MATHEMATICS HL TZ2

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

Overall grade boundaries

Discrete mathematics

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 12	13 – 25	26 – 36	37 – 47	48 – 59	60 – 70	71 – 100

Series and differential equations

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 12	13 – 25	26 – 36	37 – 47	48 – 59	60 – 70	71 – 100

Sets, relations and groups

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 13	14 – 26	27 – 38	39 – 49	50 – 61	62 – 72	73 – 100

Statistics and probability

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 13	14 – 27	28 – 39	40 – 50	51 – 62	63 – 73	74 – 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 2010 examination session the IB has produced time zone variants of the Mathematics HL papers.

Internal assessment

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 6	7 – 13	14 – 18	19 – 23	24 – 29	30 – 34	35 – 40

The portfolios produced this session gave ample evidence of the time and effort the candidates devoted to the completion of their tasks. The assessment criteria were generally well understood by both the teachers and the candidates. Unfortunately, the work was not always clearly marked, and some brief comments provided on the back of Form 5/PFCS were not entirely helpful in the moderation process. Observations made by the moderating team are summarised below:

The tasks:

Nearly all portfolio tasks were taken from the current publication, *"Mathematics HL – The portfolio – Tasks for use in 2009 and 2010",* with the most popular being *"Parabola", "Ratios of Areas and Volumes", "Viral Illness",* and *"Freight Elevator"*. There were also a few good teacher-designed tasks submitted by a number of schools. Teachers are encouraged to design their own tasks, keeping in mind the need to satisfy all criteria fully.

Tasks that were abridged versions of published tasks were not appropriate. Tasks which may have been provided in some textbooks as chapter-end revision activities generally did not satisfy all criteria and should not have been used.

There were two issues of concern this session.

1. Some teachers continued to use old tasks taken from a previous TSM. As explained in past Subject Reports and through the Coordinator's Notes, those tasks are no longer eligible for use; hence, a number of candidates lost a significant number of marks through no fault of their own! The teacher must take the responsibility of assigning appropriate tasks.
2. Tasks taken from the document for Mathematics SL are not at a suitable level for Mathematics HL and should not have been used.

Candidates' performance

The majority of candidates performed well against criterion A. Unfortunately, the use of computer notation such as "^" and "E09" were in evidence, and along with = when $\cong$" should have been used, careless notation was often overlooked by teachers. The careless misuse of some terminology (e.g. "plug in", "sub") should also be avoided.

Good communication skills were evident in some samples. Where a candidate's work began with an introduction to the task, and comments, annotations, and conclusions accompanied the steps and results, the work was easy to read and follow, and earned high marks in criterion B. However, there were many candidates whose work did not flow, particularly when there was no introduction to a task or when a question-and-answer format to a task was adopted. Unlabelled graphs and the relegation of tables to the appendix rate poorly in terms of an effective presentation and should have been penalised.

Generally, candidates produced good work, and the assessments against criteria C and D by their teachers have been appropriate. However, in some type I tasks, cursory investigation rendered the quick formulation of a conjecture questionable. In some instances, results were merely quoted from internet sources and there was little individual work in exploration and investigation, the key to the type I task.

In type II tasks, variables must be explicitly defined. Some realisation of the significance of the results obtained in terms of the created model when compared to the actual situation should have been provided, and candidates should have reflected on their findings. The analyses of data must be quantified, and if a regression analysis were appropriate, the candidate must have provided reasons for a particular choice. The use of software that automatically determines the "best" regression model leaves little for the candidate to interpret by himself and is of little merit.

The use of technology varied considerably. Full marks were often given much too generously for an appropriate but not necessarily a resourceful use of technology, for example, in the mere inclusion of a graph of data. For full marks, the use of technology should contribute significantly to the development of each task.

There were many good pieces of work; however, the awarding of full marks in criterion F requires more than completion and correctness, but the evidence of mathematical sophistication in a piece of exemplary work.

Suggestions to teachers

Tasks from the TSM and earlier publications must not be used in the candidates' portfolio work. Teachers are encouraged to design their own.

