

Problem B

LENSES

PROBLEM

An object is placed 49 cm in front of a converging lens. The image forms 23 cm behind the lens and is 8.0 cm tall. Determine the focal length of the lens and the height of the object.

SOLUTION

Given: $h' = 8.0 \text{ cm}$ $p = 49 \text{ cm}$ $q = 23 \text{ cm}$

Unknown: $f = ?$ $h = ?$

Choose the equation(s) or situation: Use the thin-lens equation to find the focal length, and the equation for magnification to find the height of the object.

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q} = \frac{1}{49 \text{ cm}} + \frac{1}{23 \text{ cm}} = 0.0204 \text{ cm}^{-1} + 0.0435 \text{ cm}^{-1}$$

$$f = \boxed{16 \text{ cm}}$$

$$M = -\frac{q}{p} = \frac{h'}{h}$$

Rearrange the equation(s) to isolate the unknown(s):

$$h = -\frac{ph'}{q} = -\frac{(49 \text{ cm})(8.0 \text{ cm})}{23 \text{ cm}} = \boxed{17 \text{ cm}}$$

ADDITIONAL PRACTICE

1. An object is placed 13 cm in front of a converging lens. The image forms 19 cm behind the lens and is 3.0 cm tall. Determine the focal length of the lens and the height of the object.
2. An object that is 15 cm tall is placed 44 cm in front of a diverging lens. A virtual image appears 14 cm in front of the lens. Determine the focal length of the lens and the height of the image.
3. A magnifying glass has a diverging lens with a 13.0 cm focal length. At what distance from a toothpick should you hold this lens to form an image with a magnification of +5.00?

4. An object with a height of 18 cm is placed in front of a converging lens. The image has a height of -9.0 cm.
 - a. What is the magnification of the lens?
 - b. If the focal length of the lens is 6.0 cm, how far in front of the lens is the object?
 - c. Where does the image appear?
5. A lighthouse places a 1000-watt bulb 4 m in front of a converging lens. The focal length of the lens is 4 m. What is the image distance and the magnification?
6. A searchlight is constructed by placing a 500-watt bulb 0.5 m in front of a converging lens. The focal length of the lens is 0.5 m. What is the image distance and the magnification?
7. A microscope slide is placed in front of a converging lens with a focal length of 3.6 cm. The lens forms a real image of the slide 15.2 cm behind the lens. How far is the lens from the slide?
8. Where must an object be placed to form an image 12 cm in front of a diverging lens with a focal length of 44 cm?
9. In the projection booth of a movie theatre, film is placed in front of a converging lens with a focal length of 9.0 cm. The lens forms a magnified real image on a screen 18 m behind the lens. How far is the lens from the film?
10. An object is placed in front of a converging lens with a focal length of 5.5 m. A virtual image appears 5.5 cm in front of the lens. How far is the object from the lens?