MATHEMATICAL STUDIES TZ2

Overall grade boundaries

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 16	17 – 30	31 – 40	41 – 53	54 – 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. As in May 2009, for the May 2010 examination session the IB has produced time zone variants of the Mathematical Studies papers. Grade boundaries for the different time zoned papers are set separately, and careful judgments are made that are based on criteria for performance level to account for differences in the papers.

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

Range and suitability of work submitted

This session there was a diverse variety of topics. Statistical tasks still predominate but other areas such as modelling, measurement, financial mathematics, calculus, trigonometry and geometry were seen.

Many students included questionnaires and raw data, but a large number did not, or they organized and presented their data in ways which precluded cross-referencing of data and checking of mathematical processes.

Many candidates are now using technology to do the mathematics for them and often do not do any mathematics themselves. Any mathematical processes using technology only are considered simple. Some candidates used mathematical processes that were outside the syllabus. Generally this was not very successful as the mathematics seemed not well understood. Other candidates performed processes and then failed to comment on their results. This has the result of leaving the moderator to wonder whether or not the candidate really understands what they are doing.

When using the internet the candidate must remember to include the web address in their bibliography. More candidates are now including a bibliography.

The length of some projects was also a cause for concern. They varied from 1 or 2 pages to well over 50 pages. It is stated that the length of the project should not normally exceed 2000 words (excluding graphs, appendices and bibliography). There is no lower limit stated - but a project would have to contain several pages if it were to satisfy all the assessment criteria.

The comments made by the teachers on the 5/PJCS forms were very clear and helpful. Teachers are also encouraged to write on the projects and indicate where the mathematics has been checked for accuracy.

Candidate performance against the criteria

A. The statement of task was usually evident and most candidates described a plan that they would follow. It is important to actually follow the stated plan. If the plan is well documented, then the rest of the work tends to be better developed and follows a logical structure. Not all plans were well focused. Some projects did not have a title. Some candidates were clearly writing their plans after completing the project and used the past tense.

B. The majority of candidates collected their data and set it up in tables ready for the analysis. Some candidates had obviously collected data (via a questionnaire or otherwise) but omitted to include this data in their project. If the raw data is not present then the moderator cannot check the accuracy of the mathematical processes used. Data varied from 2 pieces of data to well over 100 pieces. The candidates must realise that having a lot of data does not always mean that it has the quality needed to gain full marks in this section. If data is too simple and

sample spaces are too small then it limits the mathematical analysis that the candidate can perform. When secondary information is used, candidates must clearly identify the source.

C. Many candidates only included simple mathematical processes in their projects. Many used technology only to perform sophisticated techniques without realizing that this is considered as simple mathematics. Some candidates introduced mathematical processes that were totally irrelevant. This can actually result in the candidate losing marks. Many candidates and their teachers are not clear on the chi-squared test. The entries in the contingency table must be frequencies and the expected frequencies must not be less than 1 and no more than 20% between 1 and 5. Otherwise the test is invalid.

D. Most candidates produced results that were consistent with their analysis. However, few produced detailed discussions. Often this was because the project was too simple to have much to say. The stronger candidates did a good job of presenting partial conclusions as they went along and then summarized these to give an overall conclusion at the end. It would be helpful if candidates assigned letters to all their tables and graphs and refer back to each and every one by number or letter in detail when discussing results.

E. Very few candidates are convincing in their understanding of the notion of validity. Their discussions generally centred on data collection. Less often was a student able to comment on the validity of the processes themselves.

F. Most of the projects were well laid out. Many candidates recorded their actions at each stage. It is important to ensure that the notation and terminology is correct. Many candidates lost marks this session due to errors in either notation or terminology.

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:

- Give them examples of good projects so that they know what is expected of them.
- Make sure that they are aware of (and understand) the assessment criteria.
- Remind their students that the project is a major piece of work and should demonstrate a commitment of time and effort.
- Encourage them to think up their own task and explain the plan thoroughly.
- Tell them to include all raw data – but not <u>all</u> 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.

