MATHS STUDIES

Overall grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 14	15 - 27	28 - 35	36 - 49	50 - 62	63 - 75	76 - 100

There appears to be a slow but steady improvement in internal assessment performance, with criteria being well understood by most candidates and teaching staff, and reasonable attempts made to fulfil the criteria.

The overall examination package this session turned out to be quite demanding. A reasonable paper one helped to balance a slightly tricky paper two, but the grade boundaries still fell a little lower than usual. A handful of particular weaknesses showed through clearly and these are outlined in the individual paper reports below.

The progression of difficulty in paper two was misjudged a bit, with questions 2 and 3 proving noticeably harder than 4 and 5. It was resolved to take even more care in moderating the difficulty of the contextual descriptions in future as these seemed to have been a bit too hard for many candidates this session.

Internal assessment

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 4	5 - 6	7 - 8	9 - 11	12 - 14	15 - 16	17 - 20

The range and suitability of the work submitted

There was a wide range of work submitted. Candidates that had generated their own data tended to score higher marks as they often had sufficient data in terms of quantity and quality. They also showed more interest in what they were investigating. At times the tasks chosen were too narrow but in most cases the candidates did have sufficient scope to demonstrate their mathematical ability. Candidates attempted projects from a variety of branches of mathematics and it was really refreshing to moderate these. However, projects with a statistical basis still predominate. The vast majority of candidates tried to find the relationship between two variables with various levels of success. Not all of them explained their results

clearly enough to be sure that it was a relevant application to the data and not just an exercise. Only the strongest candidates gave any indication of the method used to generate their sample. Most indicated that they had distributed surveys but did not discuss how they dealt with incomplete surveys nor did they comment on the inherent bias when there are a large number of surveys distributed but not returned.

Nearly all the projects were well presented with few this year being hand written. There were a number of very short projects. The internal assessment is meant to be a substantial piece of work and three or four pages of simple mathematics will not score highly in a number of criterion areas. A number of projects did not contain the raw data. This makes it impossible for the moderator to check the accuracy of the calculations.

Plagiarism is becoming more of a problem. Several projects this year contained work that was cut and pasted from various Internet sites.

More candidates are now using their GDC to do the mathematics for them and often they forget to write down the formula they are using and mention why a particular procedure is being used. This has the result of leaving the moderator to wonder whether or not the candidate really understands what they are doing. A number of candidates could neither comment on their regression line nor interpret their results. Many candidates who used Excel to perform calculations did not explain the process or give explanations.

When using the Internet, candidates must remember to include the web address in their bibliography.

The project should be the work of each individual candidate. The project should not be the result of a piece of coursework with all the steps laid out by the teacher.

Candidate performance against each criterion

A.

Most of the topics chosen were appropriate for a Mathematical Studies project. There are still some candidates who find it difficult to explain their statement of task in a clear and concise way. In most cases this occurred when the topics chosen were quite difficult to understand. When describing the plan, many candidates explain what they are going to do to collect their data, but only some of them describe the mathematical techniques they are going to use in their project. Not all plans were well focused. Candidates with clear statements of task and plans tended to be able to extract more depth from their projects because they knew what they were looking for.

B.

The data collected was generally of sufficient quantity but was not always focused on the task. It was easier to find projects where the data could be considered enough in quantity but not in quality. Many candidates need guidance on sampling techniques. When insufficient data is collected this seriously impedes attempts to perform the chi-squared test. A few candidates did not include raw data within their project or as an appendix, and some did not include a sample questionnaire if this was the method they used to collect data. In these cases only final tables of data were given. A large number of candidates simply “dump” tables and charts straight from the Internet into their project, with little thought being given to how much of that information is really relevant to their task. The organization and presentation of relevant data becomes crucial when data is collected in this way.

C.

Most candidates used basic mathematical techniques for analysis, many relying entirely on computer generated results. Many of the candidates omitted explanations and clarifications of these techniques and were not selective about using the particular results that were relevant for their investigations. Some candidates are applying sophisticated techniques in their analysis and are omitting the simple mathematics and/or the use of graphs to analyze their information. With some of the statistical techniques, like the chi-squared test, it was evident that not all candidates knew what they were doing. Many candidates do not seem to care if their expected values are less than 1 or 5. The teachers differed in their interpretation of what constituted “sophisticated” mathematical techniques and this was an area that often required moderation.

