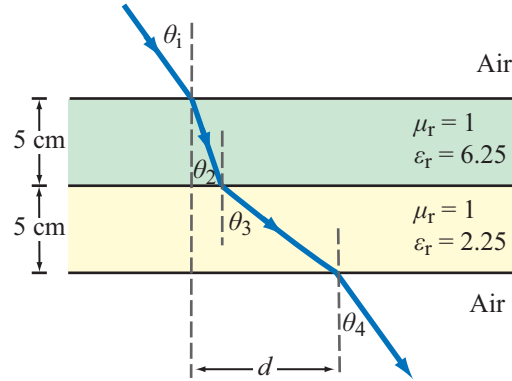


**Problem 8.20** A parallel-polarized plane wave is incident from air at an angle  $\theta_1 = 30^\circ$  onto a pair of dielectric layers as shown in Fig. P8.20.

- (a) Determine the angles of transmission  $\theta_2$ ,  $\theta_3$ , and  $\theta_4$ .
- (b) Determine the lateral distance  $d$ .



**Figure P8.20:** Problem P8.20.

**Solution:**

- (a) Application of Snell's law of refraction given by (8.31) leads to:

$$\sin \theta_2 = \sin \theta_1 \sqrt{\frac{\epsilon_{r1}}{\epsilon_{r2}}} = \sin 30^\circ \sqrt{\frac{1}{6.25}} = 0.2$$

$$\theta_2 = 11.54^\circ.$$

Similarly,

$$\sin \theta_3 = \sin \theta_2 \sqrt{\frac{\epsilon_{r2}}{\epsilon_{r3}}} = \sin 11.54^\circ \sqrt{\frac{6.25}{2.25}} = 0.33$$

$$\theta_3 = 19.48^\circ.$$

And,

$$\sin \theta_4 = \sin \theta_3 \sqrt{\frac{\epsilon_{r3}}{\epsilon_{r4}}} = \sin 19.48^\circ \sqrt{\frac{2.25}{1}} = 0.5$$

$$\theta_4 = 30^\circ.$$

As expected, the exit ray back into air will be at the same angle as  $\theta_1$ .

(b)

$$\begin{aligned}d &= (5 \text{ cm}) \tan \theta_2 + (5 \text{ cm}) \tan \theta_3 \\&= 5 \tan 11.54^\circ + 5 \tan 19.48^\circ = 2.79 \text{ cm}.\end{aligned}$$

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