Teachers should select tasks that provide candidates with a variety of mathematical activities suitable at higher level. Tasks taken from the Mathematics SL publication do not meet HL requirements. Please ensure that candidates do not lose marks due to inappropriate choices made by the teacher.

The teacher must be fully informed of the portfolio assessment criteria to avoid a significant loss of marks in moderation.

The work in the sample portfolios are expected to be originals with the teacher's marks, not unmarked copies. Teachers are expected to write directly on their candidates' work, not only to provide feedback to the candidates, but information to the moderators as well. Some samples contained very few comments, making moderation extremely difficult when it was not possible to determine the basis upon which the teacher awarded marks.

The background information to each portfolio task is required to accompany each sample, either on Form A or through anecdotal comments. Moderators find them very useful in determining the context in which the task was given when confirming the achievement levels awarded; however, such information was often missing.

A solution key for tasks from the current publication, as well as for those designed by teachers, must accompany the portfolios in order that moderators can justify the accuracy of the work, and appreciate the level of sophistication demonstrated by the candidates.

Although the tasks contained in the current document, "Mathematics HL – The portfolio – Tasks for use in 2009 and 2010", may be used by candidates in the November 2010 examination session, they should now be considered to have expired for candidates in the May examination sessions. Candidates completing their diplomas in May 2011 and beyond should not be assigned these tasks.

Paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 16	17 – 32	33 – 47	48 – 58	59 – 70	71 – 81	82 – 120

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

On this paper candidates found difficulty with describing transformations, finding the normal to a curve from an implicit equation, integration, and showing general results for vectors. It was clear that a number of candidates found difficulty with the time. This was taken into account when setting the grade boundaries, but many candidates spent a lot of time using time-consuming methods to solve relatively simple problems.

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

On the whole candidates appeared to have been reasonably well prepared for questions on most aspects of differentiation, vector and scalar product, Binomial distributions, and matrices.

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

Question 1

Most candidates made a meaningful attempt at this question with many gaining the correct answers. One or two candidates did not attempt this question at all.

Question 2

There were fewer correct solutions to this question than might be expected with a significant minority of candidates unable to complete the square successfully and a number of candidates unable to describe the transformations. A minority of candidates knew the correct terminology for the transformations and this potentially highlights the need for teachers to teach students appropriate terminology.

Question 3

The majority of candidates understood what was required in part (a) of this question and gained the correct answer. Most candidates were able to do part (b) but few realised that they did not have to calculate $|a+2b|$ as this is $|c|$. Many candidates lost time on this question.

Question 4

Many correct answers were seen to this and the majority of candidates recognised the need to use a Binomial distribution. A number of candidates, although finding the correct expressions for $P(X=3)$ and $P(X=4)$, were unable to perform the required simplification.

Question 5

Many fully correct answers were seen to this question, but two points should be noted. Firstly, a significant minority of candidates made arithmetic errors in calculating BA and secondly the large amount of time some candidates spent on trying to arithmetically evaluate part (c) led to a shortage of time in section B.

Question 6

Most candidates were able to make a meaningful start to this question, but a significant number were unable to find an appropriate expression for $\tan x$ or to rationalise the denominator.

Question 7

Part (a) was successfully answered by most candidates. Most candidates were able to make significant progress with part (b) but were then let down by being unable to simplify the expression or by not understanding the significance of being told that $a>1$.

Question 8

This was the first question to cause the majority of candidates a problem and only the better candidates gained full marks. Weaker candidates made errors in the implicit differentiation and those who were able to do this often were unable to simplify the expression they gained for the gradient of the normal in terms of c; a significant number of candidates did not know how to simplify the logarithms appropriately.

Question 9

Again very few candidates gained full marks on this question. The most common approach was to begin by integrating by parts, which was done correctly, but very few candidates then knew how to integrate $\frac{t^2}{t+1}$. Those who began with a substitution often made more progress. Again a number of candidates were let down by their inability to simplify appropriately.

Question 10

Many candidates gained the correct answer to part (a), although a significant minority left the answer in the form $y = \ldots$ or $x = \ldots$ rather than $f^{-1}\ x\ = \ldots$. Only the better candidates were able to make significant progress in part (b).

