MATHEMATICAL STUDIES TZ1

Overall grade boundaries

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 14	15 - 26	27 - 37	38 - 51	52 - 66	67 - 79	80 - 100

Time zone variants of examination papers

To protect the integrity of the examinations, increasing use is being made of time zone variants of examination papers. By using variants of the same examination paper candidates in one part of the world will not always be taking the same examination paper as candidates in other parts of the world. A rigorous process is applied to ensure that the papers are comparable in terms of difficulty and syllabus coverage, and measures are taken to guarantee that the same grading standards are applied to candidates' scripts for the different versions of the examination papers. For the May 2008 examination session the IB has produced time zone variants of the Mathematical Studies papers.

Introduction

Mathematical Studies SL continues to increase its candidature with over 17000 students taking the examination this May.

This was the first year that Mathematical Studies SL has been regionalized and the grade award meeting contained senior examiners who had marked at least two different components. This meant that for each component of the external papers the grade boundaries were carefully found using the grade descriptors with examiners who had marked both the first papers, or both the second papers, present so that the examining team could be confident that all candidates, irrespective of the papers written, were awarded the correct grade.

It was clear that there was a difference between the time zones with respect to the Internal Assessment. As a consequence a number of candidates had their final grade reduced by one. Candidates must be trained and encouraged to write full, comprehensive, original, and relevant internal assessment projects.

It was also evident that both first papers did not have a time issue whereas both second papers did. There were two graph drawing questions on each second paper and the candidates found it difficult, under examination conditions, to complete these and answer all the other questions fully. This concern was taken into account during the grade award process.

Standard level project

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

It was noticeable this session that the mark awarded for the project did make a difference to the candidate's overall grade. Many projects appeared to be rushed, were far too short, contained many errors and obviously did not even use the 20 hours class time that should be allocated to the project. As a result a poor attempt at the project had the effect of lowering the candidate's grade by one point. Other candidates had taken some pride in their work and produced very good pieces of work that had been carefully checked by their teacher. A good project generally increased the overall grade by one point.

Range and suitability of work submitted

Almost all the tasks chosen this session were appropriate for a Math Studies projects. Only in some cases were the topics too descriptive having little or no mathematical content in them. There were also isolated cases of what appeared to be an attempt at the mass production of projects by individual schools where all the projects had a similar problem to solve and the candidates solved it in the same way. 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. A few candidates used statistical tests that were outside the syllabus and, even when the mathematics was accurate, it appeared that they did not always fully understand the tests they were using.

The majority of the projects were well presented with few this year being hand written. There were a number of very short projects and a number of unfinished projects. The work produced needs to reflect the level of the course. Also, the project must not simply be a piece of work with loads of calculations. There must be a flow of ideas between the different sections and the interpretations of the results generated need to be clear and concise. Graphs must be clearly labelled, pages numbered and all sources documented. A number of projects did not contain the raw data. This makes it impossible for the moderator to check the accuracy of the

calculations. Many candidates did not show any simple mathematical processes this session and went straight to sophisticated mathematics. Some of the candidates did not have any calculations at all and just showed results from their calculator or computer with formulae nowhere to be found. This has the result of leaving the moderator to wonder whether or not the candidate really understands what they are doing.

A few candidates are still downloading “their project” from the internet. Teachers should be monitoring the project during the various phases to avoid cases of plagiarism. When using the internet the candidate must remember to include the web address in their bibliography.

Candidate performance against the criteria

A. Most of the topics had a title this session. The majority of the candidates stated their task but there are still some candidates who find it difficult to explain this in a clear and concise way. In most cases this occurs when the topics chosen unsuitable and should have been discouraged by the teacher. Most of the candidates explained how they were going to do to collect their data, but not all of them described the mathematical techniques they were going to use in their project. Not all the plans were well focused. Candidates with clear statements of task and plan generally wrote more successful pieces of work.

B. The data collected was generally relevant to the stated task. On the whole it was well collected and well organized ready for analysis. In general there was no problem with the quantity of data but the quality was questionable in many cases. A few candidates did not include their raw data so it was difficult to see how this had been structured ready for analysis. Some candidates forgot to include a sample questionnaire if this was the method they used to collect data. In these cases only final tables of data were given making it impossible for the moderator to check whether or not the tables of data were accurate. A large number of candidates just downloaded data straight from the internet with little thought being given to how much of that information was really relevant to their task. The organization and presentation of relevant data becomes crucial when data is collected in this way. It is also important to state the website in the bibliography.

