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 – 37	38 – 49	50 – 61	62 – 73	74 – 100

Series and differential equations

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 11	12 – 24	25 – 34	35 – 46	47 – 57	58 – 69	70 – 100

Sets, relations and groups

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 12	13 – 25	26 – 36	37 – 48	49 – 61	62 – 73	74 – 100

Statistics and probability

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 12	13 – 24	25 – 35	36 – 47	48 – 59	60 – 71	72 – 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 2011 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 majority of the portfolios produced this session represented a substantial amount of work on the part of the candidates. The assessment criteria were generally well understood by both the teachers and the candidates. However, a large number of teachers have not indicated their students' background information, or provided solutions keys which would have given moderators a much better understanding of the teachers' assessment of their students' work.

The tasks

Nearly all portfolio tasks were taken from the current publication, *"Mathematics HL – The portfolio – Tasks for use in 2011 and 2012".* Each of the four tasks from the document was very popular. There were also a few good teacher-designed tasks submitted by a number of schools; however, a disappointing number of teachers used very old tasks from an outdated TSM without significant modification. The resulting tasks fell short of meeting the current assessment criteria. Teachers are encouraged to design their own tasks, while keeping in mind the need to satisfy all criteria fully.

Candidates' performance

The majority of candidates performed well against criterion A. Unfortunately, the use of computer notation such as "^" and "E12" were still in evidence, and careless notation was often overlooked by teachers. The careless misuse of some colloquial terminology (e.g. "*plug in", "sub*") must be avoided.

Good communication skills were evident in many samples. Many candidates produced work that was a pleasure to read, starting with a personal introduction to the task, and providing comments, explanations, and conclusions to accompany their steps and results. Such work earned high marks in criterion B. On the other hand, there were some 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 in spite of the instructions given at the beginning of each task. Unlabelled graphs and the relegation of tables to the appendix rate poorly in terms of an effective presentation and should have been penalised by the teacher.

Candidates generally produced good and complete work, and the assessments against criteria C and D by their teachers have been appropriate. However, in some type I tasks, candidates formed conjectures much too soon from "patterns" observed from an inadequate number of observations. In some instances, generalisations were quoted from internet sources, leaving very little room for exploration and investigation, the essential components of the type I task.

In type II tasks, variables must be explicitly defined. Some realisation of the significance of the results obtained with the created model when compared to the actual situation should have been provided, and candidates should have reflected on their findings. The analysis of data must be quantified, and if a regression analysis were appropriate, the candidates should have explained the significance of the measure of the goodness of fit.

The use of technology varied considerably. The tasks from the current publication contained many opportunities for candidates to extend their work with the use of technology, ranging from 3-D graphs and dynamic spreadsheets to interactive graphs with sliders. Full marks were given much too generously for an *appropriat*e but not necessarily a *resourceful* use of technology. The use of technology should contribute to the *development* of each task, not merely its illustration.

There were many good pieces of work; nevertheless, the highest achievement level in criterion F requires more than completion and correctness, but the evidence of mathematical sophistication beyond what was expected in the statement of task.

Suggestions to teachers

Teachers are encouraged to design their own tasks; however, modifying an old task is ill advised due to the availability of model solutions to the originals readily available online.

The teacher must be fully informed of the portfolio assessment criteria to avoid a significant loss of marks in moderation. Where there is more than one teacher involved in Maths HL, a collegial process of “internal moderation” may help keep the criteria well defined.

To reiterate a recurring concern: the portfolios selected to comprise the school sample are expected to be originals with the teacher’s marks, not unmarked photocopies. Teachers are expected to write directly on their students’ work, not only to provide feedback to the students, 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 each task was given when confirming the achievement levels awarded; unfortunately, 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.

Paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 12	13 – 25	26 – 35	36 – 49	50 – 64	65 – 78	79 – 120

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

Candidates found difficulty with probability, complex numbers, vectors, sketching functions and finding inverse functions. In addition proving required results was found to be difficult by a significant number of candidates. A significant number of candidates seemed to find it difficult to allocate the time between Sections A and B difficult. Many spent more time on Section A and did not have sufficient time for Section B. Simplification of factorial expressions seemed to cause problems for a number of candidates.

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

Candidates seemed to handle the sections on basic differentiation, finding areas and applications of coordinate geometry to tangents and normals well. The structure of a proof by induction was understood well and sequences and series was done well by most candidates. Basic manipulation of algebraic expressions was done well by most.

