




Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1	a		Refraction ray drawn with angle of refraction smaller than angle of incidence ✓	1 AO 1.2	Judge by eye IGNORE direction of arrow and length of ray
	b		Glass is more (optically) dense than air ✓ The speed of light is lower in glass ✓	2 AO 2 × 1.1	ALLOW glass has a different (optical) density (to air) DO NOT ALLOW glass is less (optically) dense ALLOW glass has a different refractive index (to air) ALLOW (the light) slows down DO NOT ALLOW the speed of light is higher in glass IGNORE ideas about wavelength and frequency If no other mark scored: ALLOW light changes speed (in glass) <u>Examiner's Comments</u> Candidates demonstrated good knowledge of refraction in this question with the majority of candidates achieving at least 1 mark, mainly for identifying that glass is denser than air.
	c	i	Measure angles with a protractor ✓ Angle (of incidence and angle of refraction) measured between ray and normal ✓ And any two from: Draw normal (where ray enters block) ✓ Trace along light rays (with a pencil)✓ Detail on tracing rays e.g., draw crosses along rays first then remove block and join them up ✓	4 AO 2 × 1.2 2 × 3.3a	ALLOW can be shown on Fig 22.1 ALLOW draw line at 90° (where ray enters block) ALLOW draw a line entering block and shine laser along it ALLOW use of pins on rays to trace where the light rays are <u>Examiner's Comments</u> This question assessed candidates' working scientifically skills.

			<p>Change the angle of incidence (to measure different angles of refraction) ✓</p> <p>Plot a graph to show relationship between angle of incidence and angle of refraction ✓</p>		<p>Nearly all candidates attempted this question, but many did not appear to be very familiar with the practical activity. The question discriminated well between the lower-achieving and higher-achieving candidates. Poor quality of communication and lack of detail resulted in few candidates gaining full credit.</p> <p>Common errors included:</p> <ul style="list-style-type: none"> vague statements, e.g. measure angles, without adding detail such as the equipment used not being explicit as to what they were measuring, e.g. not stating that the angle being measured was between the ray and the normal. Some candidates scored this mark by clearly labelling the angle on Fig. 22.1 <p> Assessment for learning</p> <p>Candidates could benefit from starter or plenary activities where they are provided with a practical activity and asked to write a short method, including a list of the equipment and what the equipment measures.</p>
		ii	<p>Calculate a constant from one pair of data values ✓</p> <p>Calculate a constant from a different pair of angles and compare ✓</p>	2 AO 2 × 3.2a	<p>e.g., $22/14 = 1.57$ $34/22 = 1.55$ $48/30 = 1.60$ $55/33 = 1.67$ $62/36 = 1.72$ ALLOW use of vertical ratios e.g., $48/34 = 1.41$ $30/22 = 1.36$ etc</p> <p>ALLOW use of calculated constant from one pair of data values to show that it does not work with another pair of data values e.g., $22/14 = 1.57$ and $48 \div 1.57 \neq 30$ ALLOW use of vertical ratios e.g., $48/34 = 1.4$ but $30/22 = 1.36$ etc</p> <p><u>Examiner's Comments</u></p>

					<p>Many students demonstrated a lack of understanding of how to show if two variables are directly proportional to each other. These candidates often had the misconception that if the differences between corresponding values were not constant, then the variables were not in direct proportion.</p> <p>To gain credit, candidates could have:</p> <ul style="list-style-type: none"> calculated a ratio from one pair of data values and shown that this was not the same as the ratio calculated from another pair of data values found the multiple for one pair of data values and then shown that this would not work for another pair of data values shown that if the angle of incidence was multiplied by a factor, then the angle of refraction was not multiplied by the same factor. <p> Assessment for learning</p> <p>Candidates should note that they must evaluate the ratios, rather than expressing them as fractions with different denominators.</p>
	d		<p>(Green and red light have) different wavelengths/frequencies ✓</p> <p>(Idea that) the amount the speed changes (in glass) is different for each colour ✓</p>	<p>2 AO 2 × 1.1</p>	<p>ALLOW red light has longer wavelength/smaller frequency / ORA</p> <p>DO NOT ALLOW red light has shorter wavelength/larger frequency / ORA</p> <p>ALLOW red light slows down the least (in glass) / ORA</p> <p>ALLOW speed of red light in glass is larger (than speed of green light)</p> <p>ALLOW speed in glass is different for each colour</p>

					<p>DO NOT ALLOW speed of red light in glass is smaller (than speed of green light) / ORA</p> <p><u>Examiner's Comments</u></p> <p>Most candidates were able to explain that different colours have different wavelengths/frequencies, although some candidates thought that red light has a shorter wavelength than green light. Only the higher-achieving candidates recognised that the amount the speed changes in glass is different for each colour.</p> <p> Misconception</p> <p>A common misconception was that different colours of light have different speeds in air.</p>
	e		<p>Both rays drawn as straight lines and refract towards principal axis ✓</p> <p>The green ray crosses the principal axis closer to the lens than the red ray ✓</p>	2 AO 1.2 1.1	<p><u>Examiner's Comments</u></p> <p>The vast majority of candidates scored at least 1 mark for showing rays that converged as they passed through the lens. However, a significant number of these candidates incorrectly thought that rays of light would converge and meet at the principal axis.</p>
			Total	13	
2	a		<p>Angle of incidence not equal to angle of reflection (at mirror B/second reflection) / AW ✓</p> <p>Normal line is not at 90° (to surface of mirror B) / AW ✓</p>	2 (2 x AO 1.1)	<p>IGNORE not at correct angle</p> <p>If no other marks scored: ALLOW (second) reflected ray should be parallel to original ray for 1 mark</p> <p><u>Examiner's Comments</u></p> <p>A significant number of candidates could not apply their knowledge of reflection in enough detail to this question. Answers were often too vague, e.g. the normal is at the wrong angle, so did not gain credit.</p>

	b		dust on it/retroreflector ✓	1 (AO 3.2a)	ALLOW it is dirty/dull/scratched/not smooth
			Total	3	
3			A ✓	1 (AO1.2)	<u>Examiner's Comments</u> The most common incorrect answer for this question was option D.
			Total	1	
4			A ✓	1 (AO2.1)	<u>Examiner's Comments</u> Many candidates were unable to use differential absorption and reflection to determine the colour of the object (P5.3).
			Total	1	
5			B ✓	1 (AO1.2)	<u>Examiner's Comments</u> This question required candidates to apply their knowledge of how a light ray refracts as it passes through a glass block. Approximately two thirds of candidates chose the incorrect path.
			Total	1	