Refraction through a rectangular block

Student activity • investigation and reasoning

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The question

How does a light ray change direction when it enters and leaves an acrylic block?

Trace rays through a rectangular acrylic block, including normal incidence, and compare entry and exit directions.

Equipment

- Rectangular acrylic block, LED ray box, paper, ruler and protractor

Use smooth acrylic blocks and low-voltage LED ray boxes. Keep light on the bench and out of eyes; no laser is required. Check blocks for sharp damage, secure leads and switch off before rearranging equipment.

Course coverage: Shared Physics / Double Award: 3.9, 3.14, 3.16. Refraction and ray diagrams.

Plan, model or apparatus sketch

Draw the apparatus and wave or ray directions; label the normal or equilibrium position where relevant.

Method and reasoning

Read the whole sequence before starting

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1. Place a rectangular acrylic block on paper and trace its outline. Choose an entry point on a long face and draw a normal there.

2. Use a low-voltage LED ray box with one narrow beam along the paper. Start at approximately 20° incidence to the normal. Mark two points on the incoming ray and two on the outgoing ray.

3. Remove the block and ray box. Join the outside points and identify where the rays cross the outline. Join those boundary points to reconstruct the internal ray.

4. Draw a second normal at the exit point. Measure the entry incidence and refraction angles, then compare the incoming and outgoing directions. Repeat at about 40° and 60° using fresh outlines.

5. Repeat at normal incidence. Record whether there is a direction change, and explain that light speed still changes even if the ray is not bent.

6. Use direction arrows and labels to explain bending towards the normal on entering acrylic and away on leaving. Explain the lateral displacement for oblique incidence through parallel faces.

Cleanup

- Switch off, collect and store blocks without scratching, and retain labelled traces.

Record your evidence

Blank spaces are for your own work

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Reference and task data

For parallel faces with air on both sides, the emerging ray is parallel to the incident ray in the ideal model, with a sideways displacement at oblique incidence. Frequency stays constant across a stationary boundary; speed and wavelength change. This lesson does not require measuring refractive index.

Target incidence / °	Measured i / °	Measured r / °	Exit observation
20			
40			
60			
0			

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 angles measured?

2. Which way does the ray bend on entry?

3. Which way on exit?

4. What happens at normal incidence?

5. Is the emerging ray on the same line at oblique incidence?

6. Which wave quantity stays unchanged at the boundary?