

Solutions

These allocations are for the original questions on this sheet. B1 = one standalone point, M1 = one method point, A1 = one accuracy point.

2.1 $A = 12 \times 10^{-4} = 0.0012 \text{ m}^2$. $P = IA = 500 \times 0.0012 = 0.60 \text{ W}$. $P_{\text{useful}} = \eta P = 0.15 \times 0.60 = 0.090 \text{ W}$.

2.2 Snell's law: $n_1 \sin i = n_2 \sin r$. $r = \sin^{-1}(\sin 30.0^\circ / 1.50) = 19.5^\circ$. Frequency stays constant.

2.3 $\sin C = n_2/n_1 = 1.40/1.50$, so $C = 69.0^\circ$. Travel is to lower index and $70.0^\circ > C$, so total internal reflection occurs.

3.1 The first polariser selects one transverse vibration direction. Brightness starts at maximum, reaches minimum at 90° , and returns to maximum at 180° . The second selects a direction perpendicular to the first at the minimum. This supports transverse vibration; longitudinal waves cannot be plane polarised.

3.2 Trace the block and mark separated points on incident/emerging rays, then remove the block and join entry/exit points to reconstruct the internal ray. Draw the entry normal and measure i, r from it. Repeat a range of incidence angles. Plot $\sin i$ against $\sin r$; the best-fit gradient is index relative to air. Narrow beam and widely separated marked points or avoiding very small angles reduce direction/percentage uncertainty.

3.3 $\sin C = n_{\text{clad}}/n_{\text{core}}$. Initially $C = 69.0^\circ$; finally $C = 75.2^\circ$. The ray initially undergoes total internal reflection, but afterwards $70.0^\circ < C$, so it is no longer totally internally reflected.