MATHS SL TIME ZONE 1

Overall grade boundaries

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0-19	20-37	38-52	53-63	64-74	75-85	86-100

General Comments

This was the first session of the new course for mathematics SL. In general students seemed to be well prepared. However, as detailed below, there appeared to be some new areas of the syllabus with which candidates from some centres were unfamiliar. Details are also given below of ways in which the new requirements for Internal Assessment had not been fully implemented. Teachers should be sure they are working from the subject guide for mathematics SL, for first examinations in 2006, that was sent to schools in 2004.

All teachers are encouraged to complete G2 examination feedback forms. These are all read by the senior examining team at the Grade Award meeting and consideration is given to issues raised. G2 forms are available from your IB diploma co-ordinator or online on the OCC.

In response to some comments made on G2 forms in this session teachers are asked to note the following points:

- A standard level course can have a maximum of three hours external assessment thus increasing paper one to 1.5 hours means paper two now has to be 1.5 hours.
- The suggested teaching hours provided in the subject guide will not necessarily be reflected in the number of marks allocated to a particular topic in a particular session.
- Candidates should be familiar with the notation and the command terms detailed in the subject guide. These will be used in examinations without explanation.
- For paper one, the change in format from boxes with answer spaces to lines is intended to reflect the change in the assessment model. Correct answers with no working may not necessarily receive full marks. Therefore, the answer space has been removed to try to help candidates and to encourage them to show their working in a clear and organized way. Final answers should be written in the lined section and not against the question at the top.

Finally a couple of things that would make things easier for examiners.

- Students are required to write their answers in pen. If pencil is used it can be very difficult to read under artificial light.
- Please do not ask students to double over the green tags. It makes it extremely difficult to open out the papers for marking.

Standard level internal assessment

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0-7	8-13	14-19	20-23	24-28	29-33	34-40

The implementation of the new syllabus has presented challenges to students, teachers and moderators. New tasks have had to be adopted or created with a new assessment rubric in mind. Teachers have been faced with learning the nuances of the assessment criteria, and transmitting them successfully to students. Moderators have had to deal with schools that have presented old material that is no longer appropriate, material assessed against the old criteria, and even forms that no longer apply. Despite all this, most schools have successfully made the transition to the new assessment scheme, and it is hoped that the feedback provided to all schools will ensure that the Internal Assessment in future sessions is more consistently and successfully implemented.

The range and suitability of the work submitted

Moderators have noted that most schools chose to offer tasks selected from the new teacher support material document (TSM). While this is certainly a wise choice at this point, it is hoped that teachers will feel more confident in setting tasks of their own design in future. Teachers who have bravely offered their own tasks will be able to use the information provided in feedback to the schools, and information contained here, to confirm or revise their tasks. Those teachers who design appropriate tasks or who modify TSM tasks are encouraged to share them through the Online Curriculum Centre (OCC), so that others can offer constructive feedback, or make use of them in their classes. This professional cooperation is much appreciated.

A concern that arose regarding the choice of tasks was that some tasks found in various resources, some old TSM tasks and some new ones specifically written with the IB Mathematics SL syllabus in mind, did not adequately meet the requirements of the tasks as described in the subject guide. Particularly, they did not offer students full opportunity to achieve well at every criterion. It is critical that teachers work through any task they intend to set and assess their work against all the criteria prior to assigning it to students, to ensure that their students can address each of the criteria levels. Otherwise students may be unintentionally penalized, as they might not be able attain the highest levels simply because the task does not provide for this.

Candidate performance against each criterion

As some of the old criteria (new criteria A, B, and E) have been maintained in the new rubric, teachers have been able to use their experience with these criteria to ably assess student work in the areas of Use of Notation/Terminology, Communication, and Use of Technology. Moderators have generally been able to confirm marks in these criteria wherever supporting comments have justified the assessment. Criterion E, Use of Technology, is now assessed for both tasks, and consequently takes on greater significance in the overall mark. Teachers are advised to plan for the appropriate accommodation of technology in the tasks they use. They should especially consider how students can give evidence of the technology used, and how resourceful the use has been to the development and enhancement of the work presented. The presence of printed output does not in itself constitute resourceful use.

