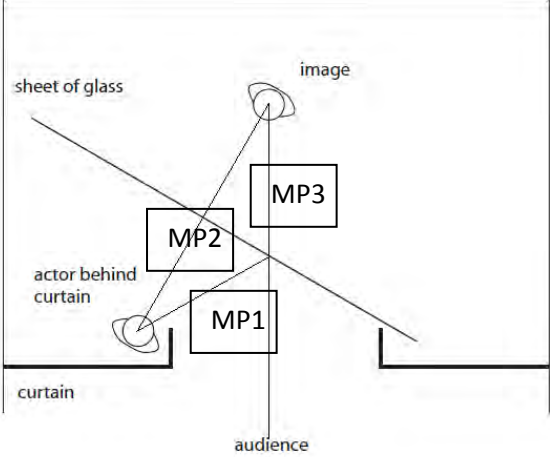
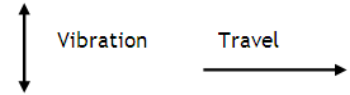



Question number	Answer	Notes	Marks
1 (a)	<p>MP1. Ray <u>reflects</u> correctly (by eye, any ray straight down the page (allow +/- 10°), ignore horizontal displacement);</p> <p>MP2. Normal shown / construction line between actor and image;</p> <p>MP3. Reflected ray projecting back to image;</p>	 <p>not spread out from 1 point for MP1</p>	3
1 (b)	<p>any <b>one</b> from:</p> <p>cannot be formed on a screen/eq ;</p> <p>rays do not actually come from there ;</p> <p>rays {diverge/don't actually cross} after reflection;</p> <p>image formed by extension (backwards) of light rays</p>	<p>ignore</p> <p>what is seen in a mirror</p> <p>not real</p> <p>properties of image in mirror, e.g. inverted, same distance</p>	1

	(c)	(i)	<p>Any suitable example;</p> <p>e. sound, ultrasound, deep water waves</p>	<p>Allow</p> <p>seismic (P-) waves, waves in a (slinky) spring</p>	1
		(ii)	<p>vibrations/oscillations are parallel or perpendicular;</p> <p>To direction of energy transfer/ direction of travel;</p> <p>Correct identification of both types;</p>	<p>allow vibrations up and down for perpendicular vibrations back and forward for parallel Accept suitably labelled diagrams</p> <p>a correct description of either wave = 2 marks</p> <p>e. Transverse:</p>  <p>Longitudinal:</p>  <p>ignore: examples of either type of waves</p> <p>if no other mark, accept descriptions of pressure changes or clear diagram(s) showing compression and rarefaction for 1 mark only</p>	3

Total 8 marks

Question number		Answer	Notes	Marks
2	(a)	<p>MP1. Substitution into correct equation;</p> <p>MP2. Rearrangement;</p> <p>MP3. Divide by 2;</p> <p>MP4. Conversion between km and m;</p> <p>e.</p> <p><math>1.5 \times 1000 = 1500</math></p> <p>Speed = <math>\frac{\text{distance}}{0.26}</math></p> <p>Distance = <math>1500 \times 0.26 = 390</math> (m)</p> <p>So distance to fish = 195 m</p>	<p>Accept <math>\times 1000</math> at any point in calculation</p> <p>0.39 gets 2 marks</p> <p>390 gets 3 marks</p>	4
	(b)	<p>Any <b>two</b> of</p> <p>MP1. Reflected from different depths within shoal;</p> <p>MP2. So (reflected pulse(s)) travels different distances;</p> <p>MP3. Fish move;</p> <p>MP4. Reflection from sea bed;</p>		2

Total 6 marks

Question number	Answer	Notes	Marks
3 (a) (i) (ii)	<p>Equal to</p> <p>Any TWO of -</p> <p>Rays continued and reflected correctly from mirror;</p> <p>Projected back behind mirror (to reasonably the right place)</p> <p>Line perpendicular to the mirror joining object and image positions (roughly equal distances in front and behind);</p>	<p>Judged by eye to be <math>i = r</math> rays should diverge after reflection</p> <p>Judged by eye</p> <p>ACCEPT (for the second mark) projection back to image even if reflected rays not drawn in front of the mirror</p> <p>Rays do not need to have arrows</p> <p>Dotted lines not required behind mirror</p> <p>Image does not have to be labelled</p> <p>Accept dotted lines in front of mirror if meaning is clear</p> <p>Use of ruler not essential, but candidates will find it difficult to draw a convincing diagram freehand</p>	1 2
(iii)	'rays do not actually meet at the image'		1

Question Number	Answer		Marks
3 (b) (i)	Added to diagram - Reflection inside fibre; At least three (with reasonable angles);	Continuous path shown inside fibre	1  1
	(ii)	Must be more (optically) dense to less (optically) dense change; Angle of incidence > critical angle;	IGNORE angle of incidence = critical angle DO NOT ALLOW angle of incidence greater than $42^\circ$  1
	(iii)	Any ONE sensible point – e.g. Less prone to noise; less prone to heating; send more information (per second); more data (per second);	IGNORE references to cost IGNORE references to speed  1
		<b>Total</b>	<b>9</b>

