

Light and Sound

Mark Scheme 1

Level	IGCSE(9-1)
Subject	Physics
Exam Board	Edexcel IGCSE
Module	Double Award (Paper 1P)
Topic	Waves
Sub-Topic	Light and Sound
Booklet	Mark Scheme 1

Time Allowed: 75 minutes

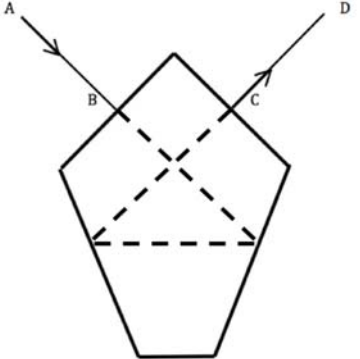
Score: /62

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	77.5%	70%	60%	55%	50%	<50%

Question number	Answer	Notes	Marks												
1 (a)	<p>3 or more correct lines = 2 marks Any two correct lines = 1 mark</p> <table border="1" data-bbox="430 587 1024 1367"> <thead> <tr> <th data-bbox="430 587 861 699">Notes about the total internal reflection of light</th> <th data-bbox="861 587 1024 699">Right or wrong</th> </tr> </thead> <tbody> <tr> <td data-bbox="430 699 861 841">the angle of incidence equals the angle of reflection</td> <td data-bbox="861 699 1024 841">✓</td> </tr> <tr> <td data-bbox="430 841 861 943">light changes speed when it is internally reflected</td> <td data-bbox="861 841 1024 943">x</td> </tr> <tr> <td data-bbox="430 943 861 1122">every ray entering the semicircular glass block is reflected by total internal reflection</td> <td data-bbox="861 943 1024 1122">x</td> </tr> <tr> <td data-bbox="430 1122 861 1224">if $i = 0$ then the ray does not deviate</td> <td data-bbox="861 1122 1024 1224">✓</td> </tr> <tr> <td data-bbox="430 1224 861 1367">the refractive index of glass is bigger than the refractive index of air</td> <td data-bbox="861 1224 1024 1367">✓</td> </tr> </tbody> </table>	Notes about the total internal reflection of light	Right or wrong	the angle of incidence equals the angle of reflection	✓	light changes speed when it is internally reflected	x	every ray entering the semicircular glass block is reflected by total internal reflection	x	if $i = 0$ then the ray does not deviate	✓	the refractive index of glass is bigger than the refractive index of air	✓		2
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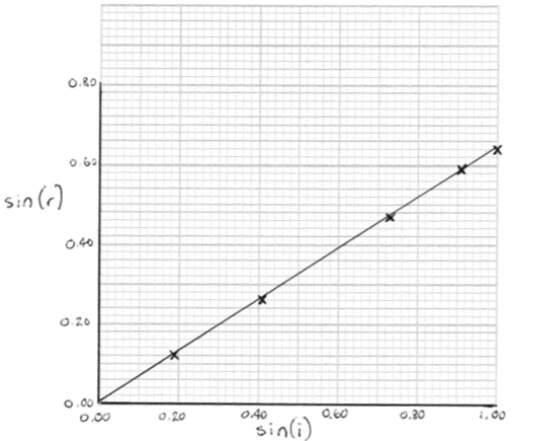
<p>(b)</p>	<p>MP1 only two internal reflections attempted; MP2 horizontal line from first TIR to second TIR; MP3 ray does not deviate on exit;</p>  <p>The diagram shows a pentagonal prism. An incident ray labeled 'A' enters the top-left face at point 'B'. It reflects off the top-right face at point 'C' and then off the bottom-left face. A dashed line represents the ray's path after the second reflection, extending horizontally to the bottom-right face. A final ray labeled 'D' exits the prism from the top-right face. The prism is oriented with its top edge horizontal.</p>	<p>horizontal line by eye ignore arrows</p>	<p>3</p>
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Question number	Answer	Notes	Marks
1 (c) (i)	<p>Statement of $\sin c = 1/n$; Substitution; Calculation;</p> <p>e.g. $\sin c = 1/n$worth 1 $\sin c = 1/1.5$.....worth 2 (= 0.667) so $c = 41.8^\circ$worth 3</p>	<p>Value of c (or n) to at least 3 s.f.</p> <p>Allow reverse argument for max 2. $\sin 42^\circ = 0.669$, giving $n = 1.49$ ("about 1.5") $\sin 42 \times 1.5 = 1.0036 \approx 1$ ($\sin 42 = 1/1.5$) Beware spurious maths that gives about 42 degrees</p> <p>allow</p> <p>$n = \text{speed}_1 / \text{speed}_2$ $n = 1 / \sin c$</p> <p>proportion for ratio</p> <p>units cancel out</p>	3
(ii)	<p>Any two of the following ideas:-</p> <ul style="list-style-type: none"> • $n = \sin i / \sin r$ • n is (only) a <u>number /ratio</u>; • a sine is a number /ratio; 		2

