8.32 Natural light is randomly polarized, which means that, on average, half the light energy is polarized along any given direction (in the plane orthogonal to the direction of propagation) and the other half of the energy is polarized along the direction orthogonal to the first polarization direction. Hence, when treating natural light incident upon a planar boundary, we can consider half of its energy to be in the form of parallel-polarized waves and the other half as perpendicularly polarized waves. Determine the fraction of the incident power reflected by the planar surface of a piece of glass with $n = 1.5$ when illuminated by natural light at 70°.

Solution: Assume the incident power is 1 W. Hence:

Incident power with parallel polarization = 0.5 W,

Incident power with perpendicular polarization = 0.5 W.

$\varepsilon_2/\varepsilon_1 = (n_2/n_1)^2 = n^2 = 1.5^2 = 2.25$. Equations (8.60) and (8.68) give

$$\Gamma_{\perp} = \frac{\cos 70^\circ - \sqrt{2.25 - \sin^2 70^\circ}}{\cos 70^\circ + \sqrt{2.25 - \sin^2 70^\circ}} = -0.55,$$

$$\Gamma_{\parallel} = \frac{-2.25\cos 70^\circ + \sqrt{2.25 - \sin^2 70^\circ}}{2.25\cos 70^\circ + \sqrt{2.25 - \sin^2 70^\circ}} = 0.21.$$

Reflected power with parallel polarization $= 0.5\,(\Gamma_{\parallel})^2$
$= 0.5\,(0.21)^2 = 22$ mW,

Reflected power with perpendicular polarization $= 0.5\,(\Gamma_{\perp})^2$
$= 0.5\,(0.55)^2 = 151.3$ mW.

Total reflected power $= 22 + 151.3 = 173.3$ mW, or 17.33%..