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

Section A

Question 1

In general candidates handled this question well although a number equated the derivative to the function value rather than zero. Most recognised the shift in the second part although a number shifted only the squared value and not both x values.

Question 2

There were quite a few algebraic errors in this question, both in the determinant and the solution of the quadratic equation. It seemed that a significant number of students were not aware of the relationship $\det A^2 = (\det A)^2$.

Question 3

Most candidates completed this question well. A number extended the graph beyond the given domain.

Question 4

It was disappointing to note the lack of diagram in many solutions. Most importantly the lack of understanding of the notation AB was apparent. Teachers need to make sure that students are aware of correct notation as given in the outline. A number used the cosine rule but then confused the required angle or sides.

Question 5

Many candidates were able to find the reciprocal but many struggled with the second part. Sketches were quite poor in detail.

Question 6

Most candidates were able to find the expressions for the two vectors although a number were not able to do this. Most then tried to use Pythagoras' theorem and confused scalars and vectors. There were few correct responses to the second part. Candidates did not seem to be able to use the algebra of vectors comfortably.

Question 7

The majority of candidates were able to find the area of Triangle AOP correctly. Most were then able to get an expression for the other triangle. In the final section, few saw the connection between the area of the sector and the relationship.

Question 8

A significant number of candidates did not recognise the need for the quadratic formula in order to find the inverse. Even when they did most candidates who got this far did not recognise the need to limit the solution to the positive only. This question was done well by a very limited number of candidates.

Question 9

There were two main methods used to complete this question, the most common being a combinations approach. Those who did this coped well with the factorial simplification. Many who did not manage the first part were able to complete the second part successfully.

Question 10

This question was done well by many students. Those who did not do it well often became involved in convoluted algebraic processes that complicated matters significantly. There were a number of different approaches taken which were valid.

Section B

Question 11

The whole of this question seemed to prove accessible to a high proportion of candidates.

(a) was well answered by most, although a number of candidates gave only the x-values of the points or omitted the value at 0.

(b) was successfully solved by the majority of candidates, who also found the correct equation of the normal in (c).

The last section proved more difficult for many candidates, the most common error being to use the wrong perpendicular sides. There were a number of different approaches here all of which were potentially correct but errors abounded.

Question 12

In part a) the factorisation was, on the whole, well done.

Part (b) was done well by most although using a substitution method rather than the result above. This used much m retime than was necessary but was successful. A number of candidates did not use the previous results in part (iii) and so seemed to not understand the use of the 'hence'.

(c) Many candidates used the approach of equating the left and right hand sides but were not able to show the connection correctly. Few used the previous results.

(d) Many candidates attempted to equate the left and right hand sides but found this difficult.

Question 13

A significant number of candidates did not seem to have the time required to attempt this question satisfactorily.

Part (a) was done quite well by most but a number found sketching the functions difficult, the most common error being poor labelling of the axes.

Part (ii) was done well by most the most common error being to divide the equation by $\sin x$ and so omit the $x = 0$ value. Many recognised the value from the graph and corrected this in their final solution.

The final part was done well by many candidates

Many candidates found (b) challenging. Few were able to substitute the dx expression correctly and many did not even seem to recognise the need for this term. Those that did tended to be able to find the integral correctly. Most saw the need for the double angle expression although many did not change the limits successfully.

Few candidates attempted part c). Those who did get this far managed the sketch well and were able to explain the relationship required. Among those who gave a response to this many were able to get the result although a number made errors in giving the inverse function. On the whole those who got this far did it well.

Recommendations and guidance for the teaching of future candidates

- Emphasise the difference between 'show', 'prove' and 'illustrate'. Students need to be able to show rigour in their work.
- Concentrate on the connections between parts of questions so that students look for connections and do not simply go to algebraic substitution for results but look for other ways of seeing relationships.
- Emphasise the need to read critically and determine what is required in the solution to a given question.
- Concentrate on the notation and terminology that is required so that students understand what is required in a given question.

- Students need to balance the time that they spend on different questions and sections of a paper.
- Solutions should be set out clearly and logically, with each question preferably on a different page.

Paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 12	13 – 25	26 – 39	40 – 54	55 – 69	70 – 84	85 – 120

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

On a paper where the use of a GDC is expected for relevant questions, it is surprising that premature rounding and the generic 3 significant figures requirement is still an issue, resulting in an unnecessary loss of marks.

The applications of calculus: kinematics; contextual questions involving related rates of change.

Communication and organisation of methods and results.

