IMTA observations on Certificate Maths papers 2016

Preamble

The Irish Mathematics Teachers' Association has considered the 2016 certificate examinations in our subject and we welcome the marked improvements at Leaving Certificate Ordinary Level this year. The feedback from Leaving Certificate students and teachers has been very positive due to the presence of scaffolding in examination questions which served to make them more accessible for students and provided a wholly positive experience for the students concerned. It is felt that the Junior Certificate Higher Level papers, particularly paper 1, would have benefitted from the same kind of scaffolding and a greater effort should be made to ensure that the examination is less intimidating for students in future.

We feel the following should be noted:

- Students spend a lot of time learning off proofs at LCHL. There should be a question each year where such work is rewarded by being asked to prove something.

- LCHL Paper 1 was laden with material on algebra and in particular logarithms. Greater balance should be aspired to so as not to overly penalise students that struggle with this material. A question on financial maths could have been included instead of one of the questions on logarithms.

- Weaker students in particular, expect to see an opportunity to use the Quadratic formula and gain some marks.

- Applied Maths and Physics students are gaining an advantage at LC level due to the nature of the papers. The papers should strive for parity and no one group should have an advantage over another.

- We were concerned to see pre-Calculus material on JCHL Paper 1. This is very unfair and not in the spirit of what is reasonable to expect when one studies the syllabus.

- There appears to be a trend towards 'in jokes' at Junior Certificate this year, which is proving unhelpful. It is unlikely that this cohort will appreciate John and Yoko on JCHL Paper 1 and the smiley face ☺ or emoji on both JCOL Paper 1 and JCFL actually served to confuse students.

- The replication of questions between all papers at Junior Certificate is worrying. There should be a notable difference between questions at HL, OL and FL. Students may feel hard done by at ordinary level or foundation level and less challenged at higher level. It is not a good reflection on how students will progress as the LC syllabus is far more advanced.

- The time allocations at JCHL have often been inaccurate, severely underestimating the amount of work involved for the average student. It is very important to take into account the amount of thought that some of these questions require.

- The use of the bold emphasis of key words is very beneficial to students at Junior Certificate. It would be helpful for this to be extended to LC FL in order to assist students with navigating the paper.

- We acknowledge the effort that has been made to keep questions on the same page. This has benefitted students with the organization of their workings and we feel that they will be less likely to encounter issues like misreading as a result. However, there is a down side to this in terms of spacing. We note that spacing has been limited at all levels, with very little extra pages available to students at the end of the exam papers at Junior Certificate. The scale on graphs has not been user-friendly at times. The spacing provided for the graphs has also been very limited at times which could impact on students' work.

- We are worried about the use of the 'B scale' in the marking schemes where a possible (0, 2 or 5) marks or (0, 5 or 10) marks are awarded. It has been observed that students can be harshly punished for any small slip or mistake. There is huge fall from 100% to a mark equivalent to 40% or 50% where the student has made a minor error. It would be fairer if the B scale was used as little as possible or if the -1 slip fault was reintroduced to marking schemes.