- If candidates are using technology then remind them that they are expected to give an example by hand of what they are doing before they start to do any mathematics on the calculator.
- Explain to the candidates how to evaluate their work, draw conclusions, examine the mathematical processes used and comment critically on them
- Emphasise the importance of meeting deadlines
- Inform their students about sampling techniques
- Show their students how to use Equation editor or Math Type.
- Check the calculations in each project
- Send the original work of the candidate to the moderator.
- Meet with the candidates at regular intervals to monitor the progress of the project.
- Write a comment to justify each achievement level awarded

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 13	14 – 26	27 – 34	35 – 47	48 – 59	60 – 72	73 - 90

General Comments

Candidates were able to attempt most of the questions on this exam paper and appeared to have enough time to complete the paper. Compared to previous exam sessions, fewer candidates attempted only parts of questions. Solutions were generally clearly set out and well labeled. This is particularly important when papers are electronically marked as examiners are required to scroll through the exam script to find a candidate's answer to a question. It is helpful if working is clearly marked with (a), (b) or (c) and is in reasonable proximity to the answer lines.

Logical working was shown by the majority of candidates so that method and follow through marks could be awarded. Fewer penalties were given than in previous years. The graphics calculator was generally used effectively, although many candidates did not use the full range of calculator functions. Very few students lost marks due to their calculator being in radian mode. Many candidates lost marks for not supporting answers with a valid reason.

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

Candidates found difficulty providing correct reasons in Questions 8, 9 and 15. Giving a linear equation in the correct form and using a compound interest formula with the rate compounded monthly, proved difficult. Finding the point of intersection between the trigonometric and linear function was poorly answered and candidates did not appear to know how to use their GDC to calculate this point. Similarly, few candidates appeared to have used their GDC to help them sketch the cosine function. Calculating the value of an unknown index with an exponential model also created difficulties for a significant number of candidates. Determining coefficients of the quadratic function using information about the axis of symmetry was poorly answered, as was the calculus question. Questions 13 and 15 caused the most complexity for candidates, while the last part of Questions 6, 8 and 12 also proved challenging.

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

Right-angled trigonometry, truth tables and logic notation, box and whisker plots, coordinate geometry, statistics, sets, arithmetic sequences, χ^2 test results, finding the gradient of a line joining two points, simple probability and currency conversion were competently answered by the majority of candidates.

The topics of conditional probability, compound interest, functions and calculus require more attention. It seemed that many candidates were not well prepared for these topics and many chose to omit questions related to these areas of the course. The use of the GDC, while improving, is still an area which requires further emphasis. Many students chose trial and error methods when they could have solved problems more efficiently using their calculator. It is important to note that questions will not be set which rely exclusively on a trial and error approach. Teachers should continue to encourage students to use sketch graphs and draw diagrams to help them start a question.

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

Question 1: Right-angled trigonometry and percentage error

This question was well answered by the majority of candidates although it was surprising to find some who could not express the given distance in metres. Where working was present, follow through marks could be awarded in the remainder of the question. Most candidates could give their answer correct to the nearest metre and find the percentage error correctly, using the formula. A common error was to use the calculated value in the denominator.

Question 2: Logic

The truth table was very well answered and where the table was incorrect a follow through mark could be given for part (b) for a correct answer resulting from their final column. Some candidates appeared unsure of the concept of a tautology. Nearly all candidates could write the proposition in part (c) in symbolic form.

Question 3: Reading values from a cumulative frequency curve and drawing a box and whisker plot

This question was well answered with many candidates gaining full marks. Some received a unit penalty in part (a) for omitting the minutes. Most of the candidates knew how to draw the box and whisker plot. A mark was deducted if the whiskers were drawn all the way through the box.

Question 4: Coordinate geometry

Although the first three parts of this question were well answered, with most candidates knowing how to find the *y* intercept, gradient of a given line and gradient of the perpendicular line, very few candidates could find the equation of the perpendicular line and correctly state it in the required form.

Question 5: Statistics

A large number of candidates gained full marks on this question. Many correct variations of the equation were given and the values of *p*, *q* and the median could then be found. Some candidates neglected the extra information of *p* less than *q* and lost a mark for having these values the wrong way around. Follow through marks could be awarded for the median, if working was shown, with incorrect values of *p* and *q*. It was pleasing to see that most candidates realised that a list had to be ordered, before finding the middle value.

Question 6: Sets

The first two parts of this question were well answered with most candidates completing the Venn diagram correctly and finding the number in the intersection. The final part, requiring a conditional probability to be found, proved more difficult as many candidates tried to use the formula, when all that was required was to look at the values in the Venn diagram. Follow through marks were awarded in part (c) for values correctly used from parts (a) and (b).

Question 7: Arithmetic Sequence

This question was very well answered with most candidates finding the common difference and the total number of singers. Most candidates used the given formulae, rather than making lists. A common mistake was to find the number of singers in the back row, rather than find the total number of singers in the choir.

