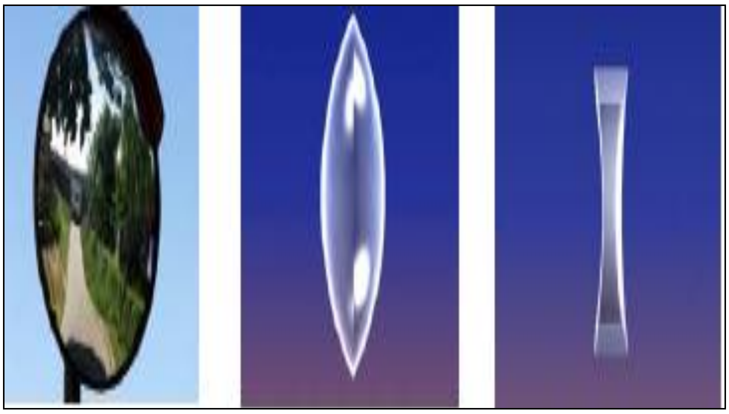
Kirkuk University

Science College

Physics Department

Lectures of GEOMETRIC OPTICS

Lecture – 7 –



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Lecture 7: Examples for Convex Mirrors

Example: A ($h_o = 4cm$) tall light bulb is placed a distance of ($d_o = 35.5cm$) from a convex mirror having a focal length of ($f = -12.2cm$). Determine the image distance ($d_i = ?$) and the image size ($h_i = ?$)?

Solution:

Like all problems in physics, begin by the identification of the known information.

$$h_\circ = 4cm, \; d_\circ = 35.5cm, \; f = -12.2cm$$

Next identify the unknown quantities that you wish to solve for.

$$d_i = ?, \; h_i = ?$$

To determine the image distance, the mirror equation must be used.

The following lines represent the solution to the image distance; substitutions and algebraic steps are shown.

$$\mathbf{1/f = 1/do + 1/d_i}$$

$$1/(-12.2 \text{ cm}) = 1/(35.5 \text{ cm}) + 1/d_i$$

$$-0.0820 \text{ cm}^{-1} = 0.0282 \text{ cm}^{-1} + 1/d_i$$

$$-0.110 \text{ cm}^{-1} = 1/d_i$$

$$\mathbf{d_i = -9.09 \text{ cm}}$$

The negative values for image distance indicate that the image is located behind the mirror.

In the case of the image distance, a negative value always indicates the existence of a virtual image located behind the mirror.

To determine the image height, the magnification equation is needed. Since three of the four quantities in the equation (disregarding the **M**) are known, the fourth quantity can be calculated.
The solution is shown below.

$$\mathbf{h_i/h_o = - d_i/d_o}$$

$$h_i /(4.0\ cm) = - (-9.09\ cm)/(35.5\ cm)$$

$$h_i = - (4.0\ cm) \bullet (-9.09\ cm)/(35.5\ cm)$$

$$\mathbf{h_i = 1.02\ cm}$$

In the case of the image height, a positive value indicates an upright image.

From the calculations in this problem it can be concluded that if a ($h_o = 4cm$) tall object is placed ($d_o = 35.5cm$) from a convex mirror having a focal length of ($f = -12.2cm$), then the image will be virtual, located ($d_i = 9.08cm$) behind the mirror, upright and ($h_i = 1.02cm$) tall.

Convex mirrors always produce images that are upright, virtual, reduced in size, and located behind the mirror.

Now let’s try a second example problem:

Example: A ($h_o = 4cm$) tall light bulb is placed a distance of ($d_o = 25.5cm$) from a convex mirror having a focal length of ($f = -12.2cm$). (**NOTE**: this is the same object and the same mirror, only this time the object is placed closer to the mirror.) Determine the image distance and the image size**?**

Solution:

Like all problems in physics, begin by the identification of the known information**.**

$$h_o = 4cm\text{, } d_o = 25.5cm\text{, } f = -12.2cm$$

Next identify the unknown quantities that you wish to solve for**.**

$$d_i = ?\text{, } h_i = ?$$

To determine the image distance, the mirror equation must be used**.**

The following lines represent the solution to the image distance; substitutions and algebraic steps are shown**.**

$$\boxed{\mathbf{1/f = 1/d_o + 1/d_i}}$$

$$1/(-12.2\text{ cm}) = 1/(25.5\text{ cm}) + 1/d_i$$

$$-0.0820\text{ cm}^{-1} = 0.0392\text{ cm}^{-1} + 1/d_i$$

$$-0.1212\text{ cm}^{-1} = 1/d_i$$

$$\boxed{\mathbf{d_i = -8.25\text{ cm}}}$$

The negative values for image distance indicate that the image is located behind the mirror**.**

In the case of the image distance, a negative value always indicates the existence of a virtual image located behind the mirror.

