Chapter 23 Reflection and Refraction of Light

3. A light ray reflects from a surface. If the angle of incidence is 24°, what is the angle between the reflected ray and the incident ray at the surface?

A. 24°  
B. 12°  
C. 66°  
D. 48°  
E. 102°

5. A light ray in air strikes a glass surface with an angle of incidence of 30.0°. The angle of refraction in the glass is 20.0°. What is the index of refraction of the glass?

A. 1.67  
B. 1.55  
C. 1.52  
D. 1.46  
E. 1.24

6. A light ray in air strikes a glass surface with an angle of incidence of 30.0°. The angle of refraction in the glass is 20.0°. What is the speed of light in the glass?

A. $3.00 \times 10^8$ m/s  
B. $2.50 \times 10^8$ m/s  
C. $2.33 \times 10^8$ m/s  
D. $2.05 \times 10^8$ m/s  
E. $1.50 \times 10^8$ m/s
8. A light ray strikes the surface of sapphire \((n = 1.77)\) at an angle of incidence of \(40.0^\circ\). What angle of refraction results?

A. 21.3°
B. 50.0°
C. 59.7°
D. 57.0°
E. 17.7°

11. A light ray in material 1 goes into material 2. The angle of incidence in material 1 is \(40.0^\circ\) and the angle of refraction in material 2 is \(31.0^\circ\). If the index of refraction of material 1 is 1.60, what is the index of refraction of material 2?

A. 3.20
B. 2.00
C. 1.88
D. 1.41
E. 1.20

13. What is the critical angle for diamond \((n = 2.42)\)?

A. 2.42°
B. 67.5°
C. 65.6°
D. 24.4°
E. 37.1°

16. When a light ray in air enters glass with index of refraction 1.60, what is the greatest angle of refraction that can occur?

A. 90.0°
B. 56.2°
C. 52.2°
D. 38.7°
E. 0.0°
19. When light in material 1, which is in contact with material 2, undergoes total internal reflection, what condition is necessary for their indices of refraction?

A. \( n_1 = 2 n_2 \)
B. \( n_1 > n_2 \)
C. \( n_1 < n_2 \)
D. \( n_1 = n_2 + 1 \)
E. \( n_2 = 1.5 \)

23. If a reflected ray in air at an angle of reflection of 60° is totally polarized, what is the index of refraction of the reflecting material?

A. 1.50
B. 2.00
C. 1.73
D. 1.15
E. This angle is not possible for an incident ray in air.

24. The critical angle for Lucite is 41.8°. What is Brewster's angle for Lucite?

A. 33.7°
B. 26.3°
C. 48.2°
D. 56.3°
E. Brewster's angle does not exist for this material.

27. In a camera, the image focused on the film is:

A. real and upright.
B. real and inverted.
C. virtual and upright.
D. virtual and inverted.
E. technically a mirage.
29. A ray of light enters an equilateral prism made of material with $n = 1.45$ at an angle of incidence $q$. The internally refracted ray is parallel to the base of the prism. What is the angle of refraction for the ray leaving the prism?

![Diagram of light ray entering prism]

A. 46.5°
B. 30.0°
C. 20.2°
D. 15.7°
E. The ray won't leave the prism.

30. A small object is enclosed in plastic ($n = 1.5$). The object appears to be 4.0 cm below the surface. What is the actual distance of the object below the surface?

A. 2.0 cm
B. 2.7 cm
C. 4.0 cm
D. 5.5 cm
E. 6.0 cm

31. A convex mirror has a radius of 10 cm. What is its focal length?

A. 10 cm
B. 5.0 cm
C. 20 cm
D. -5.0 cm
E. -10 cm

32. A mirror has a focal length -20 cm. If an object is placed 10 cm in front of the mirror, where will the image form?

A. 20 cm in front of the mirror.
B. 20 cm behind the mirror.
C. 6.7 in front of the mirror.
D. 6.7 behind the mirror.
E. No image will form.
37. An object is placed 60 cm in front of a mirror and the image is upright and ¼ the size of the object. What is the focal length of the mirror?

A. -12 cm  
B. -20 cm  
C. -45 cm  
D. -75 cm  
E. some positive value not given

42. A thin lens of focal length 12.5 cm has a 5.0 cm tall object placed 10 cm in front of it. Where will the image be formed?

A. 2.5 cm behind the lens  
B. 5.6 cm behind the lens  
C. 5.6 cm in front of the lens  
D. 50 cm behind the lens  
E. 50 cm in front of the lens

43. A thin lens of focal length 12.5 cm has a 5.0 cm tall object placed 10 cm in front of it. What is the size and orientation of the image?

A. 4.0 cm, inverted  
B. 4.0 cm, upright  
C. 8.9 cm, inverted  
D. 8.9 cm, upright  
E. 25 cm, upright

44. A thin lens of focal length -12.5 cm has a 5.0 cm tall object placed 10 cm in front of it. Where is the image located?

A. 2.5 cm behind the lens  
B. 5.6 cm behind the lens  
C. 5.6 cm in front of the lens  
D. 50 cm behind the lens  
E. 50 cm in front of the lens
47. A lens of focal length \( f \) is used to project an image of a solar eclipse on a flat sheet of paper. Which of the following image distances gives the clearest image in this case?

A. \( f/2 \)
B. \( f \)
C. \( 2f \)
D. more than 10 \( f \)
E. less than \( f/10 \)