(d)	(i)	Plot at 1.5, 42;	no tolerance	1
	(ii)	Any one of - Fits the trend/pattern; (point is on) an extrapolation of line to;	May be shown on graph OR e.g. "where the line would go"	1
	(iii)	Any two of - MP1. Idea that a reduced scale gives full(er) use of grid; MP2. RI is always more than 1 (for incidence in air) MP3. angle c greater than $\sim 20^\circ$;	allow reduced scale fits the data ranges (of RI or c) ignore RI >0 allow angle c never zero	2

Total 14 marks

Question number	Answer	Notes	Marks
2 (a)	any three from: paper / pen / pencil; protractor; ruler / straight edge; light source (& power supply); (optical) pins;	allow cork board ignore unqualified 'light' allow needles	3
(b) (i)	line drawn at P at 90° to the flat surface;	judge by eye	1
(ii)	41($^\circ$); 21($^\circ$);	tolerance +/- 3° no ECF	2
(iii)	change of medium / eq; change in speed / wavelength;	allow change of refractive index / (optical) density ignore changes direction reject second mark if contradiction seen	2

<p>(c) (i)</p>	<p>label on both axes; scale on both axes; plotting;;</p> 	<p>ignore orientation ignore any units linear scale using $\geq 50\%$ of the grid tolerance is ± 0.5 square -1 for each error</p> <table border="1" data-bbox="989 505 1264 773"> <thead> <tr> <th>$\sin i$</th> <th>$\sin r$</th> </tr> </thead> <tbody> <tr> <td>0.19</td> <td>0.12</td> </tr> <tr> <td>0.41</td> <td>0.26</td> </tr> <tr> <td>0.73</td> <td>0.47</td> </tr> <tr> <td>0.91</td> <td>0.59</td> </tr> <tr> <td>1.00</td> <td>0.64</td> </tr> </tbody> </table>	$\sin i$	$\sin r$	0.19	0.12	0.41	0.26	0.73	0.47	0.91	0.59	1.00	0.64	<p>4</p>
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0.19	0.12														
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<p>(ii)</p>	<p>straight line of best fit (towards zero);</p>	<p>points should be evenly distributed about the line</p>	<p>1</p>												
<p>(iii)</p>	<p>$n = \sin i \div \sin r$</p>	<p>accept sine for sin</p>	<p>1</p>												
<p>(iv)</p>	<p>correct use of data from graph or table seen; value in range 1.54-1.60;</p>	<p>total marks = 16</p>	<p>2</p>												

Question number	Answer	Notes	Marks
3 (a) (i)	Any two of - MP1. Idea that the reflection is (from a surface) inside the material; MP2. Idea that all of the light is reflected; MP3. Idea that reflection occurs inside the optically more dense medium; MP4. light incident at angle greater than critical angle	NB do not credit repeat of 'totally', 'internally' within Allow inside the higher refractive index medium	2
	(ii) Any two sensible uses – e. <ul style="list-style-type: none"> • optical fibres for communication; • in endoscopes; • optical fibres in decorative lamps/eq; • in safety reflector; • (Rectifying) prism in binoculars/telescope; • (Viewing) prism in camera; • (Reflecting) prism in periscope; • (Reflecting) prism in rangefinder; 	allow only allow bald 'optical fibre' if no other O.F. mark given description of use e.g bicycle/car reflector, cat's eye	2