Candidates should be encouraged to use simple mathematical techniques in their project as well as sophisticated ones. Candidates should realize that in many cases the simple processes gives a clear picture of what is going on. In many of the projects the candidates did not take time to correct errors in their calculations especially the simple processes, forgetting that these have to be mostly or completely correct to be able to achieve further marks in this criterion. Frequently candidates are using irrelevant mathematical techniques, for example calculating cumulative frequencies or standard deviations and not commenting on them. Excel is widely used to generate graphs but still a lot of the candidates do not include units on their graphs.

D.

Almost all the candidates were able to produce conclusions or interpretations that were consistent with their analysis but sometimes these were rather brief. In many cases the conclusions were obvious and not very thorough.

E.

More candidates commented on validity than in the past. Usually this was more to do with the data collection than anything else. A few commented on the mathematical processes that they had used. Of those who did, few reached the level of thoroughness required for a high level of achievement.

F.

In a few cases questionnaires used for surveys were not included in the project and in others it was difficult to follow the process because important data had not been set up for use or had been relegated to an appendix but on the whole, projects were easy to read and well structured. In most projects correct mathematical language was found and the tendency to repeat calculations and techniques on different sets of data and produce pages and pages of repetitive and often needless information has diminished to a certain extent. Many candidates now include a bibliography and references to sites accessed, although the latter are not always well documented. Notation and terminology are still a concern. Candidates should be aware of the fact that calculator notation is not acceptable.

G.

The majority of the teachers appear to have awarded marks appropriately.

Recommendations for the teaching of future candidates

- Encourage candidates to read each other's projects in order for them to appreciate clarity of style, thinking and succinctness.
- Give candidates the chance to evaluate their own work against the criteria in order to reduce the incidence of inappropriate mathematics and to appreciate more what is required for criterion E.
- Teachers should check the mathematics and initial calculations to show that they have checked them and indicate any errors.
- Teachers should give candidates guidance on sampling techniques.
- Make sure that candidates cite the website of any data that is downloaded from the Internet.
- Make sure that candidates put scales, units and labels on their graphs.
- Encourage candidates to work on the evaluation area of their project in more depth.
- Encourage candidates to organize the data they collect in ways that make it easier for the reader to understand how it is to be used in the development of the project.

- Emphasize the importance of showing sample calculations in both simple mathematical processes and sophisticated techniques and to present those calculations, regardless of the use of technology.
- Help them to understand when line graphs are not appropriate and what to use instead (for example histograms).
- Assist in the selection of topics and discourage topics that are too narrow or one-dimensional.
- Stress the significance of collecting sufficient data to perform certain techniques.
- Encourage candidates to comment on the procedures they are going to use and reflect upon them once completed.
- Give them examples of "good" projects so that they know what is expected of them.
- Encourage class discussion on factors that affect the validity of questionnaire data.
- Make sure that they are aware of (and understand) the assessment criteria.
- Encourage them to think up their own task and explain the plan thoroughly.
- Tell them to include all raw data – but not all the completed questionnaires! A sample is sufficient as long as they gather all the data in organized tables.
- Check that the mathematics used in the project is relevant.
- Encourage the candidates to use more sophisticated mathematics.
- Explain to the candidates how to evaluate their work, draw conclusions, examine the mathematical processes used and comment critically on them
- Send the original work of the candidate to the moderator.
- Meet with the candidates at regular intervals to monitor the progress of the project.

Paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 12	13 - 25	26 - 32	33 - 45	46 - 57	58 - 70	71 - 90

General comments

Candidate performance, teacher feedback and the level of the grade boundaries indicated that the paper was slightly more difficult than the previous May. Many candidates were able to utilise their graphic calculator (GDC) to good effect to solve questions and it appeared that those who were less familiar with the GDC struggled to complete the paper. A significant number of candidates seemed unfamiliar with the command terms used in this course, particularly “write down”, which also caused a timing problem.

The presentation of scripts was quite satisfactory with most candidates setting out their work clearly, using mathematical notation appropriately and gaining method marks where their final answer was incorrect. Candidates who failed to show working incurred maximum penalty for wrong answers.

