May 2012 subject reports

MATHEMATICAL STUDIES TZ2

(IB Africa, Europe & Middle East & IB Asia-Pacific)

Overall grade boundaries

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0-17	18-33	34-44	45-57	58-69	70-81	82-100

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 2012 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

The majority of the projects chosen this session were suitable and used statistics as the main mathematical process. Most of the statistical projects used Pearson's correlation coefficient or the chi-squared test. In many cases there were serious flaws in the processes. It was a delight to see projects from areas other than statistics and teachers are encouraged to promote this.

Many students this session failed to include their questionnaire or raw data in the project, making it impossible for them to score highly in Criterion B or C.

In projects where the student collected their own data, often they did not describe the data collection process in sufficient detail to allow for the assessment of the quality of the data.

Many students only included one sophisticated process in their project and omitted all simple mathematical processes. In this case the first sophisticated process is considered “simple”. A large number conducted chi-squared tests with insufficient data or non-frequency data, rendering their test invalid. Students also confused correlation and independence. What is more surprising is the fact that teachers are not highlighting these mistakes. Either they are not checking the mathematics or they themselves do not understand the test.

It must be emphasized that answers given from using technology only are considered simple. In order to gain high marks in Criterion C a candidate must show the mathematical processes by hand.

Teachers need to be aware that if there is incorrect notation or terminology in the project then no more than 1 mark can be awarded for Criterion F.

Most candidates are now scoring 1 mark for Validity but very few gain full marks for this criterion.

The project should reflect the 20 hours allocated for school work plus approximately the same amount of time outside of the classroom. This session many projects looked like homework exercises rather than a substantial piece of work.

Some school are sending copies of the projects to the moderator instead of the original. This makes it very difficult for the moderator to check any bar charts or pie charts that are now “shades of grey”. The original, in colour, should always be sent to the moderator.

As always there were some candidates who produced excellent projects that scored well in almost every assessment criterion.

The teachers must put a comment against every criterion on the 5/PJCS forms explaining why they awarded the marks that they gave the student. 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. Most candidates mentioned their task but the plans varied from thorough to non-existent. If the plan is clearly stated then the rest of the project should flow from it. It is worthwhile spending time on the stated plan. A few projects did not have a title making it impossible to get more than 1 mark for this criterion.

B. Many candidates fail to achieve full marks in this criterion for various reasons: the data was not set up for use, the quality of the data was questionable, the quantity was limited, the raw data was omitted or the source of the data was omitted. If the raw

data is not present then the moderator cannot check the accuracy of the mathematical processes used. Data that is too simple invariably results in limiting the mathematical analysis that the candidate can perform.

C. Many projects only contained 1 sophisticated process. This is then counted as the first simple process and is marked accordingly. Many candidates seem to be unaware of the conditions that make the chi-squared test invalid: not using frequencies for the entries in the contingency table, expected values less than 1, more than 20% of expected values between 1 and 5. Candidates must also be aware that finding the equation of the regression line when the correlation coefficient is weak is not a relevant process and will have the effect of reducing their marks. If technology only is used to arrive at results then this is considered a simple process.

D. If a project is simple then it is not possible to produce a detailed discussion of results. Most candidates however did score 2 marks for this criterion. The better candidates could discuss their results thoroughly and received full marks.

E. Candidates are now attempting to discuss validity and many received 1 mark for this criterion. However, it seems as if many of the candidates are not really aware of what "validity" actually is and it would be beneficial if the teacher spent some time with their students explaining what is required for this.

F. The majority of the projects had some structure with candidates recording their actions at each stage. However, many candidates lost marks due to errors in either notation or terminology. Some candidates do not seem to be aware that calculator/computer notation is not correct mathematical notation.

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:

- 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 as this gives focus to the task.
- Give them examples of "good" projects so that they know what is expected of them.
- Peer assessment is a wonderful tool. Let the students moderate each other's projects.
- Check that the mathematics used in the project is relevant.
- Encourage the candidates to use more sophisticated mathematics.

