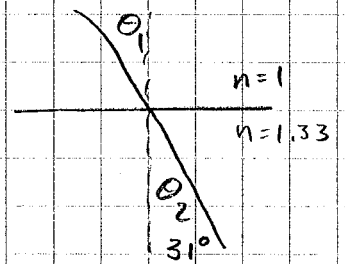
p659 29, 31, 33, 37, 38, 39, 41, 73, 74

(29)



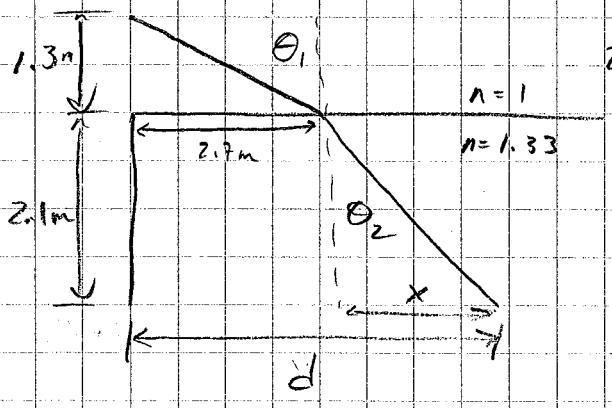
$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1}$$

$$\theta_1 = \sin^{-1}\left(\frac{n_2 \sin\theta_2}{n_1}\right) = \sin^{-1}(1.33 \sin 31°)$$

$$\theta_1 = 43°$$

From horizon $90 - 43 = \underline{47°}$

(31)



$$\tan\theta_1 = \frac{2.7}{1.3}$$

$$\theta_1 = 64°$$

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1}$$

$$\theta_2 = \sin^{-1}\left(\frac{n_1 \sin\theta_1}{n_2}\right) = \sin^{-1}\left(\frac{\sin 64}{1.33}\right)$$

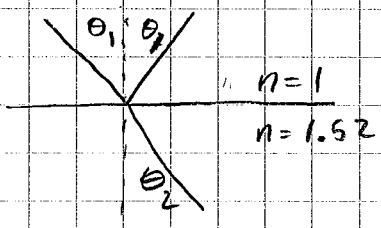
$$\theta_2 = 42.5°$$

$$\tan\theta_2 = \frac{x}{2.1}$$

$$x = 2.1 \tan 42.5° = 1.92$$

$$d = 2.7\,m + 1.92\,m = \underline{4.6\,m}$$

(33)



$$\theta_1 = 2\theta_2 \qquad \sin 2\theta = 2\sin\theta\cos\theta$$

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1}$$

$$\frac{\sin 2\theta_2}{\sin\theta_2} = \frac{n_2}{n_1}$$

$$\frac{2\sin\theta_2\cos\theta_2}{\sin\theta_2} = \frac{n_2}{n_1}$$

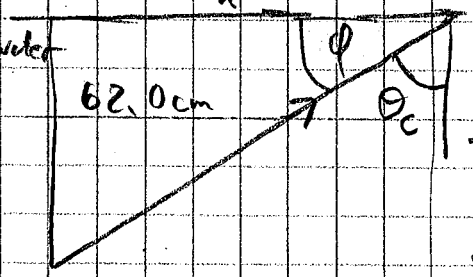
$$\theta_2 = \cos^{-1}\left(\frac{n_2}{2n_1}\right) = \cos^{-1}\left(\frac{1.52}{2}\right) = 40.5°$$

$$\theta_1 = 2\theta_2 = \underline{81°}$$

(37) $\frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1}$ $\quad \theta_2 = 90°$

$$n_1 = \frac{n_2}{\sin\theta_c} = \frac{1}{\sin 47.7} = \underline{1.35}$$

(38)



$$\frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1} \qquad \theta_2 = 90°$$

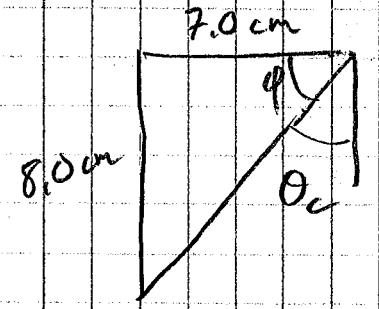
$$\sin\theta_c = \frac{n_2}{n_1} = \frac{1}{1.33}$$

$$\theta_c = 48.8°$$

$$\tan 41.2 = \frac{62.0\text{ cm}}{x}$$

$$\underline{x = 70.8\text{ cm}}$$

(39)