(b)	(i)	B - OB		1
	(ii)	$\sin c = 1/n$	Allow rearrangements and abbreviations μ for n condone $\sin i$ for $\sin c$	1
	(iii)	Substitution and rearrangement in correct equation; Evaluation; e.g. $n = 1/\sin 42^\circ = 1/0.6691$ $n = 1.5$	1.49, 1.50 (1.4945)	2

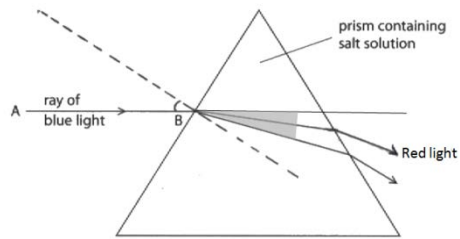
Total 8 marks

Question number	Answer	Notes	Marks
4 (a) (i)	D refraction;		1
(ii)	any 2 of: MP1. waves slow down ; MP2. waves change direction/bend/angle; MP3. wavelength decreases ;	allow 'light' for waves do not allow 'curved' allow wavefronts closer together	2
(b) (i)	line at 90° to the surface at point of contact;	judge by eye label not required	1
(ii)	angle between normal and incident ray clearly indicated;	allow ecf from normal line drawn in (b)(i) allow measured value in degrees	1

Total 5 marks

Question number	Answer	Notes	Marks
5 (a) (i)	change of direction of a wave (as it changes from 1 medium to another);	allow definition in terms of change of speed condone 'bending of light'	1
(ii)	MP1. right angle by eye; MP2. incident angle marked; MP3. incident angle value in range 31° to 34° ;	allow normal labelled with right angle (90° or symbol) Give 2 marks (MP2 and MP3) for answer in range without a marked incident angle	3

iii



MP1. $r_r > r_b$;

MP2. $r_r < i$;

MP3. less refraction than for blue light on emergence;

red line above blue line
inside prism
refraction at first surface
(inside grey area)

exit rays diverge
downwards

3

iv	what happens inside the prism ONE mark from:- MP1. (blue light will) refract more (at the first surface); MP2. it will be nearer the normal; MP3. 'r' will be smaller; what happens on emergence:- ONE mark from:- MP4. it will bend even more; MP5. so larger deviation than previously;	allow for MP1 it will go slower;	2
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Question number	Answer	Notes	Marks														
5 b i	<div data-bbox="430 370 882 730" data-label="Figure"> </div> <table border="1" data-bbox="382 751 768 1076"> <thead> <tr> <th>Sugar concentration (%)</th> <th>Refractometer reading</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>48</td> </tr> <tr> <td>10</td> <td>60</td> </tr> <tr> <td>30</td> <td>57</td> </tr> <tr> <td>50</td> <td>69</td> </tr> <tr> <td>70</td> <td>86</td> </tr> <tr> <td>90</td> <td>108</td> </tr> </tbody> </table> <p data-bbox="373 1084 1470 1258"> axes labelled with units; scales correct and linear to cover at least half the grid on one of the axes; points;; (-1 for each incorrect point to a maximum of 2) curve of best fit drawn; </p>	Sugar concentration (%)	Refractometer reading	0	48	10	60	30	57	50	69	70	86	90	108		5
Sugar concentration (%)	Refractometer reading																
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(ii)	point 10, 60 circled; (10,)50;	allow 49-52	1 1 1
(iii)	63 / ans from candidates graph;	ans in range 62-66	
(iv)	Any two from <ul style="list-style-type: none"> • pattern sentence / positive correlation / positive slope; • gradient changes/nonlinearity discussed; • not through the origin; 	as one increases the other increases allow <ul style="list-style-type: none"> • refractometer readings increase faster than % sugar concentration • attempted mathematical description e.g. exponential or similar 	2

(Total for Question 5 = 19 marks)