The greatest concerns arose in the assessment under criteria C and D. The new rubric assesses two major goals through these criteria; Processes and Results. However, the objectives of these goals differ according to the nature of the task, and thus criteria C and D have different assessment descriptors for investigative tasks (Type I) than for modelling tasks (Type II).

Type I tasks are intended to assess the students' abilities to work with mathematical patterns in numbers, expressions, shapes, etc. and to then generalize these patterns into a suitable mathematical statement. Aspects such as the validation of preliminary conjectures, exploration of scope and limitations of the variables, and some informal explanation as to why the statement is valid are also addressed.

Type II tasks are intended to assess the students' abilities to analyze raw data to develop a model function, consider how well the model fits the data and modify it as appropriate, show how it can be applied to other situations, and to critically interpret in context how reasonable the model is, what limitations apply, and what modifications might be necessary to improve the model. It is critically important that students explicitly identify the variables, parameters, and constraints used in the model. Students need to know such things before they work at the tasks, and therefore it is essential that teachers share and discuss the criteria with them. In particular it should be noted that an analytical approach that demonstrates the student's own knowledge of the mathematics involved must be used to develop the model prior to any use of regression features on a GDC or computer. Regression models are acceptable for comparison to the student-generated models, but are not mandatory. They do, however, provide a good opportunity for students to demonstrate their command of the appropriate technology.

A new criterion, F, offers the teacher an opportunity to assess holistically the quality of work presented. While there is no explicit link between performance on the other criteria and the mark awarded in criterion F, it is expected that only remarkable work, work that the teacher would stop and take admirable note of, should attain a mark of 2. On the other hand, it is expected that only a totally inadequate response would receive a mark of 0. It is expected that most assignments will achieve level 1.

Recommendations for the teaching of future candidates

Teachers are reminded that the subject guide and the TSM include specific instructions regarding the assessment of portfolios, including notes on the criteria to help explain their application. Note that, while teachers may offer advice to students as to whether they are on the right track with their work, they must not assess rough drafts and return them to students to modify prior to final submission.

Included below is a set of further notes that senior moderators have prepared to assist teachers in understanding the nuances of the criteria. A document containing fully commented criteria incorporating these further notes will be posted on the OCC. It is essential that teachers study the assessment of student work provided in the TSM. It is strongly recommended that teachers attend IBO teacher training workshops for further professional development.

Additional notes on applying the criteria

Criterion A: use of notation and terminology

Correct mathematical notation and symbols must be used eg π, rather than the word "pi". Calculator or computer notation should not be used. Notation such as ABS(x), 5.23E17, * etc, should not be used and such use will be penalised.

A single shortcoming would not preclude the awarding of level 2.

The terminology may depend on the task. In the case of Type I (Investigation) activities, terminology may include terms devised by the candidate (eg "slide", "shift", etc), provided that such terms reasonably reflect the appropriate mathematical concept.

Criterion B: communication

The "WHOA!" factor: If, in reading a candidate's work, the teacher has to pause to clarify where a result came from or how it was achieved ("WHOA! Where did that come from?!"), this generally indicates flawed communication.

Computer/calculator output may need clarification. Graphs generated by calculator or computer should present the variables and labels appropriate to the task. Hand-written labels may need to be added to screen dumps or printouts if the software doesn't provide for custom labels.

A single shortcoming would not preclude the awarding of level 3.

A "question and answer" format in the student's work does not represent the best form of mathematical communication, and the use of this format will likely preclude awarding a level 3.

Type I Criterion C: mathematical process

This criterion refers to the process of getting ready to produce the general statement. A student can achieve a 4 if everything is ready to produce the statement. (The statement does not need to be seen at this point.) The production of the statement and its correctness are assessed in D.

