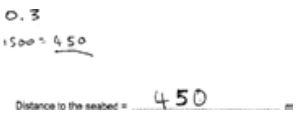
Mark scheme

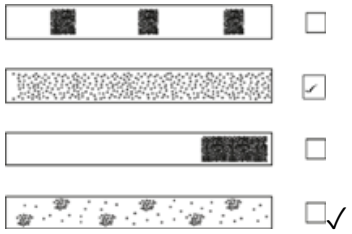
Question			Answer/Indicative content	Marks	Guidance
1	a		Y: normal Z: refracted (ray) ✓	1 (AO 1.2)	**BOTH** answers needed for 1 mark **ALLOW** refraction for refracted **Examiner's Comments** Candidates found this question to be one of the most challenging questions. Few candidates were able to identify Y as the normal, and many candidates could not identify Z as the refracted ray.
	b		**Level 3 (5–6 marks)** Prediction of the results AND a detailed method / diagram OR Detailed prediction of results AND a basic method / diagram *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Prediction of the results AND a basic (workable) method / diagram. OR Detailed prediction of the results OR Detailed method / diagram. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** A basic prediction OR a basic	6 (2 × AO 1.1) (4 × AO 3.3a)	**AO1.2 – Demonstrate knowledge and understanding of ray diagrams and reflection** • Prediction made e.g., both angles are equal • Angle of incidence = angle of reflection • Law of reflection mentioned for all angles • Marks can be awarded from labelled diagram showing the mirror with the normal, angle of incidence and angle of reflection • As i increase r increases **AO3.3a – Analyse information and ideas to develop experimental procedures** • Use of a darkened room

			(workable) method / diagram. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 mark** *No response or no response worthy of credit.*		• Use ray box (and slit) to produce ray of light. • Place mirror onto paper • Draw position of mirror • Shine ray of light at mirror • Draw normal at 90 degrees to the mirror • Trace rays by drawing crosses / marks on the paper. • Use ruler to join up crosses / marks • Measure angle between normal and incident ray / angle of incidence • Measure angle between normal and reflected ray / angle of reflection • Repeat for different angles of incidence • Marks can be awarded from labelled diagram **<u>Examiner's Comments</u>** Candidates found this question challenging. Candidates who scored higher marks tended to draw a diagram in the white space before the answer lines. Candidates should be encouraged to follow the bullet points in the question to structure their answers. To answer this question well, candidates needed to draw a diagram showing the position of the mirror and the ray box together with the incident ray, normal and reflected ray marked. The angle of incidence and the angle of reflection should also be indicated on the diagram. Candidates should also have

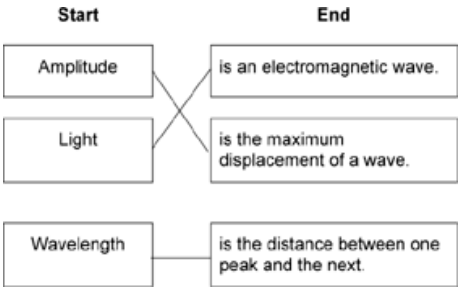
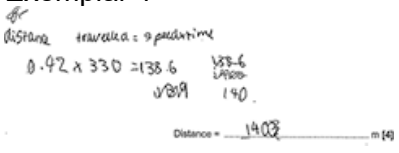
					included a description of how the ray could be drawn, e.g. the use of crosses and using the ruler to join the crosses. Then all that needed to be stated was that the protractor would be used to help in the drawing of the normal at 90° to the mirror and to measure the angle of incidence and angle of reflection. The prediction expected was that the angle of reflection was equal to the angle of incidence. It was also expected that the experiment would be repeated for different angles of incidence. The description of the experiment could also have included the use of a dark room and using a single slit in the ray box. Candidates often gave incorrect answers by drawing inaccurate diagrams often with the mirror drawn in the ray box or the incident ray drawn along the normal. Other answers were vague with little detail of an experiment. **Assessment for learning** Candidates should have the opportunity to write plans of experiments including predictions.
			Total	**7**	
2	a	i	(ultrasound pulse) may reflect off fish or different layers / rocks in seabed or named object in sea ✓	1 (AO 3.2a)	**ALLOW** not smooth (surface of seabed)

					Examiner's Comments There were many vague answers. Some candidates stated that the pulse was just reflected from the seabed without making reference to multiple reflections due to the uneven surface. The common correct answer was part of the pulse was reflected from fish. Examiners expected any additional reflection to be stated from a named object – object on its own did not score.
		ii	**First check the answer on the answer line** **If answer = 450 (m) award 3 marks** Time = 0.3 (s) (to the seabed) ✓ (distance =) 1500 x 0.3 ✓ (distance =) 450 (m) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	**ALLOW** 1500 x 0.6 for 1 mark **ALLOW** 900 (m) for 2 marks **Examiner's Comments** Only a small minority of candidates scored full marks. The common incorrect answer was 900 m, which gained 2 marks. These candidates substituted the data into the given equation and calculated the distance travelled, but this was the distance the pulse travelled from the ship to the seabed and back to the ship. High-scoring candidates clearly showed that the time of 0.6 s was divided by 2 to give 0.3 s, and then used this value in the equation. A few candidates found the total distance the pulse travelled, before dividing by 2. Candidates should be encouraged to show their working.

