

# Commentary on candidate evidence

## Candidate 1 – Measuring the Refractive Index

The evidence for this candidate has achieved the following marks for each section of this course assessment component.

Section	Mark available	Mark awarded	Comments
1 Abstract	1	0	<p>The candidate has stated an aim to compare and evaluate methods.</p> <p>Methods 1 and 2 were identified satisfactorily (<i>concave mirror</i> and <i>travelling microscope</i>), but method 3 was not clear.</p> <p>The medium for which the refractive index was measured was not clear in methods 1 and 3.</p> <p>The candidate has not stated any findings of the project in terms of the aim (to compare and evaluate methods).</p>
2 Underlying physics	4	2	<p>The candidate's description of Snell's law on pages 3 and 4 is not at Advanced Higher level.</p> <p>In the underlying physics at the start of each procedure, the candidate has stated relationships used, defined symbols and attempted justification.</p> <p>On page 6 however the angles <math>i</math> and <math>r</math> are not defined in the diagram as <i>angles QC'A</i> and <i>QCA</i> respectively.</p> <p>On pages 12 and 13, <math>n_a</math> and <math>n_g</math> are not defined and the <math>n_g = 1/n_a</math> relationship is incorrect.</p> <p>On page 21, angle C is not defined, and the lack of definition of <math>n_a</math>, <math>n_l</math> and <math>n_g</math> make the logic difficult to follow.</p>

Section	Mark available		Mark awarded	Comments
				These slips and omissions above suggest that a complete understanding is not being demonstrated.
3 Procedures	a	2	2	<p>The labelled diagram on page 7 is theoretical and misses the logistical detail necessary for easy replication.</p> <p>The labelled photographs on pages 13 and 21 are acceptable, showing the details necessary for replication.</p> <p>Overall, the diagrams and description of the apparatus was judged just sufficient for both marks.</p>
	b	2	1	<p>The descriptions of the procedures was written in <i>present</i> tense, impersonal voice, rather than <i>past</i> tense. Therefore, the maximum mark for this section is 1 mark.</p> <p>The descriptions are adequate for replication, although the number of repeats are not included.</p>
	c	3	2	<p>The candidate has completed three different procedures which are commensurate with Advanced Higher level, and which are original to the candidate. The candidate has not made repeated measurements for method 1, but has included a range of mirrors of different radius of curvature. The candidate has made a small number of repeated measurements for methods 2 and 3. A greater number of repeats may have been beneficial. In addition, the candidate could have used a range of values for method 2.</p> <p>It was felt, however, that the collection of data from the three procedures would not take 10 hours lab time.</p>

Section	Mark available		Mark awarded	Comments
4 Results (including uncertainties)	a	1	1	The candidate's data is relevant to the aim of the project. The candidate has repeated some measurements, and included all raw data. Repeating the measurements made in method 1 would have benefitted the project.
	b	4	1	<p>A 'refractive index' project should allow the candidate to analyse results graphically. The candidate has chosen a method (method 3), which does not lend itself to graphical analysis. In addition, the candidate has not used graphical analysis for methods 1 and 2, when it would be possible to do so.</p> <p>The bar graphs on pages 9 and 16 do not contribute to the project.</p> <p>On page 15, the candidate has used invalid averaging to determine the values of the refractive index.</p> <p>The candidate has however shown sample calculations for each procedure, with a small number of slips.</p> <p>Given the lack of appropriate graphical analysis, a higher mark is not possible.</p>
	c	3	1	<p>The candidate has shown a limited awareness of calibration, scale reading and random uncertainties. Random uncertainty is missing from two of the procedures due to lack of repeats (method 1) and lack of variation in measurements (method 3).</p> <p>There are some invalid calculations of random uncertainty, but there has been an attempt to combine uncertainties appropriately.</p>

Section	Mark available		Mark awarded	Comments
5 Discussion (conclusion(s) and evaluation)	a	1	1	<p>The candidate has conclusions for each of the procedures and for the overall project, which are supported by the experimental data.</p> <p>The lack of definitive final values is due to poor analysis.</p>
	b	3	0	<p>The evaluations of methods 2 and 3 are weak, with little quality reflection on sources of uncertainty or of adequacy of range or number of repeats.</p> <p>The evaluation of method 1 comments on the difficulty of measuring length and suggests a possible improvement, which could have been implemented, but wasn't.</p> <p>Overall, the evaluations are not of sufficient quality to be awarded a mark.</p>
	c	3	1	<p>There are no comments on the planning of the project, the selection of procedures, problems encountered during planning or any required modifications to planned procedures.</p> <p>The overall evaluation is not of high quality, but the candidate has made a suggestion for further work and, in the conclusions of each procedure, made a comparison of the results with accepted values.</p>
	d	1	0	<p>The candidate's report does not indicate a good, competent project, well-worked through.</p>
6 Presentation	a	1	1	<p>The report structure is easy to follow, with an informative title, contents page and page numbers.</p>
	b	1	0	<p>The candidate has included references to at least three sources</p>