Testing further cases and commenting on the results is sufficient to award a level 5. "Tests the validity" does include commenting on the results of their testing. This applies to the general statement produced by the student, regardless of its correctness.

If a student gives a proof or justification of the correct statement, no further cases need be investigated to award a level 5.

Type I Criterion D: results

It is important to note the difference between "a (ie any) general statement" in level 2 and "the general statement" in level 3.

Type II Criterion C: mathematical process

Any form of definition, informal or implied, of variables, parameters, constraints, is acceptable eg labelling a graph or table, noting domain and range.

A qualitative analysis is sufficient to award a level 4.

In the development of the model, it was intended that students initially use an analytic approach, and use the regression tool (and possibly their knowledge of regression) to support their findings.

Type II Criterion D: results

"Appropriate degree of accuracy" means appropriate in the context of the task. It may be interpreted in terms of the level of reasonableness expected to earn a level 3, 4 or 5. A minor error in accuracy (eg using 10 sf instead of 2 or 3) might not prevent a student progressing from level 3 to level 4, but could preclude them from progressing from level 4 to level 5.

Criterion E: use of technology

While printed output is not required, some statement confirming appropriate use of technology (from the teacher or student) is necessary to achieve level 3.

Note that using a computer and/or a GDC to generate graphs or tables may not significantly contribute to the development of the task, and so may not merit awarding a level 3.

The emphasis in this criterion is on the contribution of the technology to the mathematical development of the task rather than to the presentation/communication.

Criterion F: quality of work

Award level 2 only if the work presented is beyond ordinary expectations. The teacher will take pause to admire the quality of such work ("Wow! Now, that's impressive!").

Only a totally inadequate response would receive 0.

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0-19	20-39	40-52	53-61	62-71	72-80	81-90

General comments

G2 summaries

- **Comparison with last year's paper**

Much easier	A little easier	Similar standard	A little more difficult	Much more difficult
4	26	54	11	0

- **Suitability of question paper:**

	Too easy	Appropriate	Too Difficult
Level of difficulty	12	112	0
	Poor	**Satisfactory**	**Good**
Syllabus coverage	2	54	67
Clarity of wording	1	42	80
Presentation of paper	1	41	81

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

The Normal distribution caused difficulty for many including otherwise very strong candidates. The question itself was straightforward. It seems that in many schools the topic had not been taught. Complicated algebraic manipulation is not a feature of IB mathematics at this level but even so there were many examples of weakness here. Candidates often make good use of the graphic display calculator (GDC) but few support their answers with a suitable sketch as required. Where a sketch was asked for, (Question 15) it was clear that candidates had usually produced the right graph on their calculator but had taken very little care to draw a neat symmetrical curve with the vertex in approximately the correct position.

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

Throughout the paper candidates demonstrated a good level of skill in carrying out standard procedures particularly in the topics of functions and equations and calculus.

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

Question 1 (Matrices)

Mostly done correctly. Errors in part (b) included multiplying instead of subtracting the matrices, or algebraic errors.

Question 2 (Probability)

The most common error was to assume the events were independent for part (b). Candidates should have realized that a probability of 1.1 could not be correct.

Question 3 (Transformations of graphs)

Mostly done correctly.

Question 4 (Normal distribution)

Many candidates did not attempt this question. It was apparent that some centres had not taught the topic. Those who used the GDC were generally successful. There were many sign errors in part (b) from those who did not.

Question 5 (Derivatives)

Errors here included treating e^x as if e was the variable, not using chain rule correctly and omitting the constants in parts (a) and (b). A significant number of candidates did not recognize the need for the product rule in part (c).

Question 6 (Graph of quadratic function)

Mostly done correctly. Errors were mostly to do with signs. A few thought that $y = 0$ for the y-intercept.

Question 7 (Composite and inverse functions)

Mostly well done. In part (a) a few candidates interpreted $g \circ f$ as multiplication of functions.
In part (b) a few misread the notation for inverse function as that for the derivative.

