

### Practice Problems

1. A microscope produces an image that is  $1.00 \times 10^{-4}$  m high from an object that is  $4.00 \times 10^{-7}$  m high. What is the magnification of the microscope?
2. A concave mirror produces an image on a wall that is 30.0 cm high from an object that is 6.5 cm high. What is the magnification of the mirror?
3. A pinhole camera produces a  $2.34 \times 10^{-2}$  m image of a building that is actually 50.0 m high. What is the magnification of the camera?

### Example Problem 11.1

A microscope produces an image that is  $5.50 \times 10^{-4}$  m high from an object that is  $2.00 \times 10^{-6}$  m high. What is the magnification of this microscope?

#### Given

Object height  $h_o = 2.00 \times 10^{-6}$  m

Image height  $h_i = 5.50 \times 10^{-4}$  m

#### Required

Magnification  $M = ?$

#### Analysis and Solution

The correct equation is  $M = \frac{h_i}{h_o}$

Substitute the values and their units, and solve the problem.

$$M = \frac{h_i}{h_o}$$

$$M = \frac{5.5 \times 10^{-4} \text{ m}}{2.00 \times 10^{-6} \text{ m}}$$

$$= 275$$

#### Paraphrase

The magnification of the microscope is 275 times.

### Practice Problems

1. An object is placed 75 cm from a concave mirror. A real image is produced 50 cm away. What is the magnification?
2. A person standing 3.00 m from a glass window sees her virtual image 3.00 m on the other side. What is the magnification of the window?
3. A camera creates a real image of a tree 40 m away. The image is formed 3.0 cm behind the lens. Find the magnification.

### Example Problem 11.2

A candle is placed 22 cm from a concave mirror. A virtual image is produced 53 cm from the mirror. What is the magnification?

#### Given

Object distance  $d_o = 22$  cm

Image distance  $d_i = 53$  cm

#### Required

Magnification  $M = ?$

#### Analysis and Solution

The correct equation is  $M = \frac{d_i}{d_o}$

Substitute the values and their units, and solve the problem.

$$M = \frac{d_i}{d_o}$$

$$M = \frac{53 \text{ cm}}{22 \text{ cm}}$$

$$= 2.4$$

#### Paraphrase

The magnification of the mirror is 2.4 times.

### Example Problem 11.3

An electron microscope magnifies a virus that is  $3.50 \times 10^{-7}$  m. If the magnification is  $3.70 \times 10^5$ , how big will the image be?

#### Given

Object height  $h_o = 3.50 \times 10^{-7}$  m

Magnification  $M = 3.70 \times 10^5$

#### Required

Image height  $h_i = ?$

#### Analysis and Solution

The correct equation is  $M = \frac{h_i}{h_o}$

Rearrange it to solve for the variable needed:  $h_i = Mh_o$

Substitute the values and their units, and solve the problem.

$$h_i = Mh_o$$

$$h_i = (3.70 \times 10^5)(3.50 \times 10^{-7} \text{ m})$$

$$= 0.130 \text{ m}$$

#### Paraphrase

The size of the image is 0.130 m or 13.0 cm.

### Practice Problems

1. A slide projector has a magnification of 50. How wide will the projected image be if the slide is 2.8 cm wide?
2. A concave mirror creates a virtual image of a candle flame that is 10 cm high. If the magnification of the mirror is 12.5, what is the height of the candle flame?
3. A magnifying glass will magnify 6 times. If the magnifying glass is held over a page and magnifies a letter that is 2 mm tall, how big is the image?

### Example Problem 11.4

A concave mirror creates a real, inverted image 16.0 cm from its surface. If the image is 4.00 times larger, how far away is the object?

#### Given

Image distance  $d_i = 16.0$  cm

Magnification  $M = 4.00$

#### Required

Object distance  $d_o = ?$

#### Analysis and Solution

The correct equation is  $M = \frac{d_i}{d_o}$

Rearrange it to solve for the variable needed:  $d_o = \frac{d_i}{M}$

Substitute the values and their units, and solve the problem.

$$d_o = \frac{d_i}{M}$$

$$d_o = \frac{16.0 \text{ cm}}{4.00}$$

$$= 4.00 \text{ cm}$$

#### Paraphrase

The object is 4.00 cm from the mirror.

### Practice Problems

1. An insect is magnified 12 times by a concave mirror. If the image is real, inverted, and 6 cm from the mirror, how far away is the insect?
2. A lens produces a real image that is 23 times bigger than the object. If the object is 14 cm away, how far away is the image?
3. A human hair is placed 3 mm from a powerful microscope lens that has a magnification of 40 times. How far from the lens will the image be formed?