C. The mathematics used needs to be done in a meaningful manner. Some projects contained many mathematical calculations, some of which were meaningless for the actual project. The importance of relevance must be stressed. When a scatter diagram indicates that there is no correlation between two variables then it is meaningless to go on to calculate the correlation coefficient and the line of best fit. Working out standard deviations without a meaningful discussion on what the results

indicate is of no value. 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. Many candidates relied entirely on computer generated results and no explanations of the techniques used appeared in their project. With some of the statistical techniques, like the chi-squared test, it was evident that not all candidates knew what they were doing. A growing number of candidates and teachers do not realize that no more than 20% of the expected cells can have values less than 5 and none of them should have values less than 1 for the test to be valid. Also several candidates used raw data instead of frequencies.

D. Almost all the candidates were able to produce one conclusion or interpretation that was consistent with their analysis but often these were rather brief. In a many cases the conclusions were just a one or two line statement. This does not produce a meaningful discussion of results but rather a series of disjointed remarks. Teachers need to encourage candidates to ensure that their interpretations and/or conclusions are developed in a comprehensive way. Sometimes candidates were unable to discuss their interpretations/results through their own lack of understanding of the relevance of the process used.

E. Validity was generally attempted by most candidates although very few achieve level 2 for this criterion. The majority of the candidates were successfully able to comment on their data collection method or their interpretations and/or conclusions but few commented on the mathematical processes that they had used or suggested possible means to improve their project.

F. The overall presentation of the project work was good. The majority of the projects are now word processed, hence easier to read with tables and graphs clear to follow. In most cases there was an attempt to structure the work but in some cases the work was not sufficiently linked together. In some projects questionnaires used for surveys were not included and in others the data was either missing, not set up for use or was relegated to an appendix. In most projects correct mathematical language was used. Many candidates now include a bibliography and references to sites accessed, although the latter is not always well documented.

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

Recommendations and guidance for future teaching

Teachers can help their candidates in many ways:

- Write clear and full comments on the 5/PJCS forms.
- Discuss a detailed plan of the project with the candidate to see if the task chosen has a mathematical future.
- Encourage candidates to work on the evaluation area of their project in more depth.
- Encourage candidates to use a wider variety of mathematical techniques both simple and sophisticated.
- Encourage candidates to organize the data they collect in ways that makes it easier for the reader to understand how it is to be used in the development of the project.
- Emphasize the importance of showing, where appropriate, sample calculations in both simple mathematical processes and sophisticated techniques.
- Stress the importance of using appropriate notation and terminology.
- Stress the importance of documenting sources. Where does the data being analysed come from.
- Discuss in class the significance and limitations of specific techniques.
- Remind candidates that their value for r or the chi-squared test statistic only supplies evidence for or against a relationship, which can be strong but is never proof.
- Give candidates a second chance to correct errors.
- 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.
- 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.
- 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.

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 12	13 - 24	25 - 36	37 - 49	50 - 61	62 - 74	75 - 90

To improve the security of IB examinations, a selection of examination papers now have regional variants, including Mathematical Studies SL papers 1 and 2. The following report is for Mathematical Studies taken by candidates in the IB regions of North America and Latin America.

General Comments

Candidates appeared to have sufficient time to finish this paper and attempt all questions. Comments from the teachers on the G2 forms indicated that most candidates came out of the examination feeling that they had been able to demonstrate their knowledge. It was felt that this paper was not more difficult than previous ones and the mean mark for the whole candidature was most encouraging. It was pleasing to see the working clearly shown on most papers so that candidates could receive follow through and method marks even though the final answer might have been incorrect. A concern was the number of candidates who did not appear to have a straight edge (ruler) in the examination and who did not seem to be aware that the command term ‘draw’ required an accurate diagram using a straight edge. Another concern was the many candidates who lost a mark through not giving a key for the stem and leaf plot. The IB syllabus requires a key for this statistical diagram.