Question 11

Although there were a good number of wholly correct solutions to this question, it was clear that a number of students had not been prepared for questions on conjectures. The proof by induction was relatively well done, but candidates often showed a lack of rigour in the proof. It was fairly common to see students who did not appreciate the idea that $P\ k$ is assumed not given and this was penalised. Also it appeared that a number of students had been taught to write down the final reasoning for a proof by induction, even if no attempt of a proof had taken place. In these cases, the final reasoning mark was not awarded.

Question 12

This was the most accessible question in section B for the candidates. The majority of candidates produced partially correct answers to part (a), with nearly all candidates being able to use the scalar and vector product. Candidates found part (iv) harder and often did not appreciate the significance of letting $z = 0$. Candidates clearly found part (b) harder and again this was a point where candidates lost time. Many candidates attempted this using components, which was fine in part (i), fine, but time consuming in part (ii), and extremely complicated in part (iii). A number of candidates lost marks because they were careless in showing their working in part (ii) which required them to “show that”.

Question 13

Most candidates were able to make a meaningful start to part (a) with many fully correct answers seen. Part (b) was the exact opposite with the majority of candidates not knowing what was required and failing to spot the connection to part (a). Candidates made a reasonable start to part (c), but often did not recognise the need to use the result that $1+\omega+\omega^2=0$. This meant that most candidates were unable to make any progress on part (c) (ii).

Question 14

Most candidates found this question challenging and only a handful of fully correct answers were seen. Only the better candidates made significant progress in solving the differential equation. Most candidates found part (b) difficult and often did not realise that part (b) (ii) followed from the result given in part (i). It was not uncommon to see students trying to find the integral of $\sec x$.

Recommendations and guidance for the teaching of future candidates

- Students need to cover the entire syllabus.
- Students should be encouraged to pay attention to mathematical notation and accuracy.
- Teachers should emphasise the importance of students setting out their procedures in a logical fashion.
- Most of the questions in this paper used common problem solving strategies and this should be a focus for candidates.
- Students need to practise papers of a similar style in order that they understand the need to balance their time.
- Students need to be made aware of appropriate terminology.
- Students need to realise that when a question states: “show that”, they need to rigorously demonstrate the result.

Paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 12	13 – 25	26 – 36	37 – 50	51 – 64	65 – 78	79 – 120

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

- On a paper where the GDC is allowed there was little understanding that calculator notation is not an alternative to explaining methods prior to using the GDC.
- Most candidates are not familiar with the conventions of ‘sigma notation’.
- How to simplify quotients of factorials is a general problem.
- Many candidates were not able to tackle Q10 on related rates of change. This is an issue that comes up year after year.

The levels of knowledge, understanding and skill demonstrated

There was good work seen across the whole syllabus. It was pleasing to see competence in statistics and GDC work.

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

Question 1

An easy starter question, but few candidates seem to be familiar with the conventions of sigma notation.

Question 2

An easy question, well answered by most candidates. For the others it was disappointing that many did not use the fact that the probabilities add to unity.

Question 3

A straightforward Normal distribution problem, but many candidates confused the z value with the probability.

Question 4

A more difficult question. Many candidates failed to read the question carefully so did not express x in terms of ln2.

Question 5

Well done.

Question 6

Part (a) - Well done by most, although there were some answers that ignored the requirement of mathematical notation.

Part (b) - Not successfully answered by many. The main problem was not correctly interpreting the inequalities in the probability.

Question 7

Part(a) - Generally well done.

Part(b) - Moderate success here. Some forgot that an equation must have an = sign.

Question 8

Part(a) - Although most understood the notation, few knew how to simplify the binomial coefficients.

Part(b) - Many were able to solve the cubic, but some failed to report their answer as an integer inequality.

Question 9

Part(a) - The majority either obtained full marks or no marks here.

Part(b) - This question was algebraically complex and caused some candidates to waste their efforts for little credit.

Question 10

This was a wordy question with a clear diagram, requiring candidates to state variables and do some calculus. Very few responded appropriately

Question 11

This was a multi-part question that was well answered by many candidates. The main difficulty was sketching the graph and this meant that the last part was not well answered.

