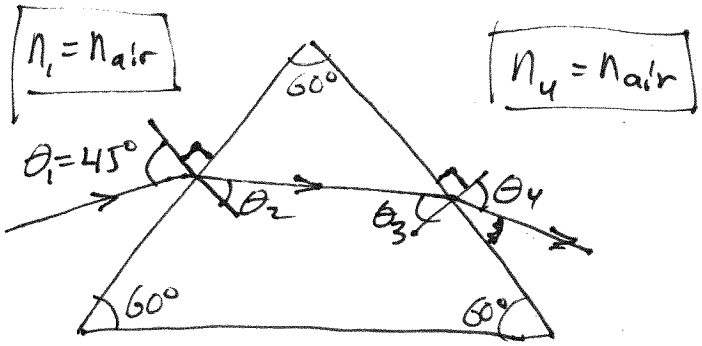
Ch.1 Prob. 61

Crown Glass

$n_R = 1.512$

$n_V = 1.530$

$n_{air} = 1.000$



The incident angle is $\theta_1 = 45°$

Use snell's law to find θ_2.

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

Red

$$\sin\theta_2 = \frac{1.000}{1.512}\sin(45°) = 0.4677$$

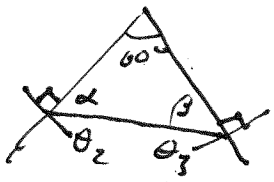
$$\theta_2 = 27.88°$$

Violet

$$\sin\theta_2 = \frac{1.000}{1.530}\sin(45°) = 0.4622$$

$$\theta_2 = 27.53$$

Use Geometry to find θ_3



$\alpha + \theta_2$ are complementary

so $\alpha + \theta_2 = 90$

$\beta + \theta_3$ are complementary

so $\beta + \theta_3 = 90$

for a triangle angles add to 180

so $\alpha + \beta + 60 = 180$

combine the equations give

$$\alpha + \beta + 60 = 180$$

$$(90 - \theta_2) + (90 - \theta_3) + 60 = 180$$

$$90 - \theta_2 + 90 - \theta_3 + 60 = 180$$

$$-\theta_2 - \theta_3 + 60 = 0$$

$$\therefore \quad \theta_3 = 60 - \theta_2$$

Red

$\theta_3 = 60° - 27.88°$

$\theta_3 = 32.12°$

Violet

$\theta_3 = 60° - 27.53°$

$\theta_3 = 32.47°$

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to leave the prism, use snell's law again

$$n_3 \sin\theta_3 = n_4 \sin\theta_4 \rightarrow \sin\theta_4 = \frac{n_3}{n_4}\sin\theta_3$$

Red

$$\sin\theta_4 = \frac{1.512}{1.000}\sin(32.120^\circ)$$

$$\sin\theta_4 = 0.8039$$

$$\boxed{\theta_4 = 53.51^\circ}$$

Red

Violet

$$\sin\theta_4 = \frac{1.530}{1.000}\sin(32.470^\circ)$$

$$\sin\theta_4 = 0.8214$$

$$\boxed{\theta_4 = 55.22^\circ}$$

violet