

Bending light: refraction, critical angle and lenses

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Lab answers

These model answers use the sample results in the table. Your own values will differ a little, but $\sin i$ against $\sin r$ should still give a straight line through the origin with a gradient equal to the refractive index.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** IGCSE 3.2

Question 1 Plot the graph

The points lie close to a straight line through the origin, showing that **$\sin i$ is directly proportional to $\sin r$** .

Question 2 Gradient

Using the first and last points: $\text{gradient} = (0.940 - 0.259) \div (0.629 - 0.174) = 0.681 \div 0.456 = \mathbf{1.49}$. The gradient equals the refractive index n .

Question 3 Mean value

Mean of the last column = **1.51**. It agrees with the graph gradient within experimental error.

Question 4 Critical angle

$\sin c = 1 \div 1.51 = 0.663$, so $c = \mathbf{41.5^\circ}$.

Question 5 Sources of error

Pins are thick, so the line through them is uncertain by about 1° ; the protractor is read to 1° . Both cause random error in r , which is **about $\pm 1^\circ$** .

Question 6 Why a wide spacing

A long line through widely spaced pins fixes the direction more precisely, so the angle drawn has a **smaller percentage error** than with pins 1 cm apart.

Question 7 Improvement

Use a ray box or laser pointer with a thin beam, or a larger protractor and thinner pins, and repeat each angle three times to **average** the results.