Question 8 (Measures of central tendency and range)

Usually done well by a variety of methods often including an element of trial and error.

Question 9 (Inverse matrix and solution of matrix equation)

Usually done well. A few candidates tried to find the inverse by hand. The syllabus clearly states that this is not required. A few who did use the GDC failed to scroll to see the full answer. Some statements in part (b) indicated that the noncommutative property of matrix multiplication was not well understood.

Question 10 (Logarithms)

Mostly well done. Most errors occurred in part (a) where candidates either could not get to grips with the question or gave answers as pq and q^2.

Question 11 (Interpreting derivatives)

Most candidates scored some marks on this question but relatively few were fully correct.

Question 12 (Kinematics)

There were many fully correct solutions. A few candidates omitted "$+c$" and so could not go on to find its value. Some weaker candidates tried to use speed=distance/time.

Question 13 (Sector of circle)

Most candidates were able to set up the two equations required. Some found very elegant ways to eliminate one variable. Others chose very awkward routes and often made errors.

Question 14 (Graph of trigonometric function)

Most candidates scored some marks. Usually a was found correctly. Answers for b sometimes included π, and for c were sometimes negative.

Question 15 (Intersections of curves)

This question required the use of GDC and most candidates realized this. Sketching of the parabola was often poorly executed. In part (c) some candidates assumed that p and q must be integers.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0-15	16-30	31-44	45-54	55-65	66-75	76-90

General comments

G2 summaries

Comparison with last year's paper

Much easier	A little easier	Similar standard	A little more difficult	Much more difficult
3	19	52	14	0

Suitability of question paper:

	Too easy	Appropriate	Too Difficult
Level of difficulty	4	107	1
	Poor	**Satisfactory**	**Good**
Syllabus coverage	2	54	64
Clarity of wording	0	47	73
Presentation of paper	0	40	80

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

There were many fine scripts and the work was generally set out in a clear, concise manner. The difficulties in this paper primarily arose from the question on three dimensional vectors and the question involving the equation of the normal to a curve. Candidates need to be exposed to all of the areas of the syllabus and it appeared that this was not always the case; there were some fairly simple questions on the areas new to the syllabus which were omitted by practically all of the candidates in a centre. A common difficulty was **showing** a result to be true. Another common problem was rounding errors and significant figures with many candidates suffering the accuracy penalty and being fortunate that it is only applied once in the paper. Many candidates did not appear to be familiar with the "command terms" listed in the subject guide used in the examinations.

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

In general, candidates demonstrated a broad range of knowledge and were able to gain some marks in every question. Candidates did well on basic integration and differentiation, and were generally successful in the questions on basic probability and solution of triangles. The clear presentation of solutions by most candidates was particularly pleasing.

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

Question 1: Calculus

A surprisingly large number of candidates had difficulty finding the equation of the normal to the quadratic curve. They did not determine the gradient of the tangent at $x = 2$, but rather gave its gradient as $-\frac{3}{2}$ since the derivative was $-\frac{3}{2}x + 1$; others equated the derivative to 0. Many others found the equation of the tangent rather than the normal and these were not able to find a second point of intersection. For candidates who use their GDC to find the second point of intersection of the normal and the curve, it is important to note that a sketch of a suitable graph is required as evidence of the method used. In writing expressions for the area of R and for the volume of the solid of revolution, many candidates made one or more small, but important, errors in these integrals. Also, candidates need to read instructions carefully as a significant number wasted much valuable time calculating the actual value of the volume of revolution when only the expression was required. The final integral from 1 to k was generally well done with a few candidates taking the derivative of the expression instead of integrating or simply substituting into the expression directly. A significant number of candidates had the correct answer to the final integral, but then multiplied it by 4 to get rid of fractions.

