

Exercise walk-through

3.2

Light refraction and sound

Pearson Edexcel · International GCSE · Physics

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The method

Method — n , c and TIR

$$n = \frac{\sin i}{\sin r} \qquad \sin c = \frac{1}{n}$$

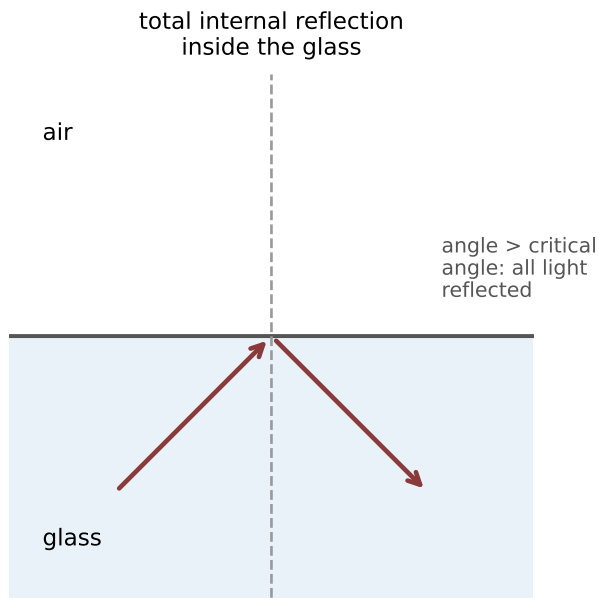
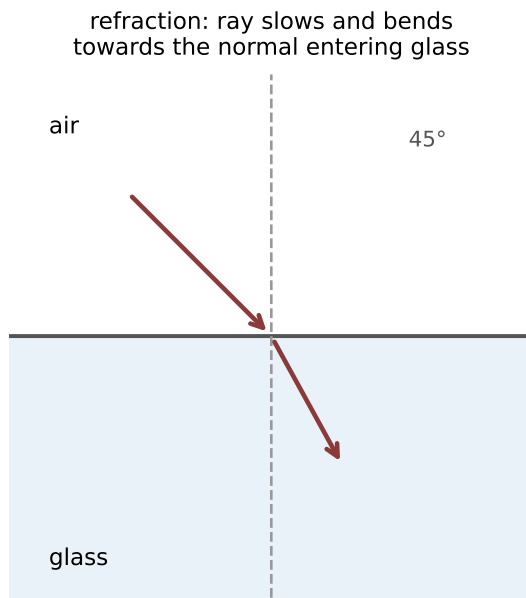
Worked check. Light hits a glass block ($n = 1.5$) at 45° :

$\sin r = \sin 45^\circ / 1.5 = 0.707 / 1.5 = 0.471$, $r \approx 28^\circ$ – bent towards the normal.

Critical angle $\sin c = 1/1.5$, $c \approx 41.8^\circ$.

Method — n , c and TIR

[$n = i$ r $c = 1$ n] Worked check.



Exercises 2.1·2.3

2.1 State the law of reflection. [1]

2.2 Which way does light bend entering glass from air, and why? [2]

2.3 Calculate the refractive index if $\sin i = 0.866$ and $\sin r = 0.5$. [2]

Exercises 2.1·2.3

2.1 State the law of reflection. [1]

2.1 The angle of incidence equals the angle of reflection.

2.2 Which way does light bend entering glass from air, and why? [2]

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

2.3 Calculate the refractive index if $\sin i = 0.866$ and $\sin r = 0.5$. [2]

2.3 $n = 0.866/0.5 = 1.73$.

Exercises 2.4·3.1

2.4 State the two conditions needed for total internal reflection. [2]

2.5 (P) State what raises the pitch of a sound and what raises its loudness. [2]

3.1 Light travels from air into water ($n = 1.33$) at an incident angle of 40° . Calculate the angle of refraction. [3]

Exercises 2.4·3.1

2.4 State the two conditions needed for total internal reflection. [2]

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

2.5 (P) State what raises the pitch of a sound and what raises its loudness. [2]

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

3.1 Light travels from air into water ($n = 1.33$) at an incident angle of 40° . Calculate the angle of refraction. [3]

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

Exercises 3.2·3.4

3.2 Explain how an optical fibre uses total internal reflection to carry information, and why the light must strike the fibre wall above the critical angle. [3]

3.3 (P) Describe how to measure the speed of sound in air using an echo method, stating the measurements taken and the calculation. [4]

3.4 (P) An oscilloscope shows a sound trace with 4 complete waves across the screen; the time base is 5 ms per division and the screen is 10 divisions wide. Calculate the frequency, and describe the trace if the sound becomes louder at the same pitch. [4]

Exercises 3.2·3.4

3.2 Explain how an optical fibre uses total internal reflection to carry information, and why the light must strike the fibre wall above the critical angle. [3]

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) Describe how to measure the speed of sound in air using an echo method, stating the measurements taken and the calculation. [4]

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) An oscilloscope shows a sound trace with 4 complete waves across the screen; the time base is 5 ms per division and the screen is 10 divisions wide. Calculate the frequency, and describe the trace if the sound becomes louder at the same pitch. [4]

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).