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

There was a noticeable lack of knowledge/ability by candidates in the following areas:

- Statistics, especially standard deviation, logic and truth tables, financial Maths including reading a table and compound interest formula, number classification, conversion of kh^{-1} to ms^{-1}.

- Nearly all candidates lost marks for accuracy, units or a financial penalty, some losing three marks on the paper.

- For some, it seemed they had not been exposed to particular aspects of the syllabus with all candidates from certain schools missing out the same question. This was especially noticeable in Question 5 concerning chi-squared.

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

Overall, the level of understanding and skills demonstrated covered the whole range of marks awarded. All questions on this paper were accessible and many candidates were able to score maximum marks in a range of questions.

The following topics were generally well understood:

Median, inter-quartile range and box and whisker plot, differentiation, mode, median and mean from a list of numbers, trigonometry, arithmetic and geometric sequences, histogram, simple probability.

Candidates, who showed their working, were able to gain method and follow-through marks.

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

Question 1 Number – Standard Form (Scientific Notation)

Many candidates gained maximum marks. The common errors were in the initial calculation due to forgetting to use brackets when entering the denominator into the GDC; using 2 decimal places instead of 2 significant figures in part (b); and using the wrong value as the denominator in part (c). Some candidates were still using the old Information booklet with the wrong formula for percentage error. Because examiners believed that the wording was ambiguous the correct answer given to 2 significant figures was awarded full marks for this part.

Question 2 Cumulative frequency/box and whisker plot

Accuracy reading the graph in part (a) was a problem with little allowance given. A number read the maximum as 130 instead of 120. Part (b) was poorly done. Many candidates did not

know how to find the quartile values from the graph. Many candidates gained follow through marks for the box and whisker plot by writing down their values for part (b). Some candidates did lose a mark for drawing the whiskers through the box.

Question 3 Calculus

Most candidates were able to score full marks for parts (a) and (b). When mistakes were made in part (a) follow-through marks could be awarded for part (b) provided working was shown. Part (c) was disappointing with many candidates not realizing that the answer in (b) was the gradient of the tangent line.

Question 4 Statistics

Part (a) was well answered, albeit with some choosing the wrong value (14.3) for the standard deviation. The majority of candidates had the correct stem and leaf plot, though many lost a mark through not including a key and a few used a single digit in the stem. Some tried to draw two stem and leaf plots for the heights and weights in part (a) without realizing that part (b) had the ages written above.

Questions 5 Chi-squared

Candidates either gained good marks for this question or almost no marks depending on their preparation. It was obvious that some schools had omitted this from their programme. Candidates generally gave a reason for their conclusion in part (d) though some compared the chi-squared value with the *p*-value, resulting in the loss of both marks.

Question 6 Logic

The common error in part (a) was not to include “but not both” and for (b), to give the inverse rather than the converse. The first column in the table (not q) was well done but a number of candidates answered the implication incorrectly.

Question 7 Trigonometry

The triangle was drawn correctly by most and a majority correctly found the length of AB - a few did not write down the units (cm) and so lost a Unit penalty mark. There was still a significant number who tried to use right-angled trigonometry to find the length.

Finding the area of the triangle was mixed with many again assuming the existence of a right angle. Some candidates had their calculators in radian mode rather than degree mode.

Question 8 Sequences

Part (a) was done well. There was some confusion in answering part (b) with many candidates unsure what they needed to write down. Often the two terms were seen

somewhere in the working without the equation being written down in the answer box, or the equation was seen in the working for part (c). Part (c) was answered well, often with follow-through marks being awarded from an incorrect part (b) provided the working was seen.

Question 9 Histogram

A surprising number of the candidates did not appear to have brought a ruler/straight edge and so lost a mark in this question as they were asked to **draw** a histogram which means the lines must be drawn using a ruler/straight edge. Some candidates drew a frequency polygon. Parts (b) and (c) were generally answered well though 20/35 was seen occasionally in part (c).

Question 10 Currency conversion

This question was well answered by a number of the candidates although a significant number lost a mark due to a financial penalty through not giving an answer correct to 2 decimal places. A very common mistake was to use 8% (0.08) for 0.8% (0.008) as the multiplier in part (c).