	Paper 1 Higher – Leaving Cert
	• It was felt that this was a nice, fair paper. • It is beneficial to students to have formula included in a number of questions. • A lot of students would have been disappointed with the absence of financial maths. • Pupils would have had sufficient time to complete this paper. • Part A was straightforward testing a range of skills. • Section B was more challenging but fair. • The balanced division of marks for Section B (40, 55, 55) is welcomed. • It was felt that the paper was algebra heavy while there was little integration present. • Students would need to be very comfortable with logarithms, appearing in 4 questions.
1	Nice introductory question, straight forward complex number question which should be accessible by most candidates. Weaker students might have problems with (c).
2	Fair, this should have assisted students with settling into the examination.
3	Grid provided was small and would present difficulty in plotting the points accurately.
4	Fair question, should be accessible to most candidates.
5	For part (b), the syllabus states that a student should 'recognise an injective function'. The question asks students to 'show' that $f(x) = 3x-2$ is injective. Most students will recognise a linear function and define an injective function.
6	Fair question, should be accessible to most candidates.
7	The language is easy to interpret, this is welcomed. A fair question, that should be accessible to most candidates.
8	Grid 1 may have given rise to confusion with the starting position of the 'centre of the ball'. It is felt that parts a (i) was appropriate but there are some concerns about parts (a) (ii) and (a) (iii). With part (a) (ii), a number of students reported that they found this confusing and were not sure as to what was meant by 'acute angle to the horizontal'. In relation to part (a) (iii), the 'parabola' $g(x)$ did not look like a translation as it only shows a section of $f(x)$. Some students would be thrown when asked to find the equation of a parabola.
9	Students reported struggling with this question. For part (a) (iii), students found completing the table difficult and the inclusion of the alternate 0 would be unfamiliar. The alternate sign also added to the difficulty of the question. For stronger students who recognised the omission of the 0 when summing to infinity this would have been a reasonable question. For part (b) it was felt that the diagram was poorly presented, the excel type grid was off putting.

Paper 2 Higher – Leaving Cert	
• Students felt that this was a more challenging paper than paper 1. • The language was, by and large, very accessible for students. • It might be beneficial to weaker students to have more than two parts to questions. • Questions 3 and 4 were two of the more difficult questions and it would have been helpful to the students if they were not occurring together. • Students found Section B more straightforward than Section A in general. • The balanced division of marks for Section B (55, 45, 50) is welcomed.	
1	It was nice to see the students assisted with recalling how to find the orthocentre. In relation to the diagram, the fact that the orthocentre is not visible from the part of the graph shown may have confused some students.
2	Part (b) would require thought and students reported that it was difficult. As there are only 2 parts to this question, ensuring a good spread of marks may be problematic.
3	Again only 2 parts to the question would mean that students that struggled with either part are potentially throwing away a lot of marks. If the question was broken into 4 parts, it would have given them a chance to gain marks.
4	Students struggled with part (a) as they found it difficult to start it. This was due to the fact that students needed to spot that they needed to work on the triangle ADC which was not mentioned in the question. The construction was fair but students found it problematic. This is because many students who could have performed the construction would have been excluded from doing so because it relied on the answer from part (a).
5	Fair question, should be accessible to most candidates, although a little wordy.
6	Fair question, should be accessible to most candidates.
7	It was felt that this question was straightforward but that the diagram was poor. Perhaps some shading, a net or more than one perspective might have been more beneficial.
8	Fair question, should be accessible to most candidates.
9	Fair question, should be accessible to most candidates.

Paper 1 Ordinary – Leaving Cert	
• It was felt that this paper appears to have been 'rebalanced' with appropriate scaffolding to reflect the cohort of students now taking this option. • The overall impression from students is that it was a nice, fair paper. • A lot of arithmetic in evidence. • Very little calculus for those that invested time in it. • There was no opportunity to use the quadratic formula.	
1	Weaker students would find part (b) difficult as they would not link the information in part (a) so as to use it in part (b). With part (c), 'time and a half' confused some students – some reported that they were uncertain as to whether the delivery was also at a time and a half.
2	For part (c), weaker students might not recognise and find the modulus successfully.
3	In part (b), weaker students would be unlikely to recognise the question as involving simultaneous equations. It is noted that HL Paper 1 Q2 (b) used the words 'simultaneous equations' and it would have been beneficial to do the same here. It is likely that many will attempt to use the quadratic formula. For part (c), it is likely that the values of x will not be listed, instead just solving the inequality.
4	In part (c) (ii), it is recommended that the equation of the line be accepted in any correct form. This is because the question does not ask for any particular form.
5	For part (b), the notation may confuse students. It is likely that they will be unable to form two equations in order to solve for b and c. For part (c), it is welcomed that the question stated 'hence or otherwise'. This is because some students will list the first 30 terms to get the answer.
6	In part (a), the term 'fortnight' may not be understood by students whose first language is not English. Similarly in part (c), the wordy nature would be problematic for some.
7	For part (d), it does not state to round the answer. It is recommended that students should not be penalised for rounding to 4%. In (e) (ii) The question asks for the answer to be given correct to 2 decimal places. This would be confusing for some students who are likely to their answer for part (c)(i) and give the incorrect answer due to it being more obvious as to how to round it.
8	The question states that 'Kieran has 21 metres of fencing', however it does not state that Kieran is required to use all 21 metres to enclose the vegetable garden. Some students reported finding this confusing. In (b)(i), it would have been helpful to restate the expression for the perimeter above the table. For (d) (iii), the weakest students may have found this particularly challenging. There is no mention of rounding the answer for part (d) (iv).
9	It is welcome that the most difficult question was left until the end. For part (a) (i), if students use the rounded answer found in the table for B(x) and multiply the previous rounded answer by 1.74, they will get the answer 91.68, it is felt that this should not be penalised. For part (c) it is recommended that the answer from the student's graph in part (b) be accepted.