Question 8: Probability

Parts (a) and (b) were well answered but very few candidates could provide a reason for the independence of *A* and *B*. A number of candidates confused independent and mutually exclusive events.

Question 9: χ^2 test

Many candidates gained full marks on this question. However, a number of candidates did not answer at all or stopped after either correctly or incorrectly defining Ho and/or H_1. Many incorrect versions of 'independent' were seen and candidates should be advised that the terms

not related, not correlated and not influenced will not be awarded marks. There were an encouraging number of full marks gained on this question.

Question 10: Compound and simple interest

Part (a) of this question was incorrectly answered by many candidates not noticing that the rate of interest was compounded monthly rather than annually. A number of candidates gave the final amount as the answer, rather than the interest. Many candidates did not read part (b) correctly and thought the question was asking them to find the interest paid if the amount gained simple interest at the same rate as in part (a).

Question 11: Cosine function

The sketch of the cosine function was poorly done with many candidates unable to sketch the graph correctly. Some drew it accurately on graph paper from a table of values, but did not realise the GDC could be a valuable tool in this question. Part (b) was poorly answered with 2 being a common error, rather than 180. Very few candidates obtained the answer to part (c).

Question 12: Exponential Model

Parts (a) and (b) were confidently answered with many candidates correctly finding the number who started the rumour and also the number involved after 5 hours. A common mistake was to let $t = 0$ but not evaluate the expression correctly. Very few candidates could answer part (c). With the working shown, it was obvious candidates could correctly state the equation, but could not use their calculators to find the value of *t*.

Question 13: Quadratic function

This question was not well answered with few candidates gaining full marks. Many candidates could find the value of *q* but not *r*. Although many found the minimum value of *y*, they could not find the maximum value of the function or express the range correctly.

Question 14: Three dimensional right-angled trigonometry

This question was well answered although a number of candidates incurred either a unit penalty (UP) or an accuracy penalty (AP). Surprisingly few candidates used the basic trigonometric ratios (for right angle triangles), opting instead to use the sine or cosine laws.

Question 15: Calculus

Very few candidates received full marks for this question and many omitted the question completely. A sketch showing the information provided in the table would have been very useful but few candidates chose this approach.

Recommendations and guidance for the teaching of future candidates

The entire syllabus should be taught and there should be time before the examination for students to answer as many past paper questions as possible to become familiar with the style of examination questions.

Graphical calculator use should be an integral part of all lessons and candidates must become familiar with all of the functions of their calculators and their application to the different areas of the syllabus.

Students should know all the command terms so that they are aware that when a question says *write down*, no calculations are required. Also, when asked to *sketch* a graph it is not necessary to write down a table of values or use graph paper.

Candidates must be reminded to give answers to the accuracy required in a question, or to 3 significant figures. Teachers should emphasise answers such as $\sqrt{(0.89)}$ are not exact values and must be evaluated. Students must also be aware that units must be given with answers wherever appropriate.

All relevant working should be shown, with the question part indicated in the working box so that follow through marks can be awarded, if applicable. Too many scripts still have numbers written all over the working box, with no real indication of which part of a question they relate to.

Candidates should always check if their answer is reasonable. A cliff that has a stated height of 700 metres calculated to be 64 metres, or a probability greater than 1 or less than zero, should ring alarm bells.

Candidates need to be aware that electronic marking requires some additional consideration toward the examiners.

In particular, the following points should be made to candidates before sitting their exams:

- box plots or any other graphs sketched or drawn on the graph paper provided need to be very clear and stand out against the grid of the graph paper
- answers should be written in the working box or in close proximity to the answer lines
- all working out should be clearly labeled with the question part next to the working
- writing in different colored pens or pencils does not show up when seen on-line
- smudging, partial erasing and illegible writing is more difficult to decipher on-line

Candidates should ensure their writing is clear, reasonably large and pens or pencils used are quite dark in colour.

Overall the candidates were well prepared for this exam paper.

Standard level paper two

Component Grade Boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 13	14 – 27	28 – 37	38 – 48	49 – 59	60 – 70	71 – 90

General Comments

This paper differentiated the candidates well as the range of marks varied from full marks to very few marks. Candidates were able to show their knowledge from Question 1 to Question 4 but struggled to answer Question 5, a calculus question which was clearly of a higher level of difficulty than the previous questions. Time did not seem to be a factor for the majority. Although a number of students did not reach the last question, the overall impression of the examiners team was that it did not seem to be due to lack of time. The examination was deemed to be an appropriate test of the syllabus by the majority of teachers submitting G2 forms.

