

Chapter 18: Ray Optics

Questions & Problems

$$\theta_r = \theta_i \quad n_1 \sin \theta_1 = n_2 \sin \theta_2 \quad n = \frac{c}{v} \quad \theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right) \quad \frac{1}{s} + \frac{1}{s'} = \frac{1}{f} \quad m = \frac{h'}{h} = -\frac{s'}{s}$$

Example 18.1

At high noon, the sun is almost directly above (about 2.0° from the vertical) and a tall redwood tree casts a shadow that 10.0 ft long. How tall is the redwood tree?

Example 18.2

You shine your laser pointer through the flat glass side of a rectangular aquarium at an angle of incidence of 45° . The index of refraction of this type of glass is 1.55.

- At what angle from the normal does the beam from the laser pointer enter the water inside the aquarium?
- Does your answer to part a depend on the index of refraction of the glass?

Example 18.3

A ray of light traveling through air encounters a 1.2-cm-thick sheet of glass at a 35° angle of incidence. How far does the light ray travel in the glass before emerging on the far side?

Example 18.4

The glass core of an optical fiber has index of refraction 1.60. The index of refraction of the cladding is 1.48. What is the maximum angle between a light ray and the wall of the core if the ray is to remain inside the core?

Example 18.5

An object is 15 cm in front of a converging lens with a focal length of 10 cm. Use ray tracing to determine the location of the image. What are the image characteristics: (i) real or virtual?, (ii) upright or inverted?, (iii) smaller, larger or same?, and (iv) the image location?

Example 18.6

A light bulb is 60 cm from a concave mirror with a focal length of 40 cm. A 5-cm-long mascara brush is held upright 20 cm from the mirror. Use ray tracing to determine the location of the image. What are the image characteristics: (i) real or virtual?, (ii) upright or inverted?, (iii) smaller, larger or same?, and (iv) the image location?

Example 18.7

A 2.0-cm tall object is 15 cm in front of a converging lens that has a 20 cm focal length. Where is the image located and what is the height of the image? What are the characteristics of the image (real or virtual, upright or inverted, enlarged or reduced)?

Example 18.8

A 1.0-cm tall object is 60 cm in front of a diverging lens that has a -30 cm focal length. Where is the image located and what is the height of the image? What are the characteristics of the image (real or virtual, upright or inverted, enlarged or reduced)?

Example 18.9

A 3.0-cm tall object is 15 cm in front of a convex mirror that has a -25 cm focal length. Where is the image located and what is the height of the image? What are the characteristics of the image (real or virtual, upright or inverted, enlarged or reduced)?

Example 18.10

A 3.0-cm tall object is 45 cm in front of a concave mirror that has a 25 cm focal length. Where is the image located and what is the height of the image? What are the characteristics of the image (real or virtual, upright or inverted, enlarged or reduced)?