Refractive index: choosing the correct angles

Student activity • observation and reasoning

YEAR 10 / LESSON 59 / PHYSICS + SCIENCE (DOUBLE AWARD)

The question

Which angle belongs in the numerator when the direction of light changes?

Use diagrams and degree-mode calculations to distinguish air-to-glass entry from glass-to-air exit.

Equipment

- Booklet, calculator, ruler and protractor

Desk-based calculation and diagram work. No light sources or glass blocks are required.

Course coverage: Shared Physics / Double Award: 3.18. n = sin i / sin r for air-to-material entry.

Plan, model or apparatus sketch

Draw a labelled ray diagram with direction arrows, boundaries and normals.

Method and reasoning

Read the whole sequence before starting

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1. Draw a labelled air-to-glass boundary and normal. Mark the angle in air as θair and the angle in glass as θglass.

2. For air-to-glass entry, label incidence i = θair and refraction r = θglass. Use n ≈ sin i / sin r, taking the refractive index of air as approximately 1.

3. Calculate n for invented pairs (30°, 19.5°), (45°, 28.1°) and (60°, 35.3°), keeping your calculator in degree mode. Explain why rounded pairs need not give identical answers.

4. Reverse each ray without changing the medium labels. At glass-to-air exit the incident angle is now θglass, so the material index is sin r / sin i, not sin i / sin r.

5. For a material with n = 1.50 and air incidence 40°, calculate the refracted angle using sin r = sin 40° / 1.50 and inverse sine.

6. Write a rule using medium labels: nmaterial ≈ sin θair / sin θmaterial. Check it against both directions and explain why normal incidence cannot give n from a 0/0 ratio.

Cleanup

- Retain corrected calculations and return calculators.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Practice data only, not measured glass results. The general relation is $n_1 \sin \theta_1 = n_2 \sin \theta_2$. For air-to-glass entry, $n \approx \sin i / \sin r$; for glass-to-air exit, $n \approx \sin r / \sin i$. Angles are always to the local normal.

θair / °	θglass / °	Calculated n
30	19.5	
45	28.1	
60	35.3	

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Where are the angles measured?

2. Which calculator mode is required?

3. Estimate n from the practice pairs.

4. What ratio applies at glass-to-air exit?

5. Find r for air incidence 40° and n = 1.50.

6. Why avoid i = r = 0° when calculating the ratio?