FURTHER MATHEMATICS

Overall grade boundaries

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 13	14 - 27	28 - 42	43 - 51	52 - 61	62 - 71	72 - 100

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 9	10 - 18	19 - 24	25 - 30	31 - 37	38 - 43	44 - 60

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

On this paper candidates found difficulty with the algebra of groups, geometry and normal distributions.

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 using the Euclidean algorithm, number bases and solving differential equations.

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

Question 1

Most candidates were able to use the Euclidean algorithm to find a gcd and to express the answer in a different form. In part b) many correct answers were seen and a majority of students were able to use the work they had studied on number bases correctly. All but the weakest candidates were able to make a meaningful start to this question.

Question 2

This question was started by the majority of candidates, but only successfully completed by a few. Many candidates seemed to be aware of this style of question, but were either unable to make significant progress or manipulated the algebra in a contorted manner and hence lost valuable time. Also a number of candidates made assumptions about commutativity which were not justified. In part c) the idea of a proof by contradiction was used by stronger candidates, but weaker candidates were often at a loss as how to start. Overall, the level and succinctness of meaningful algebraic manipulation shown by candidates was disappointing.

Question 3

A few fully correct answers were seen to this question, but many candidates were unable to make much progress after part a) (i) and a significant minority made no attempt at all. A few fully correct answers were seen to part a) (ii) and part b) (i). In both part a) (ii) and part b) (ii) a majority of candidates were unable to draw a meaningful diagram to enable them to start the question.

Question 4

A good number of wholly correct answers were seen to this question and for stronger candidates it proved to be a successful question. A small number of candidates failed to recognise part a) as needing an integrating factor. More commonly, students left out the negative sign in the integrating factor or were unable to simplify the integrating factor. In part b) many students recognised the use of L'Hopital's rule, but in a number of cases made errors in the differentiation.

Question 5

This question proved to be the most difficult on the paper and few fully correct answers were seen. In part a) (i) many candidates did know how to find the answers in terms of µ. Very few candidates successfully completed part a) (ii). In part b) (i) a number of candidates made some progress, but few realised or knew how to convert the confidence interval for E(Y) into a confidence interval for µ. For those who persevered to the end of the question, there was a reasonable degree of success in part b) (ii).

Recommendations and guidance for the teaching of future candidates

- Students need to cover the entire syllabus. Many scripts were seen where candidates would answer questions on specific topics almost wholly correctly and then other questions would not be attempted at all.

- Students need to know the correct terminology.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 15	16 - 31	32 - 51	52 - 62	63 - 73	74 - 84	85 - 120

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

Many candidates could not convincingly list and apply the conditions involved in the hypotheses of convergence tests for series.

Candidates who tackled the geometry questions often drew very poorly labelled diagrams, which sometimes made them very difficult to mark.

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

Discrete and continuous probability distributions; graph theory; modular arithmetic.

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

Question1

(a)(i) A surprising number of candidates were unaware of the definition of the mode of a distribution. (a)(ii) Generally well done, although a few candidates gave a decimal answer. (b) Generally well done, and it was pleasing that most were familiar with the direct use of the negative binomial distribution in (ii).

Question 2

Although the various parts of this question were algebraically uncomplicated, many candidates revealed their lack of understanding of the necessary rigour required in the analysis of limits, improper integrals and the testing of series for convergence. For example, in (a)(i), the telescoping was often carried out on an infinite series rather than on a partial sum and then a limit taken. In (b)(i), the upper limit in the integral was often taken as infinity, without any mention of an underlying limiting process. Many candidates were more confident with part (d) than with the other parts of the question.

Question 3

This question was generally well done.

Question 4

This question was generally well done. Candidates who lost marks tended to do so as follows: (b)(i) For failing to give an example of a Hamiltonian path; (b)(ii) for giving an incomplete reason for the non-existence of a Hamiltonian cycle; (b)(iii)(iv) for giving the same reason for both parts; (d) for giving the definition of a bipartite graph as the reason for the fact that H is not bipartite.

Question 5

The majority of candidates earned significant marks on this question. However, many lost marks in part (a) by assuming that equivalence modulo 2 and 3 is transitive. This is a non-trivial true result but requires proof.

Question 6

Part A (a) Most candidates produced a valid answer, although a small minority used a circular argument. Part A (b) A few candidates went straight to the core of this question. However, many other candidates produced incoherent answers containing some true statements, some irrelevancies and some incorrect statements, based on a messy diagram. Part B (a) This was poorly answered. Many candidates failed to note that the points Q, P and its image were defined to be collinear, and tried to invoke the notion of the Apollonius Circle theory. Others tried a coordinate approach – in principle this could work, but is actually quite tricky without a sensible choice of axes and the origin.

Recommendations and guidance for the teaching of future candidates

Future candidates will be taking the new Higher Level Further Mathematics course, so will need to be well prepared in all of the Mathematics HL options, Linear Algebra and Geometry.