

Key

Refraction of Light

1. What is the speed of light in a clear plastic whose index of refraction is 1.40?

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

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

$$\frac{3 \times 10^8}{1.4}$$

$$2.14 \times 10^8$$

2. The speed of light in a clear liquid is 2.3×10^8 m/s. What is its index of refraction?

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

$$= \frac{3 \times 10^8}{2.3 \times 10^8}$$

$$1.3$$

3. A beam of light strikes the surface of a block of glass ($n = 1.50$) and produces a refracted angle of 10.0° . What is the incident angle?

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$\sin^{-1} \left(\frac{n_2 \sin \theta_2}{n_1} \right) = 15^\circ$$

4. What is the wavelength of light in water ($n = 1.33$) if its wavelength in air is 5.30×10^{-7} m?

$$\frac{\lambda_{\text{air}}}{\lambda_{\text{new}}} = n$$

$$\lambda_{\text{new}} = \frac{\lambda_{\text{air}}}{n}$$

$$\frac{5.3 \times 10^{-7}}{1.33}$$

$$= 3.98 \times 10^{-7}$$

5. Monochromatic light has a wavelength of 6.0×10^{-7} m in air and 5.0×10^{-7} m in a clear liquid. What is the index of refraction of the clear liquid?

$$n = \frac{\lambda_{\text{air}}}{\lambda_{\text{new}}} = 1.2$$

6. Monochromatic light has a wavelength of 5.75×10^{-7} m in air and 4.32×10^{-7} m in a clear liquid. If a ray of light enters this clear liquid at an angle of incidence of 25.0° , what is the angle of refraction?

$$n = \frac{5.75 \times 10^{-7}}{4.32 \times 10^{-7}} = 1.33$$

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$1.0003 (\sin 25^\circ) = 1.33 (\sin \theta_2)$$

$$= 18.5^\circ$$

7. Monochromatic light has a wavelength of $5.20 \times 10^{-7} \text{ m}$ in air and $3.91 \times 10^{-7} \text{ m}$ in a clear liquid. What is the speed of light in the clear liquid?

$$n = \frac{5.20 \times 10^{-7}}{3.91 \times 10^{-7}} = 1.33 \quad v = \frac{c}{n} = \frac{3 \times 10^8}{1.33} = 2.2 \times 10^8$$

8. What is the index of refraction of a substance if the angle of incidence to this substance is 53.0° and the angle of refraction in this substance is 41.0° ?

$$1.00035 \sin(53) = n \sin 41 = 1.217$$

9. A ray of light strikes the surface of water ($n = 1.33$) at an angle of 60.0° from the water surface. What is the angle of refraction?

$$1.00035 \sin 60 = 1.33 \sin \theta = 40.6^\circ$$

10. What is the critical angle for an air-glass interface if the index of refraction of glass is 1.50?

more to less

$$1.00035 \sin \theta = 1.50 \sin 90 = 41.8^\circ$$

~~Bad question~~

11. What is the critical angle for a water-lucite (Plexiglas) interface if the index of refraction of water is 1.33 and of lucite is 1.51?

$$1.33 \sin \theta = 1.51 \sin 90 = 41.5^\circ$$

12. The critical angle for a certain liquid-air interface is 48.8° . What is the index of refraction of the liquid?

$$n \sin 48.8 = 1.00035$$

$$n = 1.33$$

13. What is the critical angle of a substance whose index of refraction is 1.81?

14. What is the index of refraction of a substance whose critical angle is 42.0° ?

15. The speed of light in a clear liquid is three quarters the speed of light in air. What is the critical angle of the liquid?

$$n = \frac{c}{v} \quad n = \frac{3 \times 10^8}{3 \times 10^8 \times 0.75} = 1.33 \quad 1.33 \sin \theta_c = 1.0003$$

$$= 48.6$$

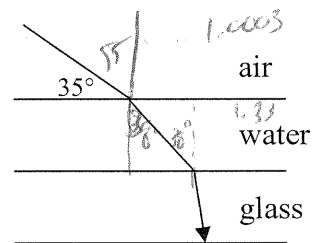
16. A ray of light travels from air into water ($n = 1.33$) and then into glass ($n = 1.50$) as shown in the diagram. Find the angle of refraction in the glass.

$$1.0003 \sin 35^\circ = 1.33 \sin \theta$$

$$= 38^\circ$$

$$1.33 \sin 38^\circ = 1.50 \sin \theta$$

$$\boxed{= 33^\circ}$$



17. A ray of light travels from glass ($n = 1.50$) into water ($n = 1.33$) into air as shown in the diagram. Find the angle that the light leaves the water-air interface.