Paper 2 Ordinary – Leaving Cert	
• It was felt that this paper was very doable. • The overall impression from students is that it was a fair paper.	
1	Part (b) may not always yield the correct answer and there was not a lot space given for the messier students.
2	If the student provides a construction, it should be considered for full marks.
3	For part (b) the mention of 'each unit' is very likely to be misinterpreted as 'each box'. For part (c), would the use of the distance formula be accepted? In part (d), the use of the word 'figure' could cause problems for students whose first language is not English.
4	In part (c), the use of set notation for the point of intersection would be unfamiliar. It would have been beneficial to provide an explanation alongside the question.
5	Fair question, should be accessible to most candidates.
6	Fair question, should be accessible to most candidates.
7	A nice opportunity for the weakest students to earn marks. Although tedious at times, there is good scaffolding in evidence.
8	It was felt that the length of this question was a bit excessive. The phrasing in part (b) (i) could lead to confusion. The use of the word 'calculate' would have been helpful. It is unclear as to what degree of accuracy is expected in measuring the angles. It would have been more helpful to ask them to round off to the nearest degree. It is noted in the similar question asked in JC OL Q3, there was no column in the table to work out the angle in the pie chart and no helpful radius line included in the pre-drawn circle.
9	Fair question, should be accessible to most candidates.

Foundation – Leaving Cert	
• A very accessible paper that suited students of this level. • Many IMTA members felt that the use of one paper is proving effective. • Students emerged from the examination very happy.	
1	Fair question, should be accessible to most candidates.
2	Fair question, should be accessible to most candidates.
3	The time is given as '12.45 pm' and '1.30 pm'. It would be more familiar to see '12:45 pm' and '1:30 pm'.
4	Fair question, should be accessible to most candidates.
5	Fair question, should be accessible to most candidates.
6	Fair question, should be accessible to most candidates.
7	Fair question, should be accessible to most candidates.
8	Is there an error in part (a) (iii) ?
9	The language here may have been problematic. The question appears to treat the terms 'thermostatic valve' and 'radiator' as interchangeable. The graph shows 'radiators' and part (iii) asks about 'valves'. It was felt that part (c) was difficult.

