Chapter 16

Terms

Be able to define or discuss the following terms and ideas, with their SI units if appropriate.

1. law of reflection
2. image point
3. real image
4. virtual image
5. diffuse reflection
6. plane mirror
7. object height
8. image height
9. object distance
10. image distance
11. concave mirror
12. convex mirror
13. focal point
14. focal length
15. vertex
16. optic axis (or axis of symmetry)
17. radius of curvature
18. center of curvature
19. upright image
20. inverted image
21. converging rays
22. diverging rays
23. speed of light, in a vacuum or any other medium
24. refraction
25. angle of refraction (measured with respect to the normal)
26. index of refraction
27. total internal reflection
28. critical angle
29. spectrum
30. dispersion
31. reflection and transmission at an interface of two mediums

Equations

Understand the meaning and know the SI units of all symbols in these equations; know how to perform each mathematical operation, such as trig functions; know how to solve for any unknown quantity; understand how changing one quantity affects another quantity (if all other quantities remain constant); be able to apply one or more equations to solve a problem.

- image for a plane mirror

$$s_o = s_i \qquad h_o = h_i \tag{1}$$

- for a spherical mirror:

$$\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f} \tag{2}$$

- for a spherical mirror:

$$f = \frac{R}{2} \tag{3}$$

- linear magnification

$$M = \frac{-s_i}{s_o} = \frac{h_i}{h_o} \tag{4}$$

- index of refraction

$$n = \frac{c}{v} \tag{5}$$

- Snell's Law

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \tag{6}$$

Skills

1. Know that an object can be treated as multiple point sources on all parts of the object.
2. (for a spherical mirror) Know that rays parallel to the optic axis intersect at the focal point.
3. (for a spherical mirror) Know that the ray incident on the vertex of the mirror reflects at the same angle with respect to the optic axis.
4. Trace a few rays from an object to show where an image is formed, especially rays parallel to the optic axis and rays incident on the vertex of the mirror (for a spherical mirror).
5. Trace both reflected and refracted rays at an interface between two mediums.
6. Know that the frequency of light is the same as light travels from medium to another; however, the wavelength will either increase or decrease depending on whether the light speeds up or slows down at the interface.
7. Know that if light travels from a lower index (of refraction) to a higher index, it bends toward the normal. If light travels from higher index to lower index, it bends away from the normal.
8. Know that if light travels from higher index to lower index and is incident at an angle greater than the critical angle, then it will only reflect and will not transmit at all through the interface. (This phenomenon is called total internal reflection and is the basis for how fiber optic cables transmit light over long distances.)
9. Calculate the critical angle for total internal reflection.
10. Know that index of refraction is not truly a constant. In fact, n depends on the frequency of light. As a result, different colors will refract different amounts. This results in dispersion. n is proportional to frequency. Thus, n is greater for higher frequency light (such as violet). As a result, violet bends more than red when white light is incident on glass or water for example, and this is how a glass prism separates light into a spectrum or how a water droplet separates sunlight into its spectrum (called a rainbow).

Lab Skills

1. Use the Optics Workbench simulation to set up a mirror and an object and show where the image is formed.

2. Using a laser pointer and piece of plane glass, mark the reflected and refracted rays on a piece of paper, measure both the angle of reflection and the angle of refraction at the interface, and use Snell's law to calculate the index of refraction of the glass.