

33. Let  $I_0$  be the intensity of the unpolarized light that is incident on the first polarizing sheet. The transmitted intensity is  $I_1 = \frac{1}{2}I_0$ , and the direction of polarization of the transmitted light is  $\theta_1 = 40^\circ$  counterclockwise from the  $y$  axis in the diagram. The polarizing direction of the second sheet is  $\theta_2 = 20^\circ$  clockwise from the  $y$  axis, so the angle between the direction of polarization that is incident on that sheet and the polarizing direction of the sheet is  $40^\circ + 20^\circ = 60^\circ$ . The transmitted intensity is

$$I_2 = I_1 \cos^2 60^\circ = \frac{1}{2} I_0 \cos^2 60^\circ,$$

and the direction of polarization of the transmitted light is  $20^\circ$  clockwise from the  $y$  axis. The polarizing direction of the third sheet is  $\theta_3 = 40^\circ$  counterclockwise from the  $y$  axis. Consequently, the angle between the direction of polarization of the light incident on that sheet and the polarizing direction of the sheet is  $20^\circ + 40^\circ = 60^\circ$ . The transmitted intensity is

$$I_3 = I_2 \cos^2 60^\circ = \frac{1}{2} I_0 \cos^4 60^\circ = 3.1 \times 10^{-2} I_0.$$

Thus, 3.1% of the light's initial intensity is transmitted.

34. In this case, we replace  $I_0 \cos^2 70^\circ$  by  $\frac{1}{2} I_0$  as the intensity of the light after passing through the first polarizer. Therefore,

$$I_f = \frac{1}{2} I_0 \cos^2 (90^\circ - 70^\circ) = \frac{1}{2} (43 \text{ W / m}^2) (\cos^2 20^\circ) = 19 \text{ W / m}^2.$$