Investigating the refractive index of glass

Student activity • investigation and reasoning

YEAR 10 / LESSON 60 / PHYSICS + SCIENCE (DOUBLE AWARD)

The question

Can measurements at several angles give a consistent refractive index for one glass block?

Trace air-to-glass entry and use a graph of sine values to estimate the block's refractive index.

Equipment

- Rectangular glass block and low-voltage LED ray box
- Paper, ruler, protractor, calculator and graph paper

Staff inspect glass for chips and remove damaged blocks. Handle blocks flat on the bench and away from edges. Keep beams below eye level and do not look into the LED source. No laser is used. Switch off before moving apparatus and keep leads clear.

Course coverage: Shared Physics / Double Award: 3.18, 3.19. Investigate refractive index using a glass block.

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. Staff check a rectangular glass block for chips. Place it on paper, trace its outline and mark a normal at an entry point on a long face. Use a low-voltage LED ray box with a single narrow beam.

2. Aim at about 20° to the normal. Mark two points on the incoming ray and two on the ray emerging from the opposite face. Remove the block and join the boundary crossing points to reconstruct the internal ray.

3. Measure actual i in air and r inside glass at the entry boundary. Record both in degrees. Repeat on fresh outlines for target incidences near 30°, 40°, 50° and 60°.

4. Repeat the entire trace at the middle setting to assess repositioning uncertainty. Keep the block and light source the same. Do not include a normal-incidence ratio.

5. Calculate sin i and sin r using degree mode. Plot sin i vertically against sin r horizontally. Draw a suitable best-fit straight line and calculate its gradient using a large triangle.

6. Interpret the gradient as the refractive index relative to air. Compare individual ratios and discuss angle resolution, alignment, beam width and evidence of a nonzero intercept rather than forcing agreement.

Cleanup

- Switch off, collect glass blocks in protective storage and retain raw traces with the graph.

Record your evidence

Blank spaces are for your own work

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Reference and task data

For air-to-glass entry, n ≈ sin i/sin r and the gradient of sin i against sin r estimates n. The ideal relation passes through the origin; a noticeable intercept can indicate systematic error. Both axes are dimensionless. Do not use the glass-to-air exit angle in place of the entry refraction angle.

Target / °	Actual i / °	Actual r / °	sin i	sin r
20				
30				
40				
50				
60				
Repeat 40				

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Which boundary is used for the calculation?

2. Which sine is on the vertical axis?

3. What does the gradient estimate?

4. Why repeat a complete tracing?

5. Why not include the 0° ratio?

6. What might a nonzero intercept suggest?