Paper 1 Higher – Junior Cert	
• A challenging paper in parts, starting off nicely but ending with being too difficult. • Overall, it was felt that this paper was not in the spirit of Junior Cert level. • A number of questions were not allocated sufficient time. • In future, thinking time should be factored in for more difficult questions. • Insufficient use of scaffolding in questions. • In particular, Question 10 was not appropriate to a Junior Certificate examination. • The replication of questions from the Ordinary Level paper is a concern.	
1	Fair question, should be accessible to most candidates.
2	It was note that part (b) (i) also appeared on the Ordinary Level Paper.
3	The notation involving the cardinal number of set difference was difficult.
4	Students reported that this was challenging. The sets are described as being 'different' but it is problematic when one set is a subset of another.
5	Some students reported difficulties with part (b). Several IMTA members felt that this part was challenging and the students would not be able to complete the graph.
6	Fair question, should be accessible to most candidates.
7	The time allocation here was inappropriate, students would need 5 minutes for part (a) alone.
8	It was strange that the pattern started at 0 for a physical pattern not involving time. It is expected that weaker students will struggle with drawing a pattern from a given rule. The use of variables here is confusing with 'N = 1 + 2S'. N would usually be used as the independent variable; this would not be helpful to students.
9	Students reported that they found this difficult; however they are not generally comfortable with indices. Again it was felt that the time allocation was inappropriate. It would be highly unlikely that students would complete this question in 5 minutes considering the difficulty involved.
10	It was felt that graphs of this type were unsuitable for Junior Certs. Modulus graphs are not on the syllabus and the students would not have seen graphs of this kind before. Students reported struggling with this question in particular with part (b) (ii). Although students found the points, they struggled to construct the graph. They were very confused encountering a graph of this type.
11	Inappropriate time allocation again – 10 minutes would not be long enough to complete the question. For those failing to recognise the difference of two squares, there would not be enough space to provide the necessary work.
12	Not enough time allocated to this question again. Students would be able to find the solution using substitution if they had enough time. Some IMTA members questioned the use of the term 'weight' and how appropriate its use is in mathematics.
13	Again it was felt that not enough time was allocated here. Students reported confusion about whether the diagram is that of a prism or a right angled triangle with a square attached. It is felt that this question is more challenging than the Pythagorean question in the LCHL paper. It is unfortunate that no scaffolding was provided that could have led students into the question. The question could have been broken into three parts making it more accessible. Many felt that this question was unfair to students; it is very difficult to work backwards with Algebra followed by Pythagoras with Algebra.
14	Again not enough time was allocated for this question. It was a difficult finish to the paper and there was no real 'thinking time' provided.

Paper 2 Higher – Junior Cert	
• This paper was better received than paper 1 but was still very challenging in parts. • Timing appears to be an issue especially with the more difficult sections. • A maturity of thought was required for the vast majority of these questions. • Several questions would benefit from better scaffolding similar to what was applied in the Leaving Certificate papers. • Many of the weakest students emerged from the examination uneasy and felt that they could not be confident about their performance overall due to the difficult parts.	
1	Part (ii) may be problematic for students. It is expected that students will use trial and error rather than forming two equations.
2	Part (d) is like to take time for students to solve.
3	Unlikely that this question would be completed within 15 minutes. It is expected that part (ii) will be an issue for students It is likely that students will have problems writing about the lower quartile in context. The use of Table 1 and Table 2 was confusing for some students. Page 9 of the paper was intended to be helpful but actually created confusion for students who felt that it should have been used in some way.
4	For part (b), students struggled to find the equation of AB and AC. It is felt that (d)(ii) is very difficult. Many students failed to recognise that BD was the diameter of the circle.
5	Fair question, should be accessible to most candidates.
6	Fair question, should be accessible to most candidates.
7	Some students reported struggling with part (b).
8	Several students misinterpreted the question and plugged in values for the isosceles triangles prematurely.
9	Better use of scaffolding could have been used here. It is felt that students will struggle with this question; it might have been beneficial to refer to it as a 3D shape rather than just a ‘shape’. Part (b)(iii) is expected to challenge the majority of students. The use of ratio or the similar triangles approach is unlikely to be seen by students.
10	Fair question, should be accessible to most candidates.
11	Fair question, should be accessible to most candidates.
12	Students are likely to struggle to construct the cross-section of the prism in part (a). Better use of scaffolding could have been used in part (b) (i). For those that failed to create right angled triangles, they would not be able to give anything meaningful for this part. With part (b)(ii), there is a danger that students may not connect part (i) to part (ii) and this will give rise to confusion when finding the area. Part (ii) refers to ‘this prism’ and students may not realise that they found x in part (i).