Question 2: Trigonometry

Applying the cosine rule in the first part of the question was well done, but only a few candidates **showed** how the factor of 4 could be extracted from the square root by factorizing out 16. The use of the Sine Rule was well done and many students proceeded correctly through the entire problem. The majority, however, received the accuracy penalty somewhere in this question due to incorrect rounding or having more or fewer than three significant figures. Several of the candidates had their calculators set in radian mode instead of degrees; some began in radians and then switched to degrees later in the question but did not go back to make the necessary corrections. Several of the candidates rounded angle BDC from $89.3°$ to $90°$ and then proceeded to use the Pythagorean Theorem. Finding the second value of angle CBD was confusing for many candidates who did not recognize the possibility of the ambiguous case. Frequently no response was given or the answer was determined by subtracting from $360°$. Even those who floundered in the middle parts of the question were able to correctly answer the part regarding area of the triangle.

Question 3: Probability

Question 3A was done very well by those candidates who were familiar with the concept of a probability distribution. Unfortunately, many candidates simply left the question blank. Question 3B was also done well with correct tree diagrams from most candidates and correct probabilities calculated from this diagram. Difficulties arose in finding the conditional probability, though. Many candidates were able to find the expected value requested, but again there was a significant number who appeared to have no idea how to proceed. Many candidates assumed that the answer was $5.00 because the probability for green was greater than the probability for red. It is important to stress that finding a probability that is greater than 1 or negative should indicate that something is seriously wrong and that the working should be checked.

Question 4: Geometric Series

This question was well done with many candidates receiving full marks. In calculating the 15th term, the formula was correctly used but many candidates made errors with sign. The biggest weakness was in calculating the other value of x which made the sequence geometric. Many candidates simply gave the correct value of -5 without any justification, presumably having used trial and error. Trial and error is an acceptable method but it must be documented in some way to receive full marks. Also, since the formula for the infinite sum of a geometric sequence is only valid if $-1 < r < 1$, candidates will not receive credit for using this formula for values of r outside this interval. Many candidates had an incorrect value for the second value of x making a geometric sequence which led to an incorrect common ratio for this sequence. Often this ratio was greater than 1 and they then proceeded to attempt to compute the sum of the infinite series.

Question 5: Vectors

A fair number of candidates did well on this question but many had great difficulty. Finding $\overline{\text{AB}}$ was well done by most students, but finding a unit vector caused problems for many. In showing that the two vectors were perpendicular, many used the scalar product but failed to give a concluding statement linking the scalar product being zero with the vectors being perpendicular. In trying to find the position vector of S, many candidates simply found one half of $\overline{\text{AB}}$. The significance of the various parts of the vector equation of a line is something that was not well-recognized. Explaining why the two vectors were not parallel presented many challenges with a common answer being “the direction vectors are not equal”. Many equally vague explanations involving slopes also appeared. Many candidates had a good idea about how to find the point of intersection of the two lines but too many failed because they did not recognize one could not use the same parameter in both equations.

Recommendations and guidance for the teaching of future candidates

- Make sure that **all** areas of the syllabus are covered . Teachers should be familiar by now with the changes to the old syllabus.
- Give candidates practice in knowing when it is appropriate to use the GDC and when analytic approaches are called for. If a graph is used to find the solution to an equation or a maximum or minimum, a sketch of the graph must be included. This is clearly stated in the directions in the examination booklet itself.
- Give students practice in giving explanations for results and be tough in the marking of such explanations, demanding accuracy and clarity.
- Much more work needs to be done on vectors and on probability.
- Give students practice on **showing that** certain results are true. All intermediate steps must be shown with no assumptions made. Generally, these types of questions are not to be with the GDC. It is also important that candidates not work in reverse and simply verify that the answer is correct.
- The rules for accuracy of answers should be used throughout the course so that candidates become familiar with them.
- Candidates should be cautioned to check carefully when solving trigonometric problems to determine whether they need to work in radians or degrees.
- Teachers should emphasize the need to read each question carefully. Candidates should be encouraged to present their working in a clear and logical manner, writing solutions down the page. Candidates should avoid writing in two columns.