Question 12

This question was generally well answered. Some were unfamiliar with the term ‘interquartile range’.

Question 13

This was a disappointingly answered question.

Part(a) - Many candidates correctly assumed that the areas of the sectors were proportional to their angles, but did not actually state that fact.

Part(b) - Few candidates seem to know what the term ‘perimeter’ means.

Question 14

Part(a) - $g \circ f$ was usually found but few found its range.

Part(b) - Inverse usually found, but most were incorrect on its domain.

Part(c) - Many found $f \circ g \circ h$ but had difficulty carrying on.

Recommendations and guidance for the teaching of future candidates

As a paper for which candidates need to assess whether or not they need to use their GDC, it is important that teachers emphasise that mathematical notation must be used at all times.

Examination technique is important, so candidates should be advised that effort spent on elaborate algebraic manipulations is often a waste of time.

Paper three – Discrete mathematics

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 6	7 – 12	13 – 19	20 – 26	27 – 32	33 – 39	40 – 60

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

The proof of Euler's Relation and results stemming from it caused problems for many candidates.

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

Algorithms involving graphs are generally well understood.

The question involving Fermat's Little Theorem and congruences was generally well done.

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

Question 1

Part (a) was generally well answered with a variety of methods seen in (a)(ii). This was set with Fermat's Little Theorem in mind but in the event many candidates started off with many different powers of 5, eg $5^4 \equiv 2, 5^8 \equiv 4 \text{ and } 5^3 \equiv -1$ (mod 7) were all seen. A variety of methods was also seen in (b), ranging from use of the Chinese Remainder Theorem, finding tables of numbers congruent to 3(mod 4) and 4(mod 5) and the use of an appropriate formula.

Question 2

Part (a) was well done by many candidates although some candidates simply drew the minimum spanning tree in (i) without indicating the use of Kruskal's Algorithm. It is important to stress to candidates that, as indicated in the rubric at the top of Page 2, answers must be supported by working and/or explanations. Part (b) caused problems for some candidates who obtained the unhelpful upper bound of 96 by doubling the weight of the minimum spanning tree. It is useful to note that the weight of any Hamiltonian cycle is an upper bound and in this case it was fairly easy to find such a cycle with weight less than or equal to 80.

Question 3

Parts (a) and (b) were generally well answered. Part (c), however, caused problems for many candidates with some candidates even believing that showing divisibility by 2 and 3 was sufficient to prove divisibility by 12. Some candidates stated that the fact that the sum of the digits was 44 (which itself is divisible by 4) indicated divisibility by 4 but this was only accepted if the candidates extended their proof in (b) to cover divisibility by 4.

Question 4

Parts (a) and (b) were found difficult by many candidates with explanations often inadequate. In (c), candidates who realised that the union of a graph with its complement results in a complete graph were often successful.

Question 5

Most candidates who solved this question used the argument that there are four variables which can take only one of three different values modulo 3 so that at least two must be equivalent modulo 3 which leads to the required result. This apparently simple result, however, requires a fair amount of insight and few candidates managed it.

Recommendation and guidance for the teaching of future candidates

Candidates should be able to justify some of the basic results in graph theory.

Candidates should be encouraged to present their work as neatly as possible. Some of the scripts seen this year were quite difficult to understand and work that cannot be read cannot be given any marks.

Paper three – Series and differential equations

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 6	7 – 13	14 – 19	20 – 26	27 – 32	33 – 39	40 – 60

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

Although it is a core topic, some candidates seem to be unable to use integration by parts, especially when repeated use is required.

This option requires a certain level of skill in algebraic manipulation and some candidates do not possess this.

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

Most candidates are able to use Euler's method for solving differential equations.

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

Question 1

Most candidates seemed familiar with Euler's method. The most common way of losing marks was either to round intermediate answers to insufficient accuracy despite the advice in the question or simply to make an arithmetic error. Many candidates were given an accuracy penalty for not rounding their answer to three significant figures.