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

Good work was seen across the whole syllabus. Competence was seen in: basic calculus, extending up to integration by parts; trigonometry, including identities; logarithms; probability/statistics; 3-d work with vectors.

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

Question 1

This was an easy starter question, with most candidates gaining full marks. Others lost marks through premature rounding or the incorrect use of radian measure.

Question 2

This question was well answered by most candidates. A few did not realise that the answer had to be an integer.

Question 3

Part (a) was generally correctly answered. A few candidates suffered the Arithmetic Penalty for giving their answer to more than 3sf. A smaller number were unable to differentiate the exponential function correctly. Part (b) was less well answered, many candidates not thinking clearly about the position and direction associated with the initial conditions.

Question 4

Part (a) was well done, with candidates making good use of trigonometric identities. Part (b) rarely attracted any marks. The identity $\det(AB) = \det(A)\ \det(B)$ does not seem to be widely known – it is clearly stated in the HL core syllabus.

Question 5

This question was generally well done, except for the behaviour near the origin. The questions alerted candidates to the existence of four turning points and an oblique asymptote, but not all reported back on this information.

Question 6

Part (a) was almost universally correctly answered, albeit with an accuracy penalty in some cases. In (b) it was generally recognised that the distribution was binomial, but with some wavering about the correct value of the parameter p. Part (c) was sometimes answered correctly, but not with much confidence.

Question 7

In part (a) almost all candidates obtained the correct answer, either in numerical form or in exact form. Although many candidates scored one mark in (b), for one gradient, few scored any more. Successful candidates almost always adopted a vector approach to finding the angle between the two tangents, rather than using trigonometry.

Question 8

It was pleasing to see some very slick solutions to this question. There were various reasons for the less successful attempts: not drawing a diagram; drawing a diagram, but putting one vertex of the triangle at the centre of the circle; drawing the circle inside the triangle; the side of the triangle being denoted by r the symbol used in the question for the radius of the circle.

Question 9

Questions of this type are often open to various approaches, but most full solutions require the application of 'related rates of change'. Although most candidates realised this, their success rate was low. This was particularly apparent in approaches involving trigonometric functions. Some candidates assumed constant speed – this gained some small credit. Candidates should be encouraged to state what their symbols stand for.

Question 10

Many candidates were able to perform the implicit differentiation. Few gained any further marks.

Question 11

This was a multi-part question that was well answered by many candidates. Wrong answers to part (a) were mainly the result of failing to draw a diagram. Follow through benefitted many candidates. A high proportion of candidates lost the mark in (e) by not writing their answer as an equation in the form $r = ...$

Question 12

Most candidates successfully answered (a) and (b). Although many found the correct answer to (c), communication of their reasoning was weak. This was also true for (d)(i). Answers to (d)(ii) were mostly scrappy and rarely worthy of credit.

Question 13

Part A: Given that this question is at the easier end of the 'proof by induction' spectrum, it was disappointing that so many candidates failed to score full marks. The $n = 1$ case was generally well done. The whole point of the method is that it involves logic, so 'let n = k' or 'put n = k', instead of 'assume ... to be true for n = k', gains no marks. The algebraic steps need to be more convincing than some candidates were able to show. It is astonishing that the R1 mark for the final statement was so often not awarded.

Part B: Part (a) was often well done, although some faltered after the first integration. Part (b) was also generally well done, although there were some errors with the constant of integration. In (c) the graph was often attempted, but errors in (b) usually led to manifestly incorrect plots. Many attempted the volume of integration and some obtained the correct value.

Recommendations and guidance for the teaching of future candidates

Many marks were lost because candidates either do not know or ignore the rules about the level of accuracy required.

Candidates must read the questions and answer appropriately. This was a particular issue in Question 5, where some candidates did not communicate clearly what they knew.

Paper three – Discrete mathematics

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 9	10 – 19	20 – 28	29 – 34	35 – 41	42 – 47	48 – 60

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

Some candidates seemed to be unfamiliar with methods for determining whether or not a number is prime.

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

Most candidates are confident in the use of the Euclidean Algorithm and the solution of Diophantine equations.

Candidates are generally able to solve straightforward problems involving graphs.

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

Question 1

This question was generally well answered although some candidates were unable to proceed from a particular solution of the Diophantine equation to the general solution.

Question 2

This question was generally well answered although some candidates failed to realise the significance of the equality of the upper and lower bounds.

