

Solutions

2.1 The angle of incidence equals the angle of reflection.

2.2 Towards the normal; light slows in the denser medium, and the change of speed changes its direction.

2.3 $n = 0.866/0.5 = 1.73$.

2.4 Light must travel in the denser medium towards the boundary at an angle greater than the critical angle.

2.5 (P) Higher frequency raises pitch; larger amplitude raises loudness.

3.1 $\sin r = \sin 40^\circ/1.33 = 0.643/1.33 = 0.483$; $r = 28.9^\circ \approx 29^\circ$.

3.2 The fibre is thin glass (dense) surrounded by air/cladding (less dense); a ray entering along the axis strikes the wall above the critical angle, so it reflects repeatedly along the fibre without escaping; pulses of light carry the information from end to end.

3.3 (P) Stand a measured distance d from a large wall; clap and time the echo's return t with a stopwatch over several claps for accuracy; speed $v = 2d/t$ – total distance there and back divided by the time; repeat and average to reduce error.

3.4 (P) Screen time = $10 \times 5 \text{ ms} = 50 \text{ ms}$ for 4 waves; period = $50/4 = 12.5 \text{ ms}$; $f = 1/0.0125 = 80 \text{ Hz}$. Louder at the same pitch: the trace peaks grow taller with unchanged waves-per-screen (frequency constant).