Financial and unit penalties were applied for the first time this session. Whilst the majority of candidates are careful in regard to the specified levels of accuracy and inclusion of units as part of an answer, a significant number of candidates did lose both of these marks.

The areas of the programme and examination that appeared difficult for the candidates

Whilst the majority of candidates could access each question to some degree, there were notable gaps in the response of candidates from some schools which suggests that they had not been exposed to the whole course. This was particularly so with question 8 (chi-squared), question 11 (calculus) and question 14 (trig functions). Question 5 was also notable in that very few candidates had much idea how to read the given financial table. It seems that they had not had the opportunity to practice with anything but the standard financial techniques.

More specifically, candidates from most centres found some or all of the following difficult:

- Discrete data.
- Finding the rate of interest over a period of 9 months.
- Finding the total interest for a loan from a table of monthly repayments.
- Calculating the first negative x-intercept of a sine graph.
- Calculating the value of x for which gradient of two graphs is the same and drawing the tangent to the curve graph for that value.
- Drawing a sketch to show how to solve simultaneous equations graphically.
- Finding the constants of an exponential equation from a mapping diagram.

The areas of the programme and examination in which candidates appeared well prepared

Candidates were generally able to make a start on each of the questions and all questions were well answered some of the time. Many candidates demonstrated a sound knowledge of the course and the ability to apply their knowledge to a wide range of problem solving areas.

The following questions were handled quite well by candidates from many centres:

Percentage error (q1), Box and whisker plot (q2), Truth tables (q4), Number (q6), Chi-squared (q8), Coordinate Geometry (q10), Simultaneous linear equations (q12) and Measurement (q15).

Unfortunately there were also many candidates who showed only limited knowledge of the syllabus and often at a superficial level only.

The strengths and weaknesses of the candidates in the treatment of individual questions

Question 1 Number – % Error

a) Almost all candidates calculated the mean correctly but less than half were able to find the % error, many dividing by 6. This was despite the boldening of 'approximate' in the question.

b) Main errors were giving the answer correct to 1 significant figure (30) or 1 decimal place. Some candidates just counted the number of figures on the calculator to determine the index for the standard form, giving 10^9 instead of 10^1.

Question 2 Statistics

a) Very few candidates obtained both marks for part (a), though a majority did gain one mark.

b) Most candidates answered (i) and (ii) well. Quite a few could not interpret the scale for (iii).

c) An easy mark for candidates. It was very disappointing to see some candidates getting this wrong.

Question 3 Exchange rates – Simple Interest

a) Was well done, though many were awarded financial penalty with an answer of 782.1 for a(i).

b) Very few candidates were able to answer this part correctly. Most of them used the correct formula but substituted the amount instead of the interest, the number of

months instead of years and a few forgot to divide by 100. The wording of the question confused some candidates, who attempted to use the compound interest formula.

Question 4 Logic

a) The majority of candidates were able to explain the difference between inclusive and exclusive correctly but many used “and” and “or” to distinguish between the two.

b) Less than half were able to find the truth value of the two disjunctions in the table correctly. Most candidates did gain some marks but a number of them left at least one cell blank even though it was a 50% chance of getting the correct value.

c) (c) Most candidates answered this part correctly with many receiving follow through for “neither” from an incorrect table.

Question 5 Financial Loans (table)

As mentioned earlier this question caused confusion. Candidates need more practice in this area.

a) Many candidates answered this part correctly though a few lost a mark by dividing the correct answer by 12. A significant number of candidates ignored the table altogether and instead applied various formulae for simple and compound interest, which of course did not apply here.

b) This part was very poorly answered regardless of how part (a) was attempted. Again, many used the simple or compound interest formulae and most did not subtract the capital.

Question 6 Number

This was the best-answered question on the paper with most candidates achieving 5 or 6 marks. The main errors were finding the mean instead of the median in part (b) and giving numbers with negative indices as irrational numbers for part (c). Some candidates gave the list in reverse order (which lost them one mark).