To determine the image height, the magnification equation is needed. Since three of the four quantities in the equation (disregarding the **M**) are known, the fourth quantity can be calculated.
The solution is shown below.

$$\mathbf{h_i/h_o = - d_i/d_o}$$

$$h_i /(4.0 \text{ cm}) = - (-8.25 \text{ cm})/(25.5 \text{ cm})$$

$$h_i = - (4.0 \text{ cm}) \bullet (-8.25 \text{ cm})/(25.5 \text{ cm})$$

$$\mathbf{h_i = 1.29 \text{ cm}}$$

In the case of the image height, a positive value indicates an upright image.

From the calculations in this problem it can be concluded that if a ($h_o = 4cm$) tall object is placed ($d_o = 25.5cm$) from a convex mirror having a focal length of ($f = -12.2cm$), then the image will be virtual, located ($d_i = 8.25cm$) behind the mirror, upright and ($h_i = 1.29cm$) tall.

Convex mirrors always produce images that are upright, virtual, reduced in size, and located behind the mirror.

Convex Mirrors

H.W: An object of height ($h_o = 6cm$) is placed at a distance of ($d_o = 10cm$) from a convex mirror with radius of curvature ($R = 30cm$)**.** Find**:-**

1- The position of the image ($d_i = ?$)**? Answer:** ($d_i = -5.99cm$)

2- The height of the image ($h_i = ?$)**? Answer:** ($h_i = 3.594cm$)

3- The magnification of the image ($M = ?$)**? Answer:** ($M = 0.599$)

4- The nature of the image ($L.O.S.T$)**?**

H.W: An object of ($h_o = 10cm$) height is placed at a distance of ($d_o = 10cm$) from a convex mirror. The radius of curvature of the mirror is ($R = 30cm$)**.** Find**:-**

1- The position of the image ($d_i = ?$)**? Answer:** ($d_i = -5.99cm$)

2- The height of the image ($h_i = ?$)**? Answer:** ($h_i = 5.99cm$)

3- The magnification of the image ($M = ?$)**? Answer:** ($M = 0.599$)

4- The nature of the image ($L.O.S.T$)**?**

H.W: An object of height ($h_o = 5cm$) is placed at a distance of ($d_o = 20cm$) from a convex mirror of focal length ($f = 10cm$)**.** Find**:-**

1- The position of the image ($d_i = ?$)**? Answer:** ($d_i = -6.67cm$)

2- The height of the image ($h_i = ?$)**? Answer:** ($h_i = 1.668cm$)

3- The magnification of the image ($M = ?$)**? Answer:** ($M = 0.334$)

4- The nature of the image ($L.O.S.T$)**?**

((Exercises about spherical mirrors))

Q 1:

A ($h_o = 1.5cm$) high diamond ring is placed ($d_o = 20cm$) from a concave (converging) mirror whose radius of curvature is ($R = 30cm$). Determine:

(a) The position of the image ($d_i = ?$)? **Answer:** ($d_i = 59.88cm$)

(b) The size of the image ($h_i = ?$)? **Answer:** ($h_i = 4.491cm$)

Q 2:

A ($h_o = 1cm$) high object is placed ($d_o = 10cm$) from a concave (converging) mirror whose radius of curvature is ($R = 30cm$). Determine:

(a) The position of the image ($d_i = ?$)? **Answer:** ($d_i = -30.30cm$)

(b) The magnification of the image ($M = ?$)? **Answer:** ($M = 3.03$)

Q 3:

A convex (diverging) mirror has a radius of curvature of ($R = 40cm$). An object is placed ($d_o = 40cm$) in front of the mirror. Determine:

(a) The location of the image ($d_i = ?$)? **Answer:** ($d_i = -13.33cm$)

(b) The magnification of the image ($M = ?$)? **Answer:** ($M = 0.33$)

Q 4:

A convex (diverging) mirror has a radius of curvature of ($R = 20cm$). An object is placed ($d_O = 30cm$) in front of the mirror. Determine:

(a) Where the image will appear ($d_i = ?$)? **Answer:** ($d_i = -7.518cm$)

(b) The focal length of the mirror ($f = ?$)? **Answer:** ($f = -40cm$)