the following problems, you are to analytically determine the image *location*, whether the image is real or virtual, *image size* and whether the image is up right or inverted. Make sure you pay attention to significant digits for the given input parameters and the results you calculate.

1. An object is 4.30 cm high and is placed 12.6 cm to the left of a concave mirror. The mirror has a radius of curvature of 6.20 cm. Locate and describe the image.

   (a) Is the **Image Type**: Real or Virtual?

   (b) How far is the image from the mirror?

   (c) Is the **Image Orientation**: Upright or Inverted?

   (d) How tall is the image ?

2. An object is 5.50 cm high and is placed 3.30 cm to the left of a convex mirror. The mirror has a radius of curvature of 5.20 cm. Locate and describe the image.

3. Is the **Image Type**: Real or Virtual?

4. How far is the image from the mirror?

5. Is the **Image Orientation**: Upright or Inverted?

6. How tall is the image ?