Refraction: three block shapes

Student activity • observation and reasoning

YEAR 10 / LESSON 58 / PHYSICS + SCIENCE (DOUBLE AWARD)

The question

How does the shape of a transparent block affect a light ray's path?

Trace a ray through three acrylic shapes. Identify refraction at each boundary and use the local normal.

Equipment

- LED ray box with low-voltage source
- Rectangular, semicircular and triangular acrylic blocks
- Paper, ruler and protractor

Use smooth-edged acrylic blocks and LED ray boxes, not lasers. Keep beams on the bench and out of eyes. Switch off before repositioning equipment, keep leads tidy and avoid darkening access routes.

Course coverage: Shared Physics / Double Award: 3.17. Investigate rectangular and semicircular blocks and triangular prisms.

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

YEAR 10 / LESSON 58 / PHYSICS + SCIENCE (DOUBLE AWARD)

1. Work in ten groups of three with a low-voltage LED ray box. Trace a rectangular block and mark an entry normal. Shine one narrow beam obliquely through opposite parallel faces.

2. Mark incoming and outgoing rays with two points each. Remove the block and join the boundary crossing points to reconstruct the internal path. Add arrows and both normals.

3. Trace a semicircular block and mark the midpoint of its flat face. Aim through the curved face along a radius towards that midpoint, so entry at the curve is approximately normal.

4. Choose about 20° incidence inside the block at the flat face. Mark the ray emerging into air and draw the normal at the flat face. Measure both angles there and identify bending away from the normal.

5. Trace a triangular prism. Staff help select an orientation with a clearly visible transmitted ray through two faces. Trace it and draw a separate perpendicular normal at each face.

6. Compare the three ray diagrams. Distinguish the refracted transmitted ray from any faint reflected ray. Explain why entry along a radius avoids bending at the curved surface.

Cleanup

- Switch off, collect blocks without scratching and retain the three labelled diagrams.

Record your evidence

Blank spaces are for your own work

YEAR 10 / LESSON 58 / PHYSICS + SCIENCE (DOUBLE AWARD)

Reference and task data

For the semicircle, the ray enters the curved face towards the centre and leaves through the flat face. At that exit it goes from acrylic to air. Use an angle well below total internal reflection for this task. Refraction angles are not reflection angles. A prism's faces are not parallel.

Shape	Entry behaviour	Exit behaviour
Rectangle		
Semicircle, radial entry		
Triangular prism		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

YEAR 10 / LESSON 58 / PHYSICS + SCIENCE (DOUBLE AWARD)

1. Why does a radial ray enter the curved face without bending?

2. Where does that ray leave?

3. Which way does it bend at the acrylic-to-air exit?

4. Why draw a normal at each prism face?

5. How do reflection and refraction differ?

6. Which block can give a parallel but displaced emerging ray?