Question 7 Sets

a) Many candidates included 1 as a prime number for set B. Most candidates were able to list the intersection of B and C correctly with many receiving a follow through for their incorrect B. Very few candidates were able to list $B \cup C'$ correctly with many listing the intersection. It was disappointing that only a few candidates listed C' separately – those that did often received a mark for this working.

b) The majority of candidates were able to write down the contrapositive correctly but many gave the inverse or the converse instead.

Question 8 Chi-squared

a) Most of the students got the null hypothesis right but quite a few used the word *correlation* instead of *independent*.

b) Candidates who used a GDC got it correct, while those who tried valiantly to calculate it by hand generally got an M1 but A0.

c) Most of the students knew how to calculate the degrees of freedom.

d) Many students did not have a clear idea which values to compare in order to arrive at a conclusion for the chi-squared test. Many compared the significance level with either the chi-squared value or the critical value. Some did not reject the hypothesis but either gave no reason or the wrong one.

As mentioned above, quite a number of candidates did not appear to have been taught this part of the course. There were many non-attempts. It was not a difficult question as indicated by the large number of candidates who scored full marks.

Question 9 Trigonometric Graph

a) Many candidates gave the period of the function correctly, the most common wrong answer being 2 (the amplitude). The majority of candidates gave the correct amplitude though 4 was a common error.

b) About half the candidates found the values of a and c correctly with some gaining follow through for a from their incorrect answer for the amplitude.

c) This was not very well done with less than a third of the candidates finding the x-intercept. Those who were well trained on the calculator used it to good effect here.

Question 10 Coordinate Geometry

There were some good answers, but many candidates showed a shaky understanding of coordinate geometry and some difficulty in dealing with negative numbers. Evidently a favourite question for some centres that consistently scored high marks here.

a) This was done quite well by most candidates with the main errors being reversal of the x, y values in the formula and using the negative, rather than the negative reciprocal for the perpendicular.

b) Poorly answered though many candidates did gain a mark by substituting the correct value for gradient into $y = mx + c$.

Question 11 Calculus

Most candidates were able to differentiate correctly, but only a third were able to calculate the value of x for which the gradients of the graphs were the same and a similar number did not attempt to. Some found the x -coordinate of the point of intersection.

c) Very few candidates were able to draw the tangent correctly. Some tangents were drawn horizontally and some at the point of intersection. The line could have been drawn without any knowledge of calculus so the indication here was that many of the candidates misunderstood the question.

Question 12 Simultaneous Linear Equations

a) Nearly all the candidates were able to write the equation but very few simplified it.

b) A majority of candidates were able to find the values of b and m. Some used the right method but made arithmetical errors, many of which were due to them using the method of substitution which involved fractions. GDC use was expected.

c) A majority of candidates did not attempt this part. For those who did, very few were able to sketch the graph correctly. Common errors were to plot the point (1.4,1.8) or draw a straight line through that point and the origin.

Question 13 Trigonometric Functions – Sets

This unusual question was surprisingly well done and a good number of candidates got full marks, though some did not attempt it at all. Most candidates who did make an attempt gained some credit, usually for the correct placement of $\sin x$ and x^2. A few made the mistake of entering values more than once. Amongst other things, this question was intended to test their adaptability to make links between different topics in the syllabus.

Question 14 Mappings – Simultaneous Equations

a) Most candidates correctly gave the values for the domain and range. Only a few reversed the order.

b) This was not an easy question and the majority of candidates did not know how to find an answer. Some centres did however seem well prepared for this question and managed to regularly score full marks, either by solving their simultaneous equations analytically, or, as often as not, by trial and error.

c) Correct answer for this part depended on (b).

Question 15 Measurement

a) and b) Two thirds of the candidates found the perimeter of the rectangle and the side of the square correctly, though most of them did not include units (thereby incurring a unit penalty).

c) Although a majority of candidates produced the quadratic equation many were unable to solve it correctly. This could easily be done using the GDC so it was disappointing.

d) Many did not attempt to find the area of the square and of those that did many did not do so correctly, a common mistake being to square the value of x.

Recommendations and guidance for the teaching of future candidates

The primary recommendation is that all topics need to be taught.