Section	Mark available		Mark awarded	Comments
				<p>of information. The references are cited in the report and listed at the end of the report, but not all are in acceptable Harvard or Vancouver systems.</p> <p>Note that 'Tyler F, A Laboratory Manual of Physics ...' is cited three times, and listed in an acceptable form but counts as one source.</p>
<b>Total</b>	<b>30</b>		<b>13</b>	

## Candidate 2 – Speed of Light

The evidence for this candidate has achieved the following marks for each section of this course assessment component.

Section	Mark available		Mark awarded	Comments
1 Abstract	1		1	<p>The aim is clearly stated. Each experiment is named, and the result of each experiment clear.</p> <p>The experiments listed give information about the methods used.</p>
2 Underlying physics	4		1	<p>The candidate has given an account of the historical background to the measurement of the speed of light on pages 4-6. This is well written and interesting, but does not contribute to the demonstration of understanding of the physics underlying the project. In addition, the Lorentz relationships, Schwarzschild radius and red shift are only obliquely connected to the project.</p> <p>The relevant relationships however have been quoted (page 7) and the symbols defined, but not justified. This merits 1 mark.</p>
3 Procedures	a	2	1	<p>The candidate has a hand drawn diagram on page 9, which is not fully labelled. From this it would be difficult for an Advanced Higher Physics candidate to replicate the procedure.</p> <p>The circuit diagrams on pages 13 and 16 also lack the detail, such as the values of components, necessary for replication. The inclusion of labelled photographs may have helped.</p> <p>Overall, the diagrams and descriptions of the apparatus give some information, but were judged</p>

Section	Mark available		Mark awarded	Comments
				insufficient for straightforward replication.
	b	2	0	<p>The descriptions of the procedures were written in present tense, impersonal voice, rather than past tense.</p> <p>In addition, the candidate's description of procedures is not sufficient for straightforward replication (for example, the lack of clarity of 'paper weight' on page 9 and lack of detail about the variation and measurement of spacing on page 16). There is also a lack of information on the range and interval of the independent variable in each of the procedures.</p>
	c	3	3	The candidate has completed three procedures, which are commensurate with Advanced Higher level, and which are original to the candidate. With the repeated measurements and the ranges used, the collection of data from the three procedures would take at least 10-15 hours lab time.
4 Results (including uncertainties)	a	1	1	The candidate's data is relevant to the aim of the project. The candidate has repeated measurements, and included all raw data.
	b	4	3	<p>The candidate has analysed the data graphically, with LINEST used, with 'data box', to find gradients and uncertainties.</p> <p>Calculations are clearly shown with few slips.</p> <p>However, the graphs are small, with large data points. In addition, the calculation of <math>A</math> (area of overlap) on</p>

Section	Mark available		Mark awarded	Comments
				<p>page 17, has been doubled inappropriately.</p> <p>Overall, the candidate has given a reasonably good analysis of the experimental data.</p>
	c	3	3	<p>The candidate has shown an awareness of calibration, scale reading and random uncertainties. The uncertainties have been combined appropriately with few slips in the majority of cases, although sample calculations were not shown. There is an issue with the determination of the uncertainty in quantities raised to a power (pages 10 and 20).</p> <p>Although not perfect, overall the uncertainties treatment is sound.</p>
5 Discussion (conclusion(s) and evaluation)	a	1	1	The candidate has a conclusion for each of the procedures, which is supported by the experimental data.
	b	3	1	<p>For each procedure, the candidate has commented on the limitations of equipment, on possible improvements and on sources of uncertainty.</p> <p>There is however some repetition, and the candidate is inconsistent in the use of <i>precision</i> and <i>accuracy</i>. In addition, the systematic uncertainty in the first procedure is not addressed (page 12), and the dominant uncertainty in the third procedure (page 19) is not recognised.</p>
	c	3	1	The candidate's overall evaluation on page 21 is brief and lacks focus. In addition, there are no comments on the planning of the project, the selection of procedures, problems encountered during planning or any

Section	Mark available		Mark awarded	Comments
				<p>required modifications to planned procedures.</p> <p>Part of the evaluations of individual procedures however covers a comparison of measurements with accepted values.</p>
	d	1	1	The candidate has produced a report which indicates a good, competent project, well worked through.
6 Presentation	a	1	1	The report is easy to follow, with an informative title, contents page and page numbers.
	b	1	1	The candidate has included references to at least three sources of information. The references are cited in the report and listed at the end of the report in acceptable Harvard form.
<b>Total</b>	<b>30</b>		<b>19</b>	