Question number	Answer	Notes	Marks
4 (a)	change in direction of waves at a boundary	ALLOW change in speed ALLOW idea of 'boundary' such as changing medium, or examples such as 'going from air into a glass block'	1
(b)	correct label for $i$  correct label for $r$	ALLOW labels written out in full as "incidence" or "angle of incidence" etc  REJECT if angles are the wrong way around	2
(c) (i)	refractive index = $\sin i / \sin r$	ALLOW 'n' for refractive index  REJECT speed in 1/speed in 2	1
(ii)	Method max 4 marks: draw around block; mark positions of incident and emergent rays; (remove block and) draw refracted ray; measure $i$ ; measure $r$ ; measure angle(s) to the normal; range of values;  Data max 2 marks: (graph of) $\sin i$ against $\sin r$ ; graph is straight line; DOP gradient gives refractive index; DOP	Accept pin or pencil method  Ignore mention of protractor  i.e. different values of $i$ not just repeating	MAX 6

Question number	Answer	Notes	Marks									
5 (a)	ANY THREE vibration / oscillation of (air) molecules / particles; longitudinal; directions of vibration and propagation are parallel; compression / rarefaction / pressure wave;	need to include what is vibrating  no need to mention molecules / particles	3									
(b) (i)	0.01 s	ALLOW 2 s.f. / 2 sig figs / 2 significant figures	1									
(ii)	speed = distance / time	ACCEPT equivalent rearrangement ACCEPT suitable abbreviations e.g. $s = d/t$ or $v = s/t$ REJECT equation 'triangles' alone	1									
(iii)	<table border="1"> <thead> <tr> <th>Student</th> <th>Mean time in s</th> <th>Speed of Sound in m/s</th> </tr> </thead> <tbody> <tr> <td>Andrew</td> <td>0.45</td> <td>330</td> </tr> <tr> <td>Keefe</td> <td>0.5</td> <td>300</td> </tr> </tbody> </table>	Student	Mean time in s	Speed of Sound in m/s	Andrew	0.45	330	Keefe	0.5	300	1 mark each correct COLUMN (ignoring sf);; mean time values as shown in mark scheme speed = 150/mean time (allow ecf)  1 mark for all significant figures correct; (i.e. 2 s.f. in first row, 1 s.f. in second row)	3
Student	Mean time in s	Speed of Sound in m/s										
Andrew	0.45	330										
Keefe	0.5	300										

Question number	Answer	Notes	Marks
5 (c)	ANY 5 relevant points, e.g. Explanation of what reaction time is; Reaction time affects readings / reaction time does matter; Reaction times vary; Reaction times do not cancel out; Reaction time should be considered / allowed for; Kefe is right (about reaction times); reaction time typically at least 0.1 s; which is large compared to measured times / large % error; time should only be to 1 s.f.; so final value should also be to 1 s.f. / Kefe's value more suitable; 3 s.f. inappropriate; closer to accepted value does not mean more accurate;	Answers should ideally relate to how <i>appropriate</i> the precision of the measurements was, linking this to the number of significant figures merited  Consideration of reaction time and its measurement may score a number of marks	MAX 5



Question number	Answer	Notes	Marks
6 (a) (i)	(cm)		1
(b)	<p>(ii) Sketched wave (at least 1 cycle) with a larger amplitude;</p> <p>Sketched wave (at least 1 cycle) with a longer wavelength;</p> <p>Any five of -</p> <p>MP1. A method to make a loud enough sound;</p> <p>MP2. Speed = <math>\frac{\text{distance}}{\text{time}}</math>;</p> <p>MP3. Need for still air;</p> <p>MP4. Repeat AND average;</p> <p>MP5. Need to check/reset stopwatch zero reading;</p> <p>MP6. Idea of clear visual signal;</p> <p>MP7. measurement of time <b>interval</b> (between visual signal and sound);</p> <p>MP8. Idea of reaction time(s) (could be a problem);</p>	<p>Shape of wave and position of axis unimportant (i.e. ignore conditions of wind and tide)</p> <p>ignore measurement of distance bald 'clap'</p> <ul style="list-style-type: none"> <li>• wooden blocks</li> <li>• noise has to heard over 100m</li> </ul> <p>RA allow repeat AND sort out anomalies</p> <p>e.</p> <ul style="list-style-type: none"> <li>• when the sound is seen to be made</li> <li>• smoke from starting pistol (because) light travels faster than sound</li> </ul>	2
			5

Continued

Question number	Answer	Notes	Marks
6 (c) (i) cont	wave speed = frequency $\times$ wavelength	Allow abbreviations and rearrangements, e.g. $v=f\lambda$	1
(ii)	Conversion to Hz;  Substitution into correct equation and rearrangement; Evaluation; e.g. 31 MHz = 31 000 000 Hz wavelength = 300 000 000 $\div$ 31 000 000 9.7 m	Allow $10^6$ seen at any stage  allow answers which round to 9.7 (9.6774)	3
(d)	Any one of the following ideas -  MP1. the two waves travel at different speeds; MP2. the two waves travel the same distance (or 1 wavelength) in different times;	ignore references to <ul style="list-style-type: none"> <li>• transverse and longitudinal</li> <li>• em spectrum</li> </ul>	1

Total 13 marks