					Exemplar 2  In this response, the candidate has clearly shown the division by 2. Then the candidate has substituted the data into the given equation to determine the distance to the seabed. Since the equation given does not need to be rearranged, there was no need to write down the given equation. If the equation had needed to be rearranged, then the rearranged equation should be written down in a candidate's answer.
	b		**First check the answer on the answer line** **If answer = 0.66 (m) award 3 marks** (λ =) v ÷ f ✓ (λ =) 330 ÷ 500 ✓ (λ =) 0.66 (m) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	**ALLOW** 1 mark for correct substitution into given equation **<u>Examiner's Comments</u>** The majority of candidates were able to rearrange the equation to give an answer of 0.66 m. Some candidates left the answer as 0.6, which did not gain credit. The common error was just to multiply the two numbers together. A large number of candidates did not show any working. Full marks were still given for a correct answer, but with no working show, an incorrect

					answer could not score any marks. **Assessment for learning** In numerical questions candidates should be encouraged to use the following method: • equation • rearrange the equation • substitute the data • consider the units • calculate the answer • consider the whether the answer looks correct.
	c	i	Longitudinal ✓	1 (AO 1.1)	**Examiner's Comments** Only a small majority of the candidates could correctly state that a sound wave is a longitudinal wave.
		ii		1 (AO 2.1)	**Examiner's Comments** A significant minority of candidates did not identify the second box representing the air particles after the sound wave had passed. This suggests that the candidates need to understand how the particles move as a sound wave passes through the medium. **Misconception** Many candidates chose the third and fourth boxes indicating a lack of

					understanding of the arrangement of particles in a gas.
	d		(frequency) stays the same (velocity) increases (wavelength) increases ✓✓	2 (2 × AO 1.1)	All 3 correct = 2 marks Any 1 or 2 correct = 1 mark **Examiner's Comments** This appeared to be a very challenging question. Many candidates did not realise that the frequency of the sound wave would stay the same. Other candidates did not realise that the velocity of the sound wave increases as it moves into a denser medium and therefore the wavelength would also increase. There was evidence that many candidates guessed the words using all three of words. **Assessment for learning** Candidates should understand how refraction of a wave affects the speed and wavelength of the wave depending on the whether the wave is moving from denser medium to a less dense medium or vice versa. Candidates should also understand that the frequency remains constant.

	e		 ✓✓	2 (2 × AO 1.1)	All 3 correct for 2 marks Any 1 or 2 correct for 1 mark **Examiner's Comments** The majority of candidates knew that light is an electromagnetic wave. A minority of candidates were confused with the definitions for amplitude and wavelength.
			Total	**13**	
3	a		Speed of light is (much) higher than speed of sound **/ AW** ✓	1 (AO1.1)	**Examiner's Comments** The majority of the candidates were able to state that the speed of light is (much) faster than the speed of sound. This question required a comparison.
	b		Longitudinal ✓ Parallel ✓	2 (2 × AO1.1)	**Examiner's Comments** Many candidates did not state that sound waves are **longitudinal** and thus the air particles vibrate **parallel** to the direction of travel.
	c		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 140 (m) award 4 marks** distance travelled = speed × time ✓ (distance travelled =) 330 × 0.42 ✓ (distance travelled =) 138.6 or 139 ✓ (distance travelled =) 140 (m) (to 2sf) ✓	4 (AO1.2) (AO2.1) (AO2.1) (AO1.2)	**Examiner's Comments** The majority of candidates were able to calculate the distance. Of these candidates, just over half were able to correctly round the distance to two significant figures. One common error was the rounding of 138 to 14 (omitting the zero). Exemplar 1  This candidate has

					demonstrated how to respond to a calculation question well. The candidate has written the equation that is to be used (in this case from the data sheet). Then the correct numbers from the question have been substituted. The candidate when reading the question has underlined the numerical data values. Then the candidate has evaluated the equation and written the answer displayed by the calculator 138.6 – this response would have scored the candidate 3 marks. The candidate then correctly rounds the response to two significant figures.
	d		Idea time measured is incorrect ✓ due to child's reaction time / distracted / child hears a different firework / sound cannot be heard clearly / wind may have an effect ✓ OR Idea speed of sound varies ✓ Air is different temperature / density ✓	2 (AO3.2b) (AO3.2a)	**DO NOT ACCEPT** faulty stopwatch **ALLOW** different altitudes **Examiner's Comments** For this question, candidates needed to identify that the distance calculated depended on the time measured and the speed of sound. To gain full marks, candidates needed to identify the quantity that was not accurate and suggest a reason as to why this quantity may have been different.
			Total	**9**	
4		i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 10 (s) award 2 marks** Unit conversion: 1 minute = 60 s ✓ Time period = 60 ÷ 6 = 10 s ✓	2 (AO1.2) (AO2.2)	**ALLOW** one mark for anything that rounds to 0.17 **Examiner's Comments** This question was generally answered well. More successful responses often

					stated that one minute was equal to sixty seconds. Candidates should show their working.
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 4 (m / s) award 3 marks** wave speed = frequency × wavelength ✓ (wave speed =) 0.2 × 20 ✓ (wave speed =) 4 (m / s) ✓	3 (AO1.2) (AO2.1) (AO2.1)	**Examiner's Comments** This question was well answered. However, many candidates stated "4" without any working which is not in keeping with a 3 mark question.
			Total	**5**	
5			B ✓	1 (AO1.1)	**Examiner's Comments** This question tested the idea that sound is reflected from hard surfaces and echoes can be heard.
			Total	**1**	