Question 11 Number theory/mapping diagram

There was a lack of familiarity with number systems and mappings - it was surprising to see how few knew what a mapping diagram involved. Part (c) (range) was also poorly answered with many giving an interval although they had correctly worked out the values for the function.

Question 12 Financial table

Given the previous year's paper, candidates should have expected to see this type of question and it was disappointing that so many seemed to have no idea of how to read the table. Many candidates ignored the table and tried to work out the question using either the simple interest or compound interest formula.

Question 13 Simple/compound interest

Part (a) on simple interest was answered well - common errors being 0.04 in the numerator as well as 100 in denominator, and using 6000 as the interest. Part (b) was not well done. Candidates struggled with interest that was not compounded yearly although such questions have been asked on previous papers.

Question 14 Perimeter/unit conversion

Candidates generally answered part (a) well. A usual mistake was taking 500 as the radius. Some candidates worked out the area rather than the circumference. A good number of

candidates correctly answered part (b). Others seemed to get lost in the conversion with multiplication by 3600 and not multiplying by 1000 being common errors. Again follow through marks could be awarded from the candidate's answer to part (a) provided working was shown.

Question 15 Exponential function

Parts (a) and (b) were answered well with most candidates attempting and gaining marks. Very few candidates gained maximum marks for part (c) with most using a list to find the number of hours rather than the formula.

Recommendations and guidance for the teaching of future candidates

There were obvious gaps in the knowledge demonstrated by candidates from some schools. The course must be covered in full, including the presumed knowledge, and candidates given the opportunity to practice the work sufficiently to be able to cope with variations of the basic course content contained in an examination paper. Students need to be exposed to a wide variety of problems within each topic to ensure that they can establish appropriate problem-solving skills. The candidates need to be aware of the different types of penalties, accuracy, unit and financial so that they can answer each question correctly without losing marks. They should also have had exposure to as many past paper questions as possible so that they can familiarize themselves with the types of questions that commonly appear on examination papers. They must read questions carefully and check that they have answered what the question has asked for. They should be aware of the different command terms and what is expected from each one in terms of working shown. They need to learn to use the GDC when appropriate – a number of candidates wasted time trying to calculate the mean and standard deviation without using the statistical function on the GDC.

Further Comments

There were a number of schools which entered candidates who were poorly prepared for the examination with none of the candidates gaining more than half marks. This was a real concern.

Standard level paper two

Component Grade Boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 11	12 - 21	22 - 30	31 - 42	43 - 55	56 - 67	68 - 90

General Comments

- It appeared that some candidates had a problem finishing the paper in the time allocated. Comments from the teachers on the G2 forms supported this observation. The fact that there were two graphs to draw on the paper proved time consuming for many candidates.
- A lot of candidates came to the examination without the necessary equipment. A ruler (straight edge) is a must in a mathematics examination.

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

- Some candidates had problems sketching a graph with asymptotes and finding the equation of a line that is perpendicular to another one. The graphs drawn, even if correct, were often far too small.
- Conditional probability continues to be a weak point for Math Studies candidates.
- Some candidates still add probabilities where they should multiply and vice versa.
- Amplitude and vertical shift were not well done and many candidates did not use strict inequality signs.
- Many candidates are still not using their GDC to its full use.
- Many were not aware of outliers.
- 3-d trigonometry proved too much for many candidates.
- Many candidates lost at least 1 mark for AP or UP.

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

- Using the GDC to find intersection points was well done.
- The Venn diagram was usually correct as were the simple probabilities related to it.
- The tree diagram was also correctly filled out on the whole.
- Those candidates who knew how to use their GDC properly had no problems with the mean, standard deviation (although some chose the wrong sd), the correlation coefficient or the value for d in the regression line.
- The simultaneous equations were well done but few candidates used their GDC to find the solution.
- The factorisation was reasonably well done although some candidates still mix up factorising with finding the solutions.
- Many managed to find the surface area of the cuboid, could rearrange the equation correctly and find the volume.