Question 2

Although this question is based on core material, many candidates were unable to perform the double integration by parts successfully. The difficulty in the method often lies in the choice of *u* and *v* and wrong choices were often made. Many candidates failed to consider adequately what happens at the upper limit (infinity). The question was structured so that the solution to (a) led to the solution for (b) but in many cases, the solutions to (a) and (b) were mixed up often to the candidates' disadvantage. In this case, candidates who obtained the required results, in whatever order, were of course given full credit.

Question 3

Most candidates recognised this differential equation as one in which the substitution $y = vx$ would be helpful and many carried the method through to a successful conclusion. The most common error seen was an incorrect integration of $\frac{1}{4+v^2}$ with partial fractions and/or a logarithmic evaluation seen. Some candidates failed to include an arbitrary constant which led to a loss of marks later on.

Question 4

Many candidates ignored the instruction in the question to use the series for $(1+x)^n$ to deduce the series for $(1-x^2)^{-1/2}$ and attempted instead to obtain it by successive differentiation. It was decided at the standardisation meeting to award full credit for this method although in the event the algebra proved to be too difficult for many. Many candidates used l'Hopital's Rule in (c) – this was much more difficult algebraically than using the series and it usually ended unsuccessfully. Candidates should realise that if a question on evaluating an indeterminate limit follows the determination of a Maclaurin series then it is likely that the series will be helpful in evaluating the limit. Part (d) caused problems for many candidates with algebraic errors being common. Many candidates failed to realise that the best way to find the exact value of the integral was to use the calculator.

Question 5

Most candidates found the radius of convergence correctly but examining the situation when $x = \pm 2$ often ended in loss of marks through inadequate explanations. In (b)(i) many candidates were able to justify the convergence of the given series. In (b)(ii), however, many candidates seemed unaware of the fact the sum to infinity lies between any pair of successive partial sums.

Recommendation and guidance for the teaching of future candidates

This option is likely to include questions which require competence in algebraic manipulation and it is essential to ensure that this is the case.

Candidates should be encouraged to present their work as neatly as possible. Some of the scripts seen this year were quite difficult to understand and work that cannot be read cannot be given any marks.

Paper three – Sets, relations and groups

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 8	9 – 17	18 – 26	27 – 32	33 – 39	40 – 45	46 – 60

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

- Some candidates seemed to be unaware that there are several ways of showing that a function is injective and that they should select the most suitable method in a particular case.
- Some candidates found matrix manipulation difficult.
- Some candidates were unfamiliar with permutations.
- Theoretical questions on groups continue to cause problems.

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

Candidates are generally extremely competent in dealing with specific groups.

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

Question 1

Solutions to (a) were often disappointing. Many candidates tried to use the result that, for an injection, $f(a) = f(b) \Rightarrow a = b$ – although this is the definition, it is often much easier to proceed by showing that the derivative is everywhere positive or everywhere negative or even to use a horizontal line test. Although (b) is based on core material, solutions were often disappointing with some very poor use of algebra seen.

Question 2

Solutions to (a) were generally poor. To show symmetry, many candidates assumed incorrectly that matrix multiplication is commutative, stating that $\boldsymbol{AH} = \boldsymbol{HB}$ implies that $\boldsymbol{HA} = \boldsymbol{BH}$. Candidates who showed correctly that $\boldsymbol{AH} = \boldsymbol{HB}$ implies that $\boldsymbol{BH}^{-1} = \boldsymbol{H}^{-1}\boldsymbol{A}$ often failed to show that $\boldsymbol{H}^{-1}$ is non-singular. To show transitivity, many candidates started with $\boldsymbol{AH} = \boldsymbol{HB}$ and $\boldsymbol{BH} = \boldsymbol{HC}$, not realising that a different '$\boldsymbol{H}$' is required for each relationship. Solutions to (b) were often not clearly expressed.

Question 3

Candidates are generally confident when dealing with a specific group and that was the situation again this year. Some candidates lost marks in (a)(ii) by not giving an adequate explanation for the truth of some of the group axioms, eg some wrote 'every element has an inverse'. Since the question told the candidates that {A,*) was a group, this had to be the case and the candidates were expected to justify their statement by noting that every element was self-inverse. Solutions to (c)(ii) were reasonably good in general, certainly better than solutions to questions involving isomorphisms set in previous years.