- Teach the students the significance and limitations of statistical techniques.
- 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.
- Encourage students to pay more attention to detail such as labels and scales on graphs, spelling mistakes, typos, computer notation.
- Emphasise the importance of meeting deadlines.
- Inform their students about sampling techniques.
- Remind them to include all raw data either in an appendix or as part of the task.
- Show their students how to use Equation editor or Math Type.
- Remind them of the importance of including simple mathematical processes in their projects.
- 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:	0-15	16-31	32-40	41-52	53-63	64-75	76-90

General Comments

This paper appeared to be accessible to all but the very weakest students. It provided candidates the opportunity to demonstrate their knowledge of the course. Most candidates had time to reach the last question however some left gaps in question parts or omitted whole questions. Most candidates showed their working and included units in their answers. Unit penalties were rarely applied. Candidate use of their graphics calculator was effective and very few made the mistake of using radians rather than degrees. Most candidates showed their working which enabled method and follow through marks to be awarded.

Comments on the G2 forms were positive and indicated that the syllabus coverage and level of difficulty of the exam paper were appropriate.

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

Candidates had difficulty using basic algebra, particularly in the substitution in the arithmetic sequence formula and in calculations involving brackets, calculating an unknown length using the area of a triangle formula, finding the values in a quadratic function, finding the values in an exponential function, finding the value of *b* in the trigonometric equation and using the geometric sequence formula for the sum of a sequence. In particular, candidates lacked understanding of the significance of the derivative of a function.

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

Working was shown by the majority of candidates so that method and follow through marks could be awarded, even when parts of questions were incorrect. However many candidates treated the working space as 'rough' working space and did not set their work out carefully or identify which part of the question they were answering. It would be helpful for the examiner, marking on-line, if candidates could keep their work within the working box and write the question part next to the relevant working.

Truth tables and logic notation were well understood as were scatter diagrams, arithmetic sequences, interpreting linear models, setting up the null hypothesis and finding the degrees of freedom in a Chi-squared test, currency conversions and finding the median and mean of a list of numbers.

Most candidates appeared to be familiar with the functions of their graphic display calculator.

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

Question 1 Standard form and number sets

Most candidates could find the value of *r* and give it in standard form, although some did not give it to the correct degree of accuracy. Some candidates gave a positive index and others used calculator notation rather than standard form. There were a number of candidates who were unable to find the three true statements about set notation.

Question 2 Logic

This question was well answered by most of the candidates who could complete the truth table, write the proposition in symbolic form and write the given proposition in words, although the 'If' was sometimes omitted. Where marks were lost on Question 2, it was generally in the second column of the truth table.

Question 3 Scatter diagram and line of best fit

Most candidates could find the values of a and b, draw the line of best fit and find an estimate of the value of y. Follow through marks could be awarded in part (c) with an incorrect line of best fit, if dotted lines were shown on their graphs, indicating their method.

Question 4 Venn diagram and set notation

The most common error in Question 4 was to omit counting the four non-music students. Explaining in words the meaning of the set notation was difficult for some candidates.

Question 5 Arithmetic sequence

This question was very well answered by most candidates. Correct working was clearly shown. Many candidates used 32 as their first term and many others subtracted 6 rather than multiplied by -6, indicating a lack of attention in their algebraic notation and manipulation.

Question 6 Linear model

The majority of the candidates showed they were able to substitute values into the model. The most common mistake was to neglect converting 1.37 km into metres. Some candidates did not appreciate the practical considerations of this question; Mount Everest will never be less than one metre high. It is important to remind students to check their answers in terms of the context of the information given.

Question 7 Area of a triangle

Candidates had difficulties finding the length of the side of the isosceles triangle and chose an incorrect angle in their substitution into the area formula. Many candidates thought this question related to right angle triangle trigonometry.

Question 8 χ^2 Test

This question was well answered by the majority of the candidates, many scoring the maximum number of marks. It was disappointing to see the number of candidates who left this question blank.

Question 9 Currency conversion

A common error in Question 9 was finding the amount of money received for part (a) rather than just the commission. Some candidates had difficulties giving the appropriate number of decimal places.

Question 10 Mean and median

This question proved to be relatively easy for most candidates. They could find the median, mean and also the pulse rate of the student who joined the group. Where mistakes were made, they were in not ordering the list of numbers. Part (c) presented the most challenge for weaker candidates.