Question 3

Part (a) was generally well answered. In (b), many candidates tested the result for $n = 1$ instead of $n = 0$. It has been suggested that the reason for this was a misunderstanding of the symbol N with some candidates believing it to denote the positive integers. It is important for candidates to be familiar with IB notation in which N denotes the positive integers and zero. In some scripts the presentation of the proof by induction was poor.

Question 4

Parts (a) and (b) were well answered by many candidates. In (c), candidates who tried to prove the result by adding edges to a drawing of G were given no credit. Candidates should be aware that the use of the word ‘Prove’ indicates that a formal treatment is required Solutions to (d) were often disappointing although a graphical solution was allowed here.

Question 5

In (a), some candidates tried to use Fermat's little theorem to determine whether or not 1189 is prime but this method will not always work and in any case the amount of computation involved can be excessive. For this reason, it is strongly recommended that this method should not be used in examinations. In (b), it was clear from the scripts that candidates who had covered this material were generally successful and those who had not previously seen the result were usually unable to proceed.

Recommendations and guidance for the teaching of future candidates

Candidates should be familiar with the notation used for certain standard sets in IB examinations, e.g. N indicates the set of the positive integers and zero.

Paper three – Series and differential equations

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 7	8 – 15	16 – 20	21 – 25	26 – 29	30 – 34	35 – 60

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

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

More generally, candidates taking this option need to have a thorough grasp of core calculus.

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

In (a), candidates who found the series by successive differentiation were generally successful, the most common error being to state that the derivative of $\ln(1+e^x)$ is $(1+e^x)^{-1}$. Some candidates assumed the series for $\ln(1+x)$ and e^x and attempted to combine them. This was accepted as an alternative solution but candidates using this method were often unable to obtain the required series. In (b), candidates were equally split between using the series or using l'Hopital's rule to find the limit. Both methods were fairly successful, but a number of candidates forgot that if a series was used, there had to be a recognition that it was not a finite series.

Question 2

Most candidates were familiar with Euler's method. The most common way of losing marks was either to round intermediate answers to insufficient accuracy or simply to make an arithmetic error. Many candidates were given an accuracy penalty for not rounding their answer to three significant figures. Few candidates were able to answer (b) correctly with most believing incorrectly that the step length was a relevant factor.

Question 3

Most candidates recognised this differential equation as one in which the substitution $y = vx$ would be helpful and many reached the stage of separating the variables. However, the integration of $\frac{1}{v^2 + 2v + 2}$ proved beyond many candidates who failed to realise that completing the square would lead to an arctan integral. This highlights the importance of students having a full understanding of the core calculus if they are studying this option.

Question 4

Part (a) is essentially core work requiring repeated integration by parts and many candidates realised that. However, some candidates left the modulus signs in I_0 which invalidated their work. In parts (b) and (c) it was clear that very few candidates had a complete understanding of the significance of the modulus sign and what conditions were necessary for it to be dropped. Overall, attempts at (b) and (c) were disappointing with few correct solutions seen.

Question 5

Solutions to (a) were generally good although some candidates failed to reach the correct conclusion from correct application of the ratio test. Solutions to (b) and (c), however, were generally disappointing with many candidates unable to make use of the signposting in the question. Candidates who were unable to solve (b) and (c) often picked up marks in (d).

Recommendations and guidance for the teaching of future candidates

This option is likely to include questions which require competence in algebraic manipulation and calculus and candidates need to be confident in these areas.

Candidates should be made aware of the accuracy rules which require answers to be given either exactly or to three significant figures. Many candidates taking this option are given accuracy penalties.

Paper three – Sets, relations and groups

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 9	10 – 18	19 – 26	27 – 33	34 – 39	40 – 46	47 – 60

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

Although candidates seem able, in general, to show that a relation is an equivalence relation, many find it difficult to determine the equivalence classes.

Isomorphism continues to be a difficult topic for many candidates.

Some candidates appeared to be unable to show that a function of two variables is a bijection.

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

Most candidates are confident in dealing with specific finite groups.

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

Question 1

Parts (a) and (b) were well done in general. Some candidates, however, when considering closure and associativity simply wrote ‘closed’ and ‘associativity’ without justification. Here, candidates were expected to make reference to their Cayley table to justify closure and to state that multiplication is associative to justify associativity. In (c), some candidates tried to show the required result without actually identifying the elements of *T*. This approach was invariably unsuccessful.

