

Problem 8.21 A light ray incident at 45° passes through two dielectric materials with the indices of refraction and thicknesses given in Fig. P8.21. If the ray strikes the surface of the first dielectric at a height of 2 cm, at what height will it strike the screen?

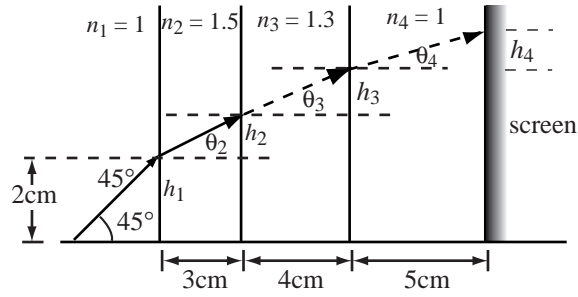


Figure P8.21: Light incident on a screen through a multi-layered dielectric (Problem 8.21).

Solution:

$$\sin \theta_2 = \frac{n_1}{n_2} \sin \theta_1 = \frac{1}{1.5} \sin 45^\circ = 0.47.$$

Hence,

$$\theta_2 = 28.13^\circ,$$

$$h_2 = 3 \text{ cm} \times \tan \theta_2 = 3 \text{ cm} \times 0.53 = 1.6 \text{ cm},$$

$$\sin \theta_3 = \frac{n_2}{n_3} \sin \theta_2 = \frac{1.5}{1.3} \sin 28.13^\circ = 0.54.$$

Hence,

$$\theta_3 = 32.96^\circ,$$

$$h_3 = 4 \text{ cm} \times \tan 32.96^\circ = 2.6 \text{ cm},$$

$$\sin \theta_4 = \frac{n_3}{n_4} \sin \theta_3 = 0.707.$$

Hence,

$$\theta_4 = 45^\circ,$$

$$h_4 = 5 \text{ cm} \times \tan 45^\circ = 5 \text{ cm}.$$

$$\text{Total height} = h_1 + h_2 + h_3 + h_4 = (2 + 1.6 + 2.6 + 5) = 11.2 \text{ cm}.$$