Question 11 Quadratic function

Question 11 proved to be the most problematic of the whole paper. Many candidates attempted this question but were not able to set up a system of equations to find the value of *b* or use the formula $x = \frac{-b}{2a}$. From the working seen, many candidates did not understand the non-standard notation for the domain, with a number believing it to be a coordinate pair. This was taken into careful consideration by the senior examiners when setting the grade boundaries for this paper.

Question 12 Exponential function

Most candidates answered parts (a) i and ii correctly, however a large number of candidates could not find the correct equation for part (b).

Question 13 Differentiation

The derivative of the function was correctly found by most candidates. Rearranging the equation of the line to find the gradient was also successfully performed. Most candidates could not find the *x*-coordinate of the point on the curve whose tangent was parallel to a given line. To most candidates, part (b) appeared to be disconnected to part (a).

Question 14 Sine graph

Although this style of question has appeared on past exam papers, candidates were unable to find the period of the function, although most successfully found the amplitude. Many could not find the exact point of intersection, although most candidates made an attempt. Candidates' answers often did not make sense in terms of the context of the problem.

Question 15 Geometric sequence

Most candidates could answer the first part of this question, although a number found it difficult to find the total distance run after 7 days. Many gave the correct answer of 1.65 km or 1650 m for part (a). In part (b), stronger candidates answered correctly, however many used a list or the incorrect arithmetic formula. In part (c), the most common mistake was to use the arithmetic formula. Many candidates rounded their answer down rather than up.

Recommendations and guidance for the teaching of future candidates

- Candidates should have as much practice as possible in answering questions written in different styles. The whole syllabus should be taught and there should be time before the examination for students to complete as many past papers as possible.
- The use of the graphical calculator is improving but must continue to be emphasized for solving problems, finding points on a graph or checking answers to questions. The calculator should be used across all areas of the syllabus.
- Some candidates still do not know the symbols for the different categories of numbers.

- Further work needs to be done on logic; specifically translating statements from symbols to words and words to symbols.
- Negative indices are still causing major difficulties for many students.
- Relevant working should be shown in each question, with the question part indicated in the working box, so that follow through marks can be awarded, if applicable. Too many scripts have numbers written all over the answer box, with no real indication of which part of a question they relate to. With electronic exam marking, it is crucial to have each part of a question clearly labelled and indicated in the working box.
- Time did not seem to be a factor with this paper as the majority of candidates attempted all 15 questions.

Standard level paper two

Component Grade Boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0-14	15-29	30-40	41-51	52-61	62-72	73-90

General Comments

The majority of the comments on the G2 forms were positive about this examination paper, its content and the level of difficulty of the questions. Very few teachers mentioned any problem with the time taken to complete the paper. However, it was noted by examiners that many candidates did not complete question 5. This may have been because they found the topic (calculus) too difficult rather than a time issue.

With e-marking, it is now more important than ever that candidates give answers to at least 3 significant figures as they can potentially lose 1 mark for incorrect accuracy on **each** question rather than 1 mark for the full paper as was previously the case. Ideally teachers should encourage their students to keep their full GDC display throughout a question and write this answer down on their answer paper before rounding to 3 significant figures or the accuracy required in the question.

Candidates should not write their answers on the question paper as this is not scanned with their written work. In this paper, several candidates must have completed the tree diagram (question 1c) on their examination paper because the answers that followed were correct. However, if the examiner does not see the completed tree diagram then no marks can be awarded for it. Thus, some candidates lost 3 marks for this part of the question because they did not follow the instruction which said “Copy and Complete”.

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

This session the candidates had problems working out combined probabilities as well as conditional probability. They also had trouble using the correct formula to find the amount received through compound interest with many of them using the formula for the interest only and forgetting to add on the original amount.

The difference between discrete and continuous data also caused problems.

An amazingly high percentage of the candidates could not use their GDC to find the mean and standard deviation of the grouped frequency. They either found the mean and standard deviation of the mid-points or the frequencies. Some calculated the mean by hand and, although this was often correct, it did take time. Many candidates also wasted time solving the simultaneous equations by hand whereas they could have found the answer quickly from their GDC.

When asked to find the **total** surface area of the 3-D shapes, many candidates lost marks by only finding the **curved** surface area.

As always candidates have problems with “show that” questions and they also appear not to take the time to read the questions carefully.

