



A-LEVEL

FURTHER MATHEMATICS

7367/3D Paper 3: Discrete
Report on the Examination

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General

This is the first session in which this examination paper has been taken. There was a very good range of marks from 3 to 49. Many students would have gained more marks by improving the rigour of their solutions, most notably where the phrase ‘Fully justify your answer’ appeared.

Question 1

The vast majority of students selected the correct answer in this question.

Question 2

The vast majority of students selected the correct answer in this question.

Question 3

In part (a), most students realised the non-negativity constraint for an optimal solution was being used and proceeded to solve a quadratic equation/inequality. However, a significant number of responses ended at this point and did not use the condition $k \geq 1$ to rule out one of the intervals for k from the quadratic inequality. Some responses had the inequality sign missing (an equality sign being used instead), the wrong way around or made use of a strict inequality.

In part (b), the majority of students stated the correct answer. A common wrong answer here was ‘ $s = 20$ ’.

Question 4

In part (a), nearly all students were able to draw a correct graph with labelled vertices and edges. Incorrect answers often resulted from a slip (an incorrect pair of vertices being adjacent) or from using letters instead of ‘dots’ for vertices.

Again, part (b) was answered very well with the majority of students stating Euler’s formula, defining each of the variables, noting down the values of the known variables for this particular problem and then proceeding to show ‘ $f = 5$ ’. Many students explained the result of their algebra.

In part (c) many students realised that only two pairs of vertices (A & D and B & D) were not adjacent, so it was only these two pairs that needed analysing. The common mistake here was to compare the sum of the degrees of the two non-adjacent vertices with 3 rather than 5. Students who did this did not score the final mark. The best solutions were well laid out and concise and referred to Ore’s theorem and the graph being Hamiltonian in the conclusion.

Question 5

In part (a)(i), nearly all students were able to show that repeated multiplication of B with itself resulted in C , D and A . However, many students then did not fully justify why this meant that B was a generator of the group G . The best solutions gave a concluding statement such as ‘As repeated multiplication of B with itself produces all of the elements of G , then B is a generator of G .’

In part (a)(ii), most students were able to get the first two marks by relating all four elements of G with the associated four elements of H . Various different notations from the ‘maps to’ symbol \mapsto

were used and these were condoned. The final two marks were harder to achieve with fewer students going on to state their association was a one-to-one mapping which preserved the group structure and conclude that G and H are isomorphic. Some responses from students showed a very good level of understanding of group theory by noting that H was a cyclic group of order 4 and that G was also a cyclic group of order 4, and as all cyclic groups of the same order are isomorphic, then G and H are isomorphic.

In part (b)(i), many responses were not complete enough to be awarded the two marks. For instance, some responses did not refer explicitly to the order of H being 4, and others did not refer to Lagrange's theorem either by use of its name or by stating the theorem. Common errors included not mentioning order such as 'the subgroup must divide the group', or not quite saying enough to fully justify the answer such as '3 is not a factor of 4'.

In part (b)(ii), poor notation was condoned for the first two marks but correct notation was required for the third mark. Most responses were able to gain the first two marks as a result of this. Common mistakes included pairs of the 4 elements which were not subgroups of H , or forgetting that H and the trivial subgroup are subgroups of H .

Question 6

This topic was answered very well by the vast majority of students. Many well-structured answers were seen and a majority of students were able to arrive at the answer of 15 minutes via the correct method. Similarly, in part (b), the vast majority of students gave their answer in the context of the question such as 'the traffic warden may have to stop and issue fines, which will increase the time taken to walk around the town centre'.

Question 7

In part (a), the majority of students were able to arrive at the correct answer of 44 litres per second, but relatively few were then able to deduce what this meant in the context of the question. The most common error was not including any context, instead keeping the answer in the language of networks, arcs and nodes rather than water flow (in the associated units) through the water pipes.

Part (b)(i) was answered well, with many students appreciating that the question involved upper and lower capacities and that an initial flow was present. The common error here was to either put the numbers on the arrows the wrong way around, or to have zero on the backwards arrow of every arc as if attempting to start from a flow of zero. Part (b)(ii) was also answered well with many students arriving at a maximum flow of 44 litres per second by finding 3, 4 or 5 augmenting paths that would increase the flow.

Many students overcomplicated the problem with their choice of augmenting paths, often choosing paths that doubled-back on themselves rather than attempting to get from the source S to the sink T in as few nodes as possible. This often led to marks not being awarded due to having extra flows which did not add to 6 litres per second.

Part (c) was more demanding and relatively few students were able to link their answers to part (a) and (b) to come up with the correct recommendation for the pipe to be upgraded.

Question 8

Nearly all students were able to draw out the activity network in part (a)(i), but many students made numerical mistakes when determining the earliest start times and latest finish times for each activity in part (a)(ii). This led to mistakes in stating the two critical paths in part (b), with some responses having just one or three critical paths.

Part (c)(i) was not answered as well, with many students not constructing a histogram due to leaving gaps under their rectangles. Some students constructed Gantt charts instead of the resource histogram, and some responses had float represented on the histogram. Whilst it is not necessary to have critical path activities on the bottom row of the histogram, it is good practice as it prevents unallocated regions appearing at the base of the histogram.

Part (c)(ii) was similar to (c)(i) in that only a few students were able to arrive at an answer of 66 days by resource levelling. Whilst it was not necessary to use Figure 5 in order to achieve the marks for (c)(ii), the most successful responses made use of this figure to arrive at the correct answer.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the [Results Statistics](#) page of the AQA Website.