$$\varphi = \tan^{-1}\left(\frac{8}{7}\right) = 48.8°$$

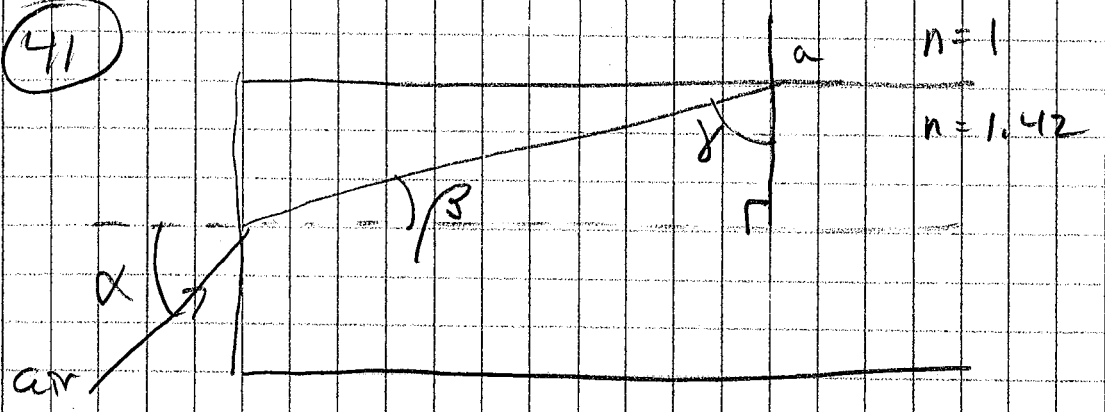
$$\theta_c = 41.2°$$

$$\frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1} \qquad \theta_2 = 90°$$

$$n_1 = \frac{n_2}{\sin\theta_c} = \frac{1}{\sin 41.2} = 1.51$$

$$\underline{n \geq 1.5}$$

(41)



for total internal reflection $\gamma \geq \theta_c$

$$\frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1} \qquad \theta_2 = 90^\circ$$

$$\theta_c = \sin^{-1}\left(\frac{1}{1.42}\right) = 44.76^\circ$$

$$\beta + \gamma = 90^\circ$$

$$\beta \leq 90 - 44.76 = 45.24^\circ$$

from air

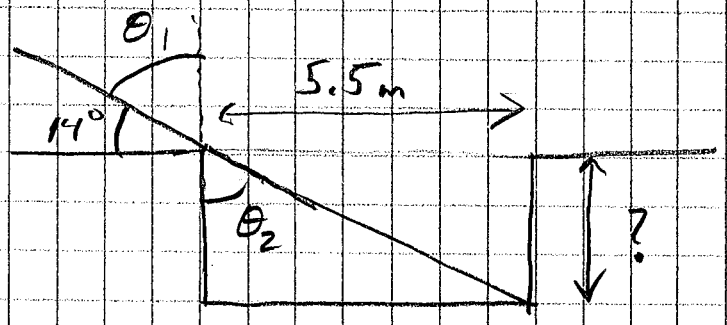
$$\frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1}$$

$$\sin\alpha = \frac{n_2 \sin\beta}{n_1} = 1.42 \sin 45.24 = 1.01$$

so for any $\alpha \leq 90^\circ$ β will be ≤ 45.24

and thus $\gamma \leq 44.76^\circ$

(73)



$\theta_1 = 90 - 14 = 76°$

$$\frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1}$$

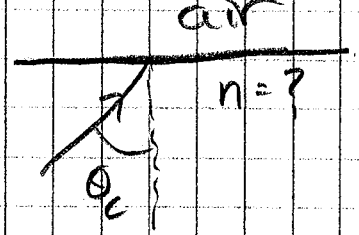
$$\theta_2 = \sin^{-1}\left(\frac{n_1 \sin\theta_1}{n_2}\right) = \sin^{-1}\left(\frac{\sin 76}{1.33}\right)$$

$\theta_2 = 46.85°$

$$\tan 46.85 = \frac{5.5}{?}$$

$$\text{Depth} = 5.16 \text{ m}$$

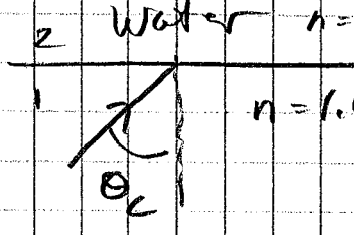
(74)



$$\frac{n_1}{n_2} = \frac{1}{\sin\theta_c}$$

$$n_1 = \frac{1}{\sin 37.3}$$

$n_1 = 1.65$



$$\sin\theta_c = \frac{n_2}{n_1} = \frac{1.33}{1.65}$$

$\theta_c = 53.7°$