The optimisation question was very poorly attempted either due to lack of knowledge or due to lack of time.

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

The candidates were well prepared for topics such as simple probabilities, tree diagrams and percentages.

Although they sometimes wasted time solving simultaneous equations by hand, this was generally well attempted.

Interest compounded annually was also well done as was finding the modal group and mid-point.

In general the candidates drew the cumulative frequency graph well and could read values from it. However, there were still some candidates who drew a histogram instead.

Candidates were also well prepared for the Theorem of Pythagoras, right angled trigonometry, sine and cosine rules and simple differentiation.

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

Question 1

(a) Most candidates found this correctly although a few wrote 180 instead of 90.
(b) This was also answered well. The main errors were putting 65/90 in part (ii) and 24/90 in part (iv).
(c) The tree diagram was completed correctly in most scripts. It appears that some candidates may have answered this on their question paper and this was not sent to the scanning centre with the answer papers.
(d) Many answered this correctly. Some added instead of multiplying.
(e) Surprisingly well answered. Again some added and multiplied in the wrong place.
(f) Most candidates added here and then divided by 2 rather than multiplying.
(g) This was badly done with very few correct answers seen.

Question 2

(a) Most candidates managed to answer this correctly.
(b) On the whole this was well answered but some candidates gave 7200 as their final answer.
(c) Some candidates found this surprisingly difficult, others gave the answer as $x + 24y = 7100$.
(d) Many managed to find the correct answers for x and y even though their answer to part (c) was not correct. Others received follow through marks.
(e) The most common answer here was 26 months.
(f) Part (i) was well done but there were fewer correct answers seen for part (ii). Some candidates used 6000 instead of 2000, others did not give their answer to the nearest euro and others kept the same interest rate for both parts of the question.

Question 3

(a) Many candidates thought that this was discrete data.
(b) This part was very well done with the occasional candidate writing down the number rather than the group.
(c) Fairly well done although 15.5 was seen quite often.
(d) This was really badly done with most candidates only putting the midpoints into their GDC or only putting the frequencies into their GDC. Perhaps they did not know how to use their GDC correctly.
(e) The values of q and r were mostly correct.
(f) Most candidates plotted the points correctly. Some had problems plotting the 23 and 173. A few candidates used the midpoints instead of the end points and some drew bar charts.
(g) There was a lot of follow through marks gained here by those candidates who drew lines or put marks on their graphs in the correct places.

Question 4

(a) This part was very well done on the whole.
(b) Amazingly badly done. Many candidates used 146.4 for the height and others tried unsuccessfully to find slant heights and angles to that they could use the area of a triangle formula $\frac{1}{2}ab\sin C$.

(c) This was fairly well done.
(d) Quite a few candidates managed to show this although they did not always put down the unrounded answer and so lost the last mark. Some even tried to use 52° to verify its value.
(e) Very well done on the whole – even if part (d) was wrong.
(f) This was well done by those who attempted it. Not all candidates used VM to find x and so lost one mark. There were quite a few different methods of finding the answer.
(g) Again this was well done by those who attempted it. Again there were many different ways to reach the correct answer.

Question 5

Many candidates did not answer this question at all and others did not get past part (c). It was unclear if this was because they could not do the question or they ran out of time.

(a) This was very poorly done. Most candidates had no idea what they were supposed to do here. Many tried to find values for x.
(b) Similar comment as for part (a) although more candidates made an attempt at finding the Volume.
(c) This part was very well done.
(d) Not many correct answers seen. Many candidates graphed the wrong equation and found 1.333 as their answer.
(e) Some managed to gain follow through marks for this part.
(f) Again here follow through marks were gained by those who attempted it.
(g) Very few correct answers for the surface area were seen. Most candidates thought that there were 4 equal faces $2xy$ and 2 faces xy. Some managed to get follow through marks for the last part if they divided by 60.

Recommendations and guidance for the teaching of future candidates

- Teach the full syllabus.
- Give students past papers to practice on.
- Remind students about the importance of giving their answers to at least three significant figures.
- Remind students of the importance of putting units in their answers.
- Give the students timed questions so that they know how to manage their time in the examination.
- Make sure that the students know how to use their GDC properly.