Paper 1 Ordinary – Junior Cert	
• It was a tough paper overall, given the range and depth involved for these candidates. • The introduction of the higher level junior cert questions and leaving cert foundation level questions was unfair. Many members have asked the question as to 'who is the paper meant to be examining?' • There was no logical flow to this exam with the levels of difficultly increasing and decreasing as the students progressed through the paper. • Ordinary level students would benefit from some kind of order to the paper. Many have complained that 'anything can appear anywhere'.	
1	It is possible that students may think that each number can only be used once.
2	The contemporary context was welcomed.
3	Nice connection with Venn diagrams although the emoji was off-putting.
4	Fair question, should be accessible to most candidates.
5	Heavy use of language here, the concept of 'basic call out fee' would be alien to these students. The use of the word 'part' in 2 or 3 different contexts could be confusing for weaker students.
6	This question would be more suited to higher level where it was also asked. The language and complexity of part (c) in particular is noted. It is difficult for these students to handle comparisons such as dealing with fractions of a litre.
7	It is expected that students will struggle with this question.
8	Fair question, should be accessible to most candidates.
9	The graph here was welcomed, students found it very clear. For part (d) the phrase 'mean speed' created confusion for some, they are more familiar with 'average speed'.
10	Fair question, should be accessible to most candidates.
11	Fair question, should be accessible to most candidates.
12	This question is well structured. A few students were confused as to whether does '5 years time' refer to from J or from J+2
13	Fair question, should be accessible to most candidates, although some found the graph confusing.
14	Giving one of the factors as in part (a)(i) is actually unhelpful to students. To many, this looked like an equation to solve. It was a disservice to those who use other methods to factorise such as the 'guide number' or 'array model' methods.

Paper 2 Ordinary – Junior Cert	
• A demanding paper with a lot of content, especially after the experience with Paper 1. • The justification questions are getting better with prompts given where necessary.	
1	Nice clear layout.
2	Fair question, should be accessible to most candidates.
3	The use of just two divisions in a pie chart is unusual. The positioning of the 300 above was not helpful. Students might have benefitted from the inclusion of a column in the table for the angle equivalent to the question asked at LC OL. It was however helpful to have a clear division of Company A and Company B on separate pages and B would have helped with A when seen by candidates.
4	The diagram was good here.
5	It is clearly not an absolute cuboid. Despite the given assumption, the diagram is not helpful for solving the question. The contradictory evidence made it unfair.
6	'One such triangle' was confusing to students for whom English is a second language.
7	Fair question, should be accessible to most candidates.
8	Fair question, should be accessible to most candidates.
9	When asked to 'write down the midpoint' – students may wonder about the use of the formula.
10	Fair question, should be accessible to most candidates.
11	Fair question, should be accessible to most candidates.

Foundation – Junior Cert	
• As in previous years, the paper generally reflected the ability of students and was pitched at an appropriate level.	
1	Students sitting this paper often have language difficulties. What do they gain in mathematical knowledge by learning the technical term ‘reciprocal’?
2	The phrase ‘showing the elements of P and Q’ is more likely to confuse rather than help.
3	A well-crafted question that relates to student experience.
4	Fair question that allows the student to show his/her knowledge.
5	The presentation is unhelpful here. The paper would have benefitted from a squared section to indicate where the student could sketch prior to obtaining an answer. It is expected that answers are likely to be the result of guesswork.
6	For part (b) some students could easily interpret this as ‘work out the discount PER COSTUME’. Either answer should be accepted for full marks in (b). (c) Students should not get full marks here unless the discount is given for 28 costumes.
7	In part (b) the subtlety of the question is beyond the competency of the typical student at this level. It is unfair to ask this of them.
8	A well-crafted question.
9	Fair question, should be accessible to most candidates.
10	In part (b), root 32 or 4 root 2 should be accepted for full marks. Part (c) should have come earlier in the question.
11	Fair question that allows the student to show his/her knowledge.
12	As with ordinary level, a few students were confused as to whether does ‘5 years time’ refer to from J or from J+2
13	Fair question, should be accessible to most candidates.
14	Fair question, should be accessible to most candidates.
15	Again, the emoji face caused confusion for students.

Mathematical Applications – Leaving Cert Applied
The paper was well received by the candidates and teachers indicated that it was a well-constructed paper.