There also needs to be continued emphasis placed on the use of the GDC. There are several places mentioned in the syllabus where the use of the GDC is considered to be appropriate. Paper setters take this into account when writing questions. Topics include chi squared tests, correlation and regression, simultaneous equations and also in those topics where solutions from graphing are appropriate e.g. exponential, quadratic, trigonometric equations and any unfamiliar functions.

The finance questions caused problems for most candidates and teachers could try to pose more practice questions in a slightly different format to the usual.

The need for candidates to use the correct units has not been penalized in examinations prior to this year and it will be important for teachers to be aware of this from now on in all their teaching.

For examinations, candidates should:

- Read the questions carefully more than once and follow instructions strictly.
- Know the value of showing clear working, identified for specific parts of questions.
- Understand that work crossed out is given no credit.
- Be critical of answers, checking solutions for error and ‘reasonableness’.
- Pace an examination, leaving time for an attempt at all questions.
- Use a ruler for graphs and drawing diagrams.
- Practice with the given formula list to ensure understanding of relevance.
- Know when rounding of numbers is and is not appropriate.

- Practice with past papers as much as possible.

Teachers should also emphasise that follow through marks cannot be awarded without working being shown. Furthermore, an answer without working corrected to **less than** 3 significant figures without the correction process seen is also regarded as wrong. (This is not even an accuracy penalty because the correction process cannot be judged.)

Paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 11	12 - 22	23 - 29	30 - 40	41 - 52	53 - 63	64 - 90

General comments

It was detected early on by senior examiners that the marks being obtained in this paper were lower than usual across the board. The distribution appeared normal but with a very slight lean to the left. Comments from examiners and from the G2 forms generally supported the notion that the paper was on the hard side. Overall though, the comments were not unduly negative and included plenty of satisfied customers as well.

After consideration of the comments and exposure to many papers, the senior team came to the following verdict. Overall the paper was towards the hard end of the spectrum, though just within acceptable bounds. No individual question was unacceptable, however, the combination of all these five questions proved to be a bit over-wordy in the descriptions of context and there were some situations which, while well within the syllabus, proved a bit arduous for candidates. Just occasionally, there was a question part that might have been worded more clearly. Because of the problems reading the context, some candidates had a minor problem with time.

The assignment of relatively low grade boundaries for paper two was made with this verdict in mind. It was also felt that paper one was fair and that this would assist in redressing the balance.

In the Spanish version of the paper, a typographical error was introduced after the final checking procedures. This has led to a review of those procedures. The error occurred in question 5 (ii)(b) and involved the symbol n, for the number of elements in a set being replaced with m.

Examiners marking in both Spanish and English were asked to monitor the performances of candidates in this part to decide if any had been disadvantaged. Lists were made of the mark

transition from part (a) to part (b). No significant difference was detected between the English and Spanish performances and it was concluded that any effect was negligible. Indeed few candidates seemed to notice the error at all.

The areas of the programme and examination that appeared difficult for the candidates

Understanding the context of a problem and turning this into meaningful mathematics proved a problem, even sometimes for the most able candidates.

Far too many candidates were attempting statistical calculations by hand when what was intended was GDC use. The standard deviation was almost never found correctly by hand.

Almost no candidates at all were able to convert cubic centimetres to cubic metres. Many scaled up or down by factors of 10 or 100. A few managed to scale at the squared level but very few used the cube.

Non-right-angled trigonometry caused many problems, with many attempts using right-angled triangles inappropriately.

Full understanding of the calculus required for question 3 was rarely seen. There were many non-attempts at the graph indicating that the problem had been very poorly understood. Even allowing for the context being a bit tricky, this should have been done better.

Many candidates had no notion of a general proof, replacing this with fallacious proof by single example.

Compound probability was not well known in either of the contexts used (tree diagram and Venn diagram).

The strengths and weaknesses of the candidates in the treatment of individual questions

Question 1 Descriptive statistics. Regression data.

a) b), c) There was much confusion about how to present the intervals. Often the mid-point only was seen. (eg. 65 instead of 60-70). Understanding of mode, median and mean was usually good but too many candidates wasted time calculating standard deviation by hand and got it wrong. In c(ii) ‘greater than three’ caused no problems but ‘above the mean’ was often ignored.

d) This was often well done, even if earlier parts were poorly done.

e) Rather mixed performance here. It was hard to identify any consistency in the errors made.

