

PHYS 1304, Ch 35 HW Solutions (7th Ed)

35.8 $\Delta t = t_{ice} - t_{vacuum} = \frac{d}{v_{ice}} - \frac{d}{v_{vacuum}} = \frac{d}{c/n_{ice}} - \frac{d}{c}$
 $= \frac{d}{c} (n_{ice} - 1) = \frac{6.20 \text{ m}}{3 \times 10^8 \text{ m/s}} (1.309 - 1)$
 $= \boxed{6.39 \times 10^{-9} \text{ s}}$

P35.9 Using Snell's law, $\sin \theta_2 = \frac{n_1}{n_2} \sin \theta_1$
 $\theta_2 = \boxed{25.5^\circ}$
 $\lambda_2 = \frac{\lambda_1}{n_2} = \boxed{442 \text{ nm}}$

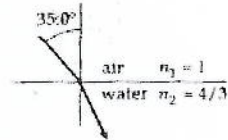


FIG. P35.10

P35.12 (a) $f = \frac{c}{\lambda} = \frac{3.00 \times 10^8 \text{ m/s}}{6.328 \times 10^{-7} \text{ m}} = \boxed{4.74 \times 10^{14} \text{ Hz}}$
 (b) $\lambda_{\text{glass}} = \frac{\lambda_{\text{air}}}{n} = \frac{632.8 \text{ nm}}{1.50} = \boxed{422 \text{ nm}}$
 (c) $v_{\text{glass}} = \frac{c_{\text{air}}}{n} = \frac{3.00 \times 10^8 \text{ m/s}}{1.50} = 2.00 \times 10^8 \text{ m/s} = \boxed{200 \text{ Mm/s}}$

P35.13 $n_1 \sin \theta_1 = n_2 \sin \theta_2$
 $\sin \theta_1 = 1.33 \sin 45^\circ$
 $\sin \theta_1 = (1.33)(0.707) = 0.943$
 $\theta_1 = 70.5^\circ \rightarrow \boxed{19.5^\circ \text{ above the horizon}}$

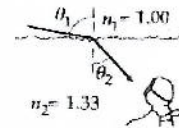


FIG. P35.13

P35.19 At entry, $n_1 \sin \theta_1 = n_2 \sin \theta_2$
 or $1.00 \sin 30.0^\circ = 1.50 \sin \theta_2$
 $\theta_2 = 19.5^\circ$

The distance h the light travels in the medium is given by

$$\cos \theta_2 = \frac{2.00 \text{ cm}}{h}$$

or $h = \frac{2.00 \text{ cm}}{\cos 19.5^\circ} = 2.12 \text{ cm}$

The angle of deviation upon entry is

$$\alpha = \theta_1 - \theta_2 = 30.0^\circ - 19.5^\circ = 10.5^\circ$$

The offset distance comes from $\sin \alpha = \frac{d}{h}$

$$d = (2.12 \text{ cm}) \sin 10.5^\circ = \boxed{0.388 \text{ cm}}$$

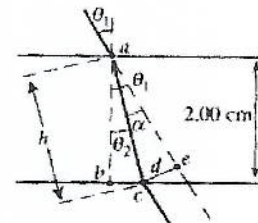


FIG. P35.21

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P35.24 Consider glass with an index of refraction of 1.5, which is 3 mm thick. The speed of light in the glass is

$$\frac{3 \times 10^8 \text{ m/s}}{1.5} = 2 \times 10^8 \text{ m/s}.$$

The extra travel time is

$$\frac{3 \times 10^{-3} \text{ m}}{2 \times 10^8 \text{ m/s}} - \frac{3 \times 10^{-3} \text{ m}}{3 \times 10^8 \text{ m/s}} = \boxed{\sim 10^{-11} \text{ s}}.$$

For light of wavelength 600 nm in vacuum and wavelength $\frac{600 \text{ nm}}{1.5} = 400 \text{ nm}$ in glass,

the extra optical path, in wavelengths, is $\frac{3 \times 10^{-3} \text{ m}}{4 \times 10^{-7} \text{ m}} - \frac{3 \times 10^{-3} \text{ m}}{6 \times 10^{-7} \text{ m}} = \boxed{\sim 10^3 \text{ wavelengths}}.$

P35.36 $n \sin \theta = 1$. From Table 35.1,

(a) $\theta = \sin^{-1}\left(\frac{1}{2.419}\right) = \boxed{24.4^\circ}$

(b) $\theta = \sin^{-1}\left(\frac{1}{1.66}\right) = \boxed{37.0^\circ}$

(c) $\theta = \sin^{-1}\left(\frac{1}{1.309}\right) = \boxed{49.8^\circ}$