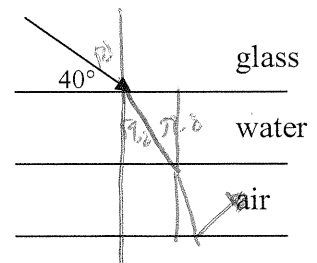
$$1.50 \sin 40^\circ = 1.33 \sin \theta = 59.8^\circ$$

$$1.33 \sin 59.8^\circ = 1.0003 \sin \theta$$

> TIR

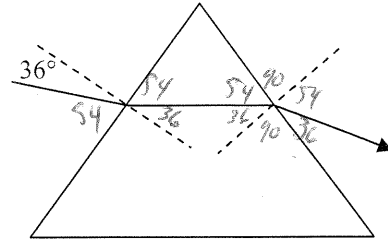
$$= \sin \theta_c = \frac{1.0003}{1.33}$$

$$= 48.7$$



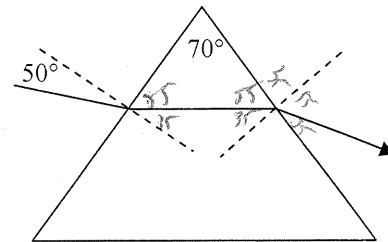
18. A ray of light strikes a side of an **equilateral** lucite ($n = 1.5$) prism at 36° as shown in the diagram. Find the angle that the light leaves the prism.

54°



19. A ray of light strikes a side of lucite ($n = 1.50$) prism at 50° , as shown in the diagram. Find the angle that the light leaves the prism.

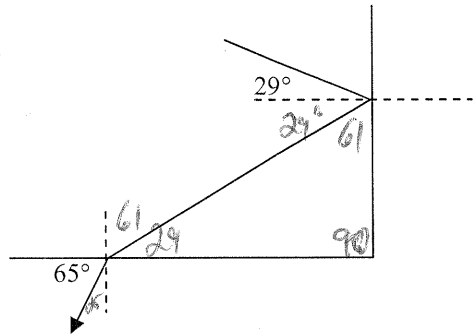
35°



20. A ray of light reflects from a mirror onto the surface of a clear liquid as shown in the diagram. Determine the index of refraction of the liquid.

$$1.00 \sin 61^\circ = n \sin 61^\circ$$

$$n = 2.07$$

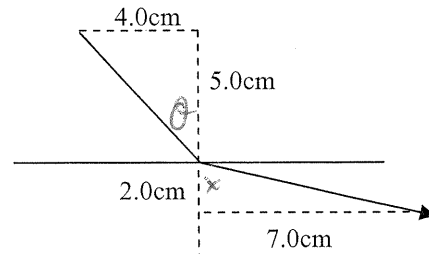


21. A ray of light travels through a clear liquid into a clear plastic as shown in the diagram. Find the index of refraction of the plastic compared to the liquid.

$$\theta = \tan^{-1}\left(\frac{4}{7}\right) = 38.7^\circ$$

$$x = \tan^{-1}\left(\frac{7}{2}\right) = 15.95^\circ$$

low
to
high



22. What is the frequency of light in diamond ($n = 2.42$) if the frequency in air is 6.20×10^{14} Hz?

$$\cancel{\lambda = \frac{v}{f}} \quad v = f\lambda \quad \frac{\cancel{\lambda}}{\cancel{\lambda}} = \frac{v}{f} \quad \lambda = \frac{v}{f} = \frac{3 \times 10^8}{6.2 \times 10^{14}} = 4.84 \times 10^{-7}$$
$$v = \frac{c}{n} = \frac{3 \times 10^8}{2.42} = 1.24 \times 10^8 \quad f = \frac{v}{\lambda} = \frac{1.24 \times 10^8}{4.84 \times 10^{-7}} = 2.56 \times 10^{13} \text{ Hz}$$

23. Monochromatic light of a wavelength of 6.22×10^2 nm enters lucite ($n = 1.51$). What is the frequency of the light in the lucite?

$$v = f\lambda \quad v = \frac{c}{n} \quad \frac{3 \times 10^8}{1.51} \quad v = 1.99 \times 10^8$$

24. Monochromatic light of a wavelength of 4.00×10^{-7} m enters water ($n = 1.33$). What is the period of the light in water?

25. The period of a light wave in air is 1.70×10^{-15} s. What is its wavelength in water ($n = 1.33$)?