Too much time was spent on this question. It was only worth two marks and candidates ought to have realised that it relied on a general pictorial understanding of the concepts, possibly supplemented by a little elementary arithmetic only, to compare (iii) and (vi). With good understanding, many of the options could be ruled out in a few seconds.

Question 2 Three-dimensional geometry. Non-right-angled trigonometry.

(i) Many candidates incurred the new one-off unit penalty here. Too many ignored the call for two decimal places and some extrapolated that instruction to later parts (which was clearly not intended). There was the predictable confusion of using radius instead of diameter. Another common error was to divide the cylinder volume by that of the ball, to decide how many would fit. Some follow-through was allowed later from this error, however, this led to zero or negligible air volume, which was clearly ridiculous.

Choice and use of the formulae for volumes was often competent but the conversion to cubic metres was very badly done. Almost no correct answers were seen at all.

(ii) Candidates were often sloppy in reading the information. In particular, despite the statement BL = 120 clearly written, many took GL as 120. Triangle TBL was often taken as right-angled. Angle BTL presented few problems, though sometimes the method was very long-winded. Candidates often managed part (a) then went awry in later parts. Many unit penalties were applied, if not already used in questions 1 or 2.

Question 3 Calculus. Quadratic graph with GDC.

(i) An attempt at part (a) was seen only rarely. If there was an attempt, it was often not a meaningful equation. If an equation was seen, sometimes it was for y, not x.

The derivative seemed manageable for many, though with the expected mis-handling of the negative power quite often. Parts (c) and (d) proved problematical. Marking of (d) was lenient and it was reaffirmed that testing of the concept in (d) will be done in a more straightforward context in future, when done at all.

(ii) Many candidates failed to recognise that extensive use of the GDC was intended for this question. An indicator of this was the choice of awkward coefficients. It is recognised that the context confused some candidates and that the horizontal shift was a bit disturbing for some.

Nevertheless, a lot of candidates could have earned more marks here if they had persevered. Many gave up on the graph, and elementary marks for scale and labels were lost unnecessarily.

As this was the first time for the unit penalty, we were lenient about the units left off the labels but this is likely to change in the future.

Question 4 Arithmetic and geometric progression.

(i) Identification of u_1 and d was fine. In (b) many candidates failed to recognise the need for a general proof and simply gave an example substitution. Part (c) was well done.

(ii) Too many candidates here failed to swap to the GP formulae. Those who did know what was happening here often performed the calculations well and got decent marks. The explanations in (d) were often unsatisfactory but some allowance was made for the language difficulties encountered by candidates writing in a 2nd or higher language. The last part (e) of the question, intended as a high-grade discriminator performed that task very well.

Question 5 Tree diagrams. Probability. Venn diagrams.

(i) (a),(b) Elementary probability calculations were performed well and compound ones often poorly. Filling in of the tree diagram in b(i) was quite well done. Conditional probability in particular was poorly implemented.

(ii) Most candidates had some idea how to fill in the numbers on the diagram. Full marks were common here and most candidates got some of the marks. Part b(i) was handled better than b(ii), with the complement causing problems. Extensive follow-through was used here from (a).

Part (c) was rarely completed, perhaps due to time constraints, but also due to lack of understanding.

Recommendations and guidance for the teaching of future candidates

If a standard deviation is required, candidates should be trained to automatically enter data in their GDC and find it that way.

Remind them to be wary of unit penalty throughout the examination. Units must appear on graph labels also.

Take some extra moments to look at the question again and study diagrams and information on diagrams very thoroughly before diving into calculations. Candidates should know that it is unlikely a long question will be devoted entirely to right-angled trigonometry.

If numbers appear awkward then GDC use is probably expected. (It might be expected even if they are not of course.) Better judgement on when to reach for a GDC needs to be developed.

Try to foster a broad understanding of mathematical techniques as well as detailed calculations. In question 1(e) a broad picture was needed.

Words emboldened are telling you that we are worried you might misinterpret something. Study these parts with extra care.

Clearly a little more time on unit conversion is needed for most centres.

When a question part is finished, consider the result and apply common sense to look for errors or misunderstandings.