



ANSWER BOOK

Refraction and total internal reflection

Waves · Year 12

AQA 3.3.2.3 · OCR A 4.4.2

10 questions · 29 marks

NAVY EDITION

SECTION A · Warm-up

- A1** Refractive index n = speed of light in a vacuum / speed of light in the material = c/v . It is always greater than or equal to 1. [2]
- A2** $n = c/v = (3.0 \times 10^8)/(2.0 \times 10^8) = 1.5$. [2]
- A3** The light must be travelling in the more optically dense medium (higher n) towards the boundary with a less dense one, and the angle of incidence must exceed the critical angle. [2]

SECTION B · Standard

- B1** $n_1 \sin \theta_1 = n_2 \sin \theta_2$: $\sin \theta_2 = \sin 40^\circ / 1.5$, so $\theta_2 = 25.4^\circ$. [3]
- B2** $\sin \theta_c = 1/n = 1/1.5$, so $\theta_c = 41.8^\circ$. [3]
- B3** $\lambda_{\text{glass}} = \lambda/n = 600/1.5 = 400 \text{ nm}$. $v = c/n = (3.0 \times 10^8)/1.5 = 2.0 \times 10^8 \text{ m s}^{-1}$. [3]
- B4** $n_1 \sin \theta_1 = n_2 \sin \theta_2$: $1.33 \times \sin 30^\circ = 1 \times \sin \theta_2$, so $\theta_2 = 41.7^\circ$. [3]

SECTION C · Stretch

- C1** $\sin \theta_c = n_{\text{cladding}}/n_{\text{core}} = 1.40/1.50$, so $\theta_c = 69.0^\circ$. [4]
- C2** The critical angle is 41.8° . Since 45° is greater than the critical angle, the ray undergoes total internal reflection and does not leave the block. [3]
- C3** It has a central core of high refractive index surrounded by a cladding of slightly lower refractive index. The cladding gives a well-defined boundary for total internal reflection, protects the core, and reduces signal loss and crossover between fibres. [3]