Questions matter

A-level
Further Mathematics

7367/3D Paper 3 Discrete

Report on the Examination

7367
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Question 1

Around 80% of students selected the correct response.

Question 2

Just over 80% of students selected the correct response.

Question 3

The vast majority of students selected the correct response.

Question 4

In part (a), just under half of students were awarded all 3 marks, with over 80% receiving at least 2 marks. Where marks were not awarded, it was typically for incomplete reasoning as to why a stable solution did not exist. The statement '$1 \neq -1$' was not sufficient for the R1 mark; students had to make an explicit statement that max(row minima) did not equal min(column maxima).

Over 80% of students were awarded the mark available in part (b).

Question 5

Over two-thirds of students received the 2 marks available in part (a)(i). The most successful method was using Prim's algorithm, starting at X and therefore having a subnetwork which was always connected. Students who used Kruskal's algorithm were less successful, due to selecting an arc either whose weight was not optimal or that introduced a cycle.

Around 70% of students were awarded the mark in part (a)(ii), with students who had a spanning tree which was not optimal still being able to access this mark. Students who were not awarded this mark typically fell into two categories: those that did not have a spanning tree in part (a)(i), that is with too few arcs; or those that did not include "hours."

Less than half of students stated a valid limitation of the installation in part (b), which focused on the connectedness of the network. Answers that did not receive the mark argued that there wouldn't be enough electricity to supply all the car parks, or that there would be delays in the electrical current reaching the more distant car parks.

Question 6

Just under a third of students were awarded all 6 marks, with almost 80% receiving at least 5 marks. Virtually all students could identify the odd-degree nodes of the network, and by far the most common reason that marks were not awarded was obtaining a shortest distance of 4.0 for *A–O* (*AEINO*) instead of the correct shortest distance of 3.9 (*AFKO*). This led to the third mark (A1) not being awarded. Some students, having identified the odd-degree nodes, tried to find an Eulerian cycle around the network.

Question 7

Just under half of students received both marks in part (a). Most provided a counter example to associativity, typically using simple values like 1, 2 and 3, or performing the test for associativity with algebra using x, y and z. If marks were not awarded, it was typically for an incorrect expansion of both brackets or for not giving a fully reasoned argument as to why a group was not formed: as the group axiom of associativity was not met for this set and operation. Some students were awarded zero marks because they tested for commutativity.

Over 90% of students received all 3 marks in part (b)(i). Minor mistakes included numerical errors, but some students didn't seem to understand what was meant by multiplication modulo 19.

Over 90% of students received the mark in part (b)(ii).

About a third of students were awarded both marks in part (c)(i). The vast majority of students could identify at least two correct possible orders for the subgroups of *G*, but fewer provided the correct possible orders for the proper subgroups of *G* and gave a full reason for these orders. Many students confused proper and non-trivial, and others did not support their statement with a reference to Lagrange's theorem and the factors of 6.

Less than a third of students received all 3 marks in part (c)(ii), whilst over three-quarters of students received at least 2 marks. The most common reasons for losing the third mark included poor notation (not giving answers in the form specified in the question), giving answers that were not proper subgroups of *G* or omitting the trivial subgroup.

Less than a quarter of students named a group isomorphic to *G*. As *G* had 6 elements, a significant number incorrectly gave the group of symmetries of the equilateral triangle as their answer. Successful responses were the group of rotational symmetries of the regular hexagon, or the cyclic group of order 6.

Question 8

Over half of students were awarded both marks in part (a), with over 85% receiving at least one mark. The most common mistake was to omit arrows on the arcs being introduced, or to include upper capacities that would incur restrictions on the network.

About three-quarters of students received all 4 marks in part (b). Some started from an initial flow of zero, and some made mistakes in choosing the augmenting paths.

Less than a fifth of students were awarded both marks in part (c). Most students did not state that the arc *EG* was saturated or was operating at its maximum flow or was one of the arcs the minimum cut of the network would pass through. Students that did make this observation tended not to go on and reason that this flow could not be redirected through other arcs in the network, instead leaping to a comment about the engineer's claim.

Question 9

The vast majority of students were awarded the mark in part (a), for correct identification of the strategy $\mathbf{J_1}$ and for use of the correct vocabulary, ie 'dominates' or 'is dominated by'.

In part (b)(i), just over half of students were successful in translating the objective function and the inequalities into the Simplex tableau. The vast majority of students introduced 4 slack variables. Most of the mistakes were sign errors in the tableau, often for the slack variables.

Part (b)(ii) proved a little more challenging than part (b)(i), with less than half of students receiving both marks. The most common mistake was to use an incorrect row (the row corresponding to the sum of the probabilities not exceeding 1) as the pivot row.

In part (c), the vast majority of students obtained the correct answer. A common incorrect answer was that strategy $\mathbf{J_3}$ should be played with a probability of zero.

Question 10

Virtually all students received the single mark in part (a).

Just over one-third of students were awarded all 3 marks in part (b), with over two-thirds receiving at least 2 marks. Common reasons why all 3 marks were not awarded include having 'overhangs' for some activities, including ideas about float times, or simply starting and finishing one or more activities at incorrect times.

In part (c), just under one-third of students produced a fully correct levelled resource histogram, and a minimum completion time of 96 days. Some students did not appreciate that when the number of workers was limited to 4, activities *A*, *B* and *C* could not occur simultaneously.

Mark Ranges and Award of Grades

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