Kirkuk University

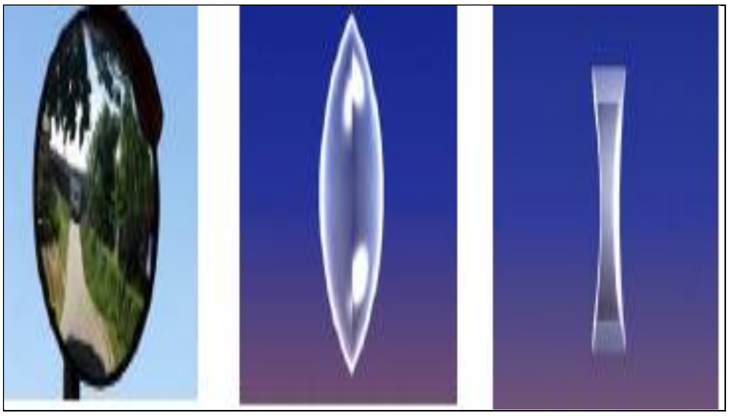
Science College

Physics Department

Lectures of

GEOMETRIC OPTICS

Lecture – 16 –



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Lecture 16: Examples for Diverging (double concave) Lens

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

Solution:

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

$$h_\circ = 4cm \text{ , } d_\circ = 35.5cm \text{ , } f = -12.2cm$$

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

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

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

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

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

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

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

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

$$\mathbf{d_i = -9.08 \text{ cm}}$$

The negative values for image distance indicate that the image is located on the object's side of the lens **.**

In the case of the image distance, a negative value always indicates the existence of a virtual image located on the object's side of the lens**.**

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**.**

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

$$h_i /(4.0 \text{ cm}) = - (-9.08 \text{ cm})/(35.5 \text{ cm})$$

$$h_i = - (4.0 \text{ cm}) \bullet (-9.08 \text{ cm})/(35.5 \text{ cm})$$

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

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 ($d_o = 35.5cm$) from a diverging lens having a focal length of ($f = -12.2cm$),then the image will be virtual , located ($d_i = 9.08cm$) from the lens on the object's side ,upright and ($h_i = 1.02cm$) tall**.**

Diverging lenses always produce images that are upright, virtual, reduced in size, and located on the object's side of the lens**.**

Now lets try a second example problem:

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

Solution:

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

$$h_\circ = 4cm \,,\; d_\circ = 25.5cm \,,\; f = -12.2cm$$

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

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

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

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

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

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

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

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

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

The negative values for image distance indicate that the image is located on the object's side of the lens**.**

In the case of the image distance, a negative value always indicates the existence of a virtual image located on the object's side of the lens.

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 diverging lens having a focal length of ($f = -12.2cm$), then the image will be virtual, located ($d_i = 8.25cm$) from the lens on the object's side, upright and ($h_i = 1.29cm$) tall.

Diverging lenses always produce images that are upright, virtual, reduced in size, and located on the object's side of the lens.

Diverging (double concave) Lens

H.W: An object of height ($h_o = 4cm$) placed at a distance ($d_o = 5cm$) from ($f = 20cm$) focal length concave lens. Find:

1- The position of the image ($d_i = ?$)**? Answer:** ($d_i = -4cm$)

2- The height of the image ($h_i = ?$)**? Answer:** ($h_i = 3.2cm$)

3- The magnification of the image ($M = ?$)**? Answer:** ($M = 0.8$)

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

H.W: An object of height ($h_o = 5cm$) is placed perpendicular to the principal axis of a diverging lens of focal length ($f = 30cm$) at a distance of ($d_o = 20cm$) from the lens. Find:

1- The position of the image ($d_i = ?$)**? Answer:** ($d_i = -12.5cm$)

2- The height of the image ($h_i = ?$)**? Answer:** ($h_i = 3.125cm$)

3- The magnification of the image ($M = ?$)**? Answer** ($M = 0.625$)

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

H.W: An object of height ($h_o = 7cm$) placed at ($d_o = 3cm$) from ($f = 10cm$) focal length double concave lens**.** Find:

1- The position of the image ($d_i = ?$)**? Answer:** ($d_i = -2.33cm$)

2- The height of the image ($h_i = ?$)**? Answer:** ($h_i = 5.436cm$)

3- The magnification of the image ($M = ?$)**? Answer** ($M = 0.776$)

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

((Exercises about Lenses))

Q 1:

An object is placed ($d_o = 10cm$) from a ($f = 15cm$) focal length converging lens. Determine:

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

(b) What is the magnification of the image ($M = ?$)? **Answer** ($M = 3.03$)

Q 2:

An object is located ($d_o = 18cm$) in front of ($f = 24cm$) focal length convex lens. Find:

(a) Where is the image located ($d_i = ?$)? **Answer:** ($d_i = -71.4cm$)

(b) What is the magnification of the image ($M = ?$)? **Answer** ($M = -3.96$)

Q 3:

An object of height ($h_o = 5cm$) is placed perpendicular to the principal axis of a concave lens of focal length ($f = 10cm$) at a distance of ($d_o = 20cm$) from the lens. Find:

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

(b) The size of the image ($h_i = ?$)? **Answer:** ($h_i = 1.67cm$)

Q 4:

An object of ($h_o = 5cm$) height is placed at a distance of ($d_o = 10cm$) from a double concave lens, if the focal length of the mirror is ($f = 15cm$). Find:

(a) The position of the ($d_i = -5.98$)?

(b) The height of the image ($h_i = 2.99cm$)?

(c) The magnification of the image ($M = 0.589$)?

(d) The nature of the image ($L.O.S.T$)?