Question 2

It was disappointing to find that many candidates wrote the elements of A and B incorrectly. The most common errors were the inclusion of 1 as a prime number and the exclusion of 3 in B. It has been suggested that some candidates use N to denote the positive integers. If this is the case, then it is important to emphasise that the IB notation is that N denotes the positive integers and zero and IB candidates should all be aware of that. Most candidates solved the remaining parts of the question correctly and follow through ensured that those candidates with incorrect A and/or B were not penalised any further.

Question 3

Many candidates solved (a) correctly but solutions to (b) were generally poor. Most candidates seemed to have a weak understanding of the concept of equivalence classes and were unaware of any systematic method for finding the equivalence classes. If all else fails, a trial and error approach can be used. Here, starting with 1, it is easily seen that 4, 6,… belong to the same class and the pattern can be established.

Question 4

Candidates who knew that they were required to give a rigorous demonstration that *f* was injective and surjective were generally successful, although the formality that is needed in this style of demonstration was often lacking. Some candidates, however, tried unsuccessfully to give a verbal explanation or even a 2-D version of the horizontal line test. In 2-D, the only reliable method for showing that a function *f* is injective is to show that $f(a,b) = f(c,d) \Rightarrow (a,b) = (c,d)$.

Question 5

Solutions to (a) were often poor with inadequate explanations often seen. It was not uncommon to see

$$pq = pr$$
$$p^{-1}pq = p^{-1}pr$$
$$q = r$$

without any mention of associativity. Many candidates understood what was required in (b)(i), but solutions to (b)(ii) were often poor with the tables containing elements such as ab and bc without simplification. In (b)(iii), candidates were expected to determine the isomorphism by noting that the group defined by {1, – 1, i, – i} under multiplication is cyclic or that – 1 is the only self-inverse element apart from the identity, without necessarily writing down the Cayley table in full which many candidates did. Many candidates just stated that there was a bijection between the two groups without giving any justification for this.

Paper three – Statistics and probability

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 8	9 – 16	17 – 22	23 – 29	30 – 35	36 – 42	43 – 60

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

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 arithmetic penalty for not giving numerical answers correct to three significant figures.

Candidates should be aware that questions on this paper may involve mathematical topics from the core, including calculus.

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 one exception in the case of many candidates is determining the value of an unbiased estimate of variance which is usually not given directly but has to be obtained by squaring an appropriate standard deviation.

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

Question 1

As might be expected, (a) was well answered by many candidates, although those who gave 0.6915 straight from tables were given an arithmetic penalty. Parts (b) and (c), however, were not so well answered with errors in calculating the variances being the most common source of incorrect solutions. In particular, some candidates are still uncertain about the difference between nX and $\sum_{i=1}^{n} X_i$.

Question 2

This question was generally well answered. Some candidates lost marks by excessive rounding of the expected frequencies, sometimes going to the nearest integer. Here, the candidates should have given all expected frequencies exactly.

Question 3

In (a), most candidates gave a correct estimate for the mean but the variance estimate was often incorrect. Some candidates who use their GDC seem to be unable to obtain the unbiased variance estimate from the numbers on the screen. The way to proceed, of course, is to realise that the larger of the two ‘standard deviations’ on offer is the square root of the unbiased estimate so that its square gives the required result. In (b), most candidates realised that the t-distribution should be used although many were awarded an arithmetic penalty for giving either t = 2.911 or the critical value = 2.821. Some candidates who used the p-value method to reach a conclusion lost a mark by omitting to give the critical value. Many candidates found part (c) difficult and although they were able to obtain t = 2.49…, they were then unable to continue to obtain the confidence interval.

Question 4

Solutions to this question were often disappointing with many candidates not knowing what had to be done. Even those candidates who knew what to do sometimes made errors in evaluating the probabilities, often by misinterpreting the inequality signs. Candidates who used the Central Limit Theorem to evaluate the probabilities were given only partial credit on the grounds that the answers obtained were approximate and not exact.

Question 5

In general, candidates were able to start this question, but very few wholly correct answers were seen. Most candidates were able to write down the probability function but the process of taking logs was often unconvincing. The vast majority of candidates gave an incorrect domain for *f*, the most common error being $x \geq 3$. Most candidates failed to realise that the solution to (b) was to be found by setting the right-hand side of the given equation equal to zero. Many of the candidates who obtained the correct answer, 6.195…, then rounded this to 6 without realising that both 6 and 7 should be checked to see which gave the larger probability.

Recommendations 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. Many candidates taking this option are given accuracy penalties.
- Candidates should be aware that questions on this paper may involve the use of topics from the core including calculus.
- Candidates need to cover the entire syllabus and be prepared for questions on any of the distributions given in the syllabus.