Question 4

Many candidates scored well on this question although some gave the impression of not having studied this topic. The most common error in (b) was to believe incorrectly that $p_1 p_2$ means p_1 followed by p_2. This was condoned in (i) but penalised in (ii). The Guide makes it quite clear that this is the notation to be used.

Question 5

Solutions to (a) were often disappointing with some solutions even stating that a cyclic group is, by definition, commutative and therefore Abelian. Explanations in (b) were often poor and it was difficult in some cases to distinguish between correct and incorrect solutions. In (c), candidates who realised that Lagrange's Theorem could be used were generally the most successful. Solutions again confirmed that, in general, candidates find theoretical questions on this topic difficult.

Recommendation and guidance for the teaching of future candidates

Candidates should be aware that there are several methods for showing that a function is injective.

More emphasis needs to be placed on matrix algebra which might be needed in questions on groups and equivalence relations.

The notation for combining permutations needs to be made clear.

Candidates should be encouraged to present their work as neatly as possible. Some of the scripts seen this year were quite difficult to understand and work that cannot be read cannot be given any marks.

Paper three – Statistics and probability

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 9	10 – 18	19 – 27	28 – 34	35 – 41	42 – 48	49 – 60

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

It is clear that many candidates are not familiar with Type I and Type II errors.

Many candidates do not appreciate the difference between nX and $\sum_{i=1}^{n} X_i$. The situation is not helped by the fact that some candidates write the former to indicate the latter.

Many candidates suffer an accuracy penalty for not giving numerical answers correct to three significant figures.

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

Most candidates are extremely competent in the use of the calculator to solve problems involving statistical inference.

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

Question 1

This was well answered by many candidates. In (a), some candidates chose the wrong standard deviation from their calculator and often failed to square their result to obtain the unbiased variance estimate. Candidates should realise that it is the smaller of the two values (ie the one obtained by dividing by $(n-1)$) that is required. The most common error was to use the normal distribution instead of the *t*-distribution. The signpost towards the *t*-distribution is the fact that the variance had to be estimated in (a). Accuracy penalties were often given for failure to round the confidence limits, the *t*-statistic or the *p*-value to three significant figures.

Question 2

This question caused problems for many candidates and the solutions were often disappointing. Some candidates seemed to be unaware of the meaning of Type I and Type II errors. Others were unable to calculate the probabilities even when they knew what they represented. Candidates who used a normal approximation to obtain the probabilities were not given full credit – there seems little point in using an approximation when the exact value could be found.

Question 3

This was the best answered question on the paper, helped probably by the fact that rounding errors in finding the expected frequencies were not an issue. In (a), some candidates thought, incorrectly, that all they had to do was to show that $\int_0^6 f(x)\,\mathrm{d}x = 1$. In (b), some candidates thought, again incorrectly, that the given distribution was uniform rather than triangular. It was noted that many candidates used the goodness of fit facility on their calculators to calculate χ^2_{calc} and this was of course accepted. This approach does, however, run the risk of mis-entering data and obtaining an incorrect answer for which no method mark could be awarded if the value is simply written down.

Question 4

Solutions to this question again illustrated the fact that many candidates are unable to distinguish between nX and $\sum_{i=1}^{n} X_i$ so that many candidates obtained an incorrect variance to evaluate the final probability.

Question 5

Questions on these discrete distributions have not been generally well answered in the past and it was pleasing to note that many candidates submitted a reasonably good solution to this question. In (a) the most common error was to believe or state that the appropriate distribution was binomial. This gave the correct mean but an incorrect variance. In (b), the determination of the value of p was often successful using a variety of methods including solving the equation $p(1-p) = (0.000396\ ...)^{1/5}$, graph plotting or using SOLVER on the GDC or even expanding the equation into a 10th degree polynomial and solving that. Solutions to this particular question exceeded expectations.

Recommendation and guidance for the teaching of future candidates

Candidates should be made aware of the accuracy rules which require answers to be given either exactly or to three significant figures.

Candidates should be encouraged to present their work as neatly as possible. Some of the scripts seen this year were quite difficult to understand and work that cannot be read cannot be given any marks.