There was an error in Question 4(c) though examiners agreed that in general this error did not affect candidates. Also the way in which the question was written allowed for the students to

be able to move on to the following parts. However, as communicated on the OCC, the examining team were aware of this error immediately and the mark scheme was adapted accordingly to cover all the possible situations. Examiners were also given clear instructions to identify those students that seemed to be affected by the error. These students' scripts were studied carefully then at Grade Award by the senior team and decisions were made on an individual basis.

Many candidates appeared to be well prepared giving their answers to the correct number of significant figures or to the specified accuracy in the financial questions where appropriate, and using the correct units. However many others were not aware and were penalized with all three penalties, accuracy, unit and financial leading to the loss of three marks in the paper.

A number of candidates lost marks in the "show that" parts of the questions. When candidates are required to reach a given answer that is written to a specified accuracy, they must write down that value with a higher degree of accuracy (unrounded value). Further, premature rounding resulted in marks being lost.

In the questions asking for angles it is becoming far less common to find candidates using their GDC in radians; this is an encouraging trend.

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

- Conditional probability
- Evaluating the reliability of regression line estimates
- Distinguishing details on a diagram
- Conversion between units (m to cm and m^2 to cm^2)
- Writing expressions in terms of x
- Optimization

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

- Elementary probability
- Drawing a scatter diagram and a line of regression

- Elementary financial questions
- Trigonometry
- Use of GDC

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

Question 1: Probability

This question was well handled by most of the candidates except for (c)(ii) in which they had to find a conditional probability. Some candidates did not copy the second tree diagram in the answer sheets and instead wrote their answers in the exam booklet thus losing the 3 marks allocated to part (b).

Question 2: Regression

This question was well answered by most of the candidates. Diagrams were in general well drawn except for some students that reversed the axes or did not use the stated scales. They were able to use the GDC to find the means and the equation of the regression line. Very few students could take the correct decision in (g) (ii) by stating that the value was outside the range of the data set. The majority inclined their answers towards the context of the question and forgot what they had been taught about how wrong extrapolation can be.

Question 3: Financial Mathematics

Most of the students read carefully the instruction written in the heading of the question and therefore gave their answers with the accuracy stated but some did not, for which they were applied the financial penalty.

Simple interest was well done as well as compound interest with only a small minority of candidates making no progress. A number of students lost the answer mark in (b) for not showing the unrounded answer before writing the answer given. It is also important to mention that calculator commands are not accepted as correct working and therefore full marks are not awarded. Also, some candidates wrote their answers without showing any working leading to a number of marks being lost.

It was nice to see many students recovering after part (d) and to gain full marks in the last two parts of the question.

Question 4: Geometry and Trigonometry

Part (a) was well done except for the fact that very few students were able to convert correctly from m^2 to cm^2 and this was very disappointing.

In part (b) the cosine rule and the area of a triangle were well done. In some cases units were missing and therefore a unit penalty was applied.

Part (c) was clearly the most difficult one for the students. The general impression was that they did not read the diagram in detail. A number of candidates could not distinguish the circle from the triangle and hence used an incorrect method to find the radius.

It was pleasing to see candidates recovering well to get full marks for the last two parts.

Question 5: Optimization

This was the most difficult question for the candidates. It was clear that the vast majority of them had not had exposure to this style of question. Part (a) was well answered by most of the students. In part (b) the correct expression "in terms of x" for the curve surface area was not frequently seen. In many cases the impression was that they did not know what "in terms of x" meant as correct equivalent expressions were seen but where the h was also involved. Those candidates that made progress in the question, even with the wrong expression for the total area of the can, A were able to earn follow through marks.

Recommendations and guidance for the teaching of future candidates

- Ensure candidates can use the GDC efficiently, especially with graphs of functions and statistics
- Time management – a mark a minute is the guide – and ensure that all questions are attempted
- Cover the whole syllabus; it will all be examined
- Practice with "show that" questions by having candidates communicate through their mathematics

- Ensure candidates label and scale the axes whenever they draw or sketch a graph
- Ensure candidates start each question on a new page and to show all their working
- Formula booklet should be part of everyday teaching so that candidates become familiar with it
- Applying AP´s, UP´s and FP´s should be part of a teacher routine in marking throughout the 2 year course
- Train candidates to write an appropriate amount of detail in their responses. Both too little and too much are not good options.
- More time should be spent on algebra to help students to improve their algebra skills