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

Question 1: Graph sketching, asymptotes, intersection of two graphs, linear equation

a) This was not very well done. The graph was often correct but was so small that it was difficult to check if axes intercepts were correct or not. Often the vertical asymptote looked as if it were joined to the rest of the graph. Very few of the candidates put a scale and/or labels on their axes.

b) Reasonably well done. Some put $y = -4$ while others omitted the minus sign.

c) Fairly well done – but once again too small to check the axes intercepts properly. Also, many candidates did not appear to have a ruler to draw the straight line.

d) Well done.

e) Most could find the gradient of the line.

f) Many forgot to find the gradient of the perpendicular line. Others had problems with the equation of a line in general.

Question 2: Venn diagram, probability, tree diagram

2(i)

a) The Venn diagram was well drawn on the whole although some of the candidates missed out the Universal box and others filled in the intersections wrongly but still gained ft marks for the remaining parts of the question.

b) Well answered.

c) Well answered.

d) Few correct answers. Either candidates added instead of multiplying or they used replacement and so the fractions given were the same.

e) Again few correct answers. Candidates wrote the answer out of 50 instead of 15.

2(ii)

a) The tree diagram was well done on the whole. It appears as if some candidates may have completed this on the exam paper and this was not included with their papers. However, the question did state clearly "Copy and complete …."

b) (i)This part was well done by those candidates who remembered to multiply instead of add.

(ii)Many candidates just wrote down "Claire" for this answer. Others wrongly multiplied or added 0.3 with 0.6.

Question 3: Cosine graph, mean, standard deviation, correlation coefficient, equation of the regression line

3(i)

a) (i) & (ii) Very few candidates managed to get both these values correctly.

b) This "show that" was well done – but, considering how few managed part (a), perhaps this was more by chance than good understanding of the period.

c) Many candidates found the two values but put $\leq$ signs instead of strict inequalities.

3(ii)

a) (i) Generally well done but many lost an AP here

(ii) Only correct if the candidate knew how to use their GDC and even then several gave the wrong standard deviation.

b) Again, only correct if the candidate could use their GDC. Many answers given were greater than 1 and the candidates did not see anything wrong with this.

c) Many received a ft mark for this part. The word "positive" was often omitted.

d) (i) Most candidates substituted the first set of points into the equation instead of finding the regression line on their GDC.

(ii) Most managed to score a ft point here. But some did not give their answer as a whole number.

e) Not many candidates mentioned the idea of an outlier. Most came up with some creative reason, all be it wrong, as to why the answer might be unreliable. Some of them made interesting reading.

Question 4: Simultaneous equations, square-based pyramid, trigonometry, surface area, volume

4(i)

a) Most candidates managed to write down the equation.

b) Most candidates managed to write down the equation.

c) Many managed to find the correct answer and the others tried their best but made some mistake in the process.

d) (i)Few candidates sketched the graphs well. Few used a ruler.

(ii)Many candidates could not be awarded ft from their graph because the answer they gave was not possible.

4(ii)

a) Very few correct drawings.

b) Some managed to show this more by good fortune and ignoring their original triangle than by good reasoning.

c) (i) Many found this as ft from the previous part. Some lost a UP here.

(ii)This was not well done. The most common answer was 40°.

d) Many managed this or were awarded ft points.

e) This was well done and most candidates also remembered their units on this part.

Question 5: Quadratic function, calculus, maximum volume

5(i)

a) Most candidates made a good attempt to factorise the expression.

b) Many gained both marks here from a correct answer or ft from the previous part.

c) Many used the formula correctly. Some forgot to put $x =$

d) Most candidates found this value from their GDC.

5(ii)

a) A good attempt was made to show the correct surface area.

b) Many could rearrange the equation correctly.

c) Although this was not a difficult question it probably looked complicated for the candidates and it was often left out.

d) Those who reached this length could usually manage the differentiation.

e) (i) Many found the correct value of x but not of y.

(ii) This was well done and again the units were included in most scripts.

Recommendations and guidance for the teaching of future candidates

- Remind candidates to label all graphs with an appropriate scale and axes labels.
- Explain what needs to be included in a sketch.
- Emphasise the importance of good time keeping.
- Coach candidates when and how to use their GDC.
- Encourage candidates to show all working out.
- Practice more examples of “show that” type questions.
- Remind candidates about significant figures and the importance of putting in the units.