AQA

A-LEVEL
FURTHER MATHEMATICS

7367/3D Discrete
Report on the Examination

7367
June 2022

Version: 1.0

Question 1

Nearly all students provided the correct answer for this question.

Question 2

As with question 1, nearly all students provided the correct answer for this question.

Question 3

Fewer students provided the correct answer for this question when compared with questions 1 and 2, being tripped up by selecting the answer with the lowest minimum completion time (option 3) rather than the correct answer which respected the order of precedence of the activities.

Question 4

Around three-quarters of students were awarded the mark in part (a). Where the mark was not awarded, it was often for identifying the wrong strategy or not providing a reason why strategy D should not be played.

Just over half of all students were awarded the full 3 marks in part (b). The main reason why marks were lost was not being fully explicit in why a stable solution did not exist. This was often due to not properly identifying the maximum of the row minima and the minimum of the column maxima and clearly stating that these two quantities were not equal.

In part (c) just under three quarters of students received both marks. Most students were able to identify that Ben should play strategy A, but fewer students provided the necessary explanation based on Jadzia's play-safe strategy.

Question 5

Two thirds of students were awarded all 4 marks in part (a). The vast majority of students identified the correct procedure to follow, but made numerical errors in finding the lowest total weight between odd nodes. However, students who did make a mistake were still able to be awarded the final 'follow-through' mark if they did the correct calculation from their working.

In part (b), a little under two-thirds of students correctly calculated a relevant value based on this simple model for the village, either estimating the average distance between street lights or estimating the minimum number of street lights required using the 2250 metres from the stem of the question. The most common error was using the answer to part (a), in the calculation for part (b). Where students did perform the correct calculation, a clear comparison between two values and a clear statement about whether the village met the requirement was necessary, and some students did not provide a comparison or a statement that was clear enough for the second mark.

Question 6

Most students were able to obtain the first two marks in part (a)(i), but fewer than half of students were awarded all 3 marks, due to students writing down one or more of the latest finish times incorrectly. The best solutions included an additional ‘END’ activity of zero duration, which helped students recognise the correct total duration of the project.

Just over two thirds of students were awarded the mark in part (a)(ii). Those who did not achieve the mark usually had incorrect critical activities from an error in the earliest start times and latest finish times in part (a)(i).

In part (b) most students were able to identify that activity *J* was the one that should be selected, but fewer than half of the students were able to explain that all other activities would only reduce the minimum completion time by at most 1 week, whereas activity *J* is the only activity that would reduce the minimum completion time by the full 2 weeks.

Question 7

Around a third of students received both marks in part (a). The inclusion of ‘Fully justify your answer’ was a nudge to the explanation of, or reference to, Lagrange’s theorem, and this was most often omitted by the students who gained the first mark.

In part (b)(i) just under three quarters of students were able to correctly state that such an element is called a generator.

Part (b)(ii) was found challenging with relatively few students able to provide the name of a group isomorphic to *G*, with ‘abelian’ being the most common incorrect answer. The best answers were ‘rotational symmetries of the regular polygon with p sides’ and ‘cyclic group of order p’.

In part (c) just over a third of students were awarded both marks, and generally if a student could start the question by writing down the correct relationship for an inverse element, they tended to go on and complete the question correctly.

Answers to part (d)(i) were often too general in what closure meant for a group, rather than why the group *G* given in the stem to (d) was closed. This resulted in fewer than a quarter of students being awarded the mark.

The previous part did not have an influence on the answering of (d)(ii) as around 85% of students were awarded the mark. The most common errors were a numerical error in one of the table entries or using multiplication modulo 5 rather than addition modulo 5.

Question 8

Three quarters of students were awarded at least one mark in part (a) by correctly introducing a supersink with correctly directed arcs. Common mistakes included not giving upper and lower capacities on the two new arcs or giving incorrect capacities.

In part (b), a quarter of students received all 4 marks, with units on the final correct answer necessary for the final mark. There were a number of students that seemed to start from a flow of zero, but this is not a feasible flow due to the lower capacities on the arcs and so this approach was awarded zero marks.

Just under 20% of students were awarded both marks in part (c). Whilst students were typically able to identify the correct minimum cut using set notation or by listing the arcs that are cut, most students did not provide a full proof of why the flow of 79 m^3 s^{-1} was the maximum flow. It was necessary to explain or refer to the maximum-flow minimum-cut theorem.

In part (d) a lot of students argued that no more flow could be passed through the arc *AG* if its capacity was increased, but this is incorrect as flow along *AE* could be redirected along *AG*. The better answers included that *AG* was not present in the minimum cut or argued that the flow into node *A* is already at its maximum value so increasing the upper capacity of *AG* would have no influence. The best answers then provided the necessary clear 'comment on the validity of the trainee's claim' with sentences like 'Hence the trainee's claim is incorrect'.

Question 9

In part (a)(i) a little under three-quarters of students received the sole mark for showing the binary operation was commutative. The most common reason why the mark was not awarded was not enough working being shown to convincingly show that the operation was commutative. The number of lines of working was a nudge to provide lines of intermediate working.

In part (a)(ii) just under half of students received both marks, and students who received the first mark typically went on to receive both marks. The most common reasons why the marks were not awarded was due to misunderstanding the test for associativity or for not showing that both sides of the associativity test simplified to the same collection of terms.

Over half of all students were awarded all 3 marks in part (b) and just under three-quarters of students were awarded at least 1 mark, which is pleasing given the novel nature of the question. There was the odd numerical slip which led to irrational values for k, but overall students performed reasonably well on this part.

Question 10

The single marks in parts (a)(i) and (a)(ii) were awarded to approximately two-thirds of students. Common mistakes in these parts were to not discuss the necessary conditions in terms of the three probabilities, or to mistakenly explain the conditions based upon dominance.

Over three quarters of students gained all 3 marks in part (b), with by far the most common loss of marks being for writing down the transpose of the correct pay-off matrix. Other, less frequent mistakes included simply getting one or two of the entries in the pay-off matrix wrong.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.