Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

Summer 2025

Pearson Edexcel GCE

In A Level Further Mathematics (9FM0)

Paper 3D Decision Mathematics 1

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Introduction

The paper proved to be accessible to almost all candidates, with many able to gain high marks on at least questions 1, 2, 3 and parts of 4 and 6. The remaining questions differentiated well, challenging the most able candidates and producing a good spread of marks. It was pleasing to see that a good number of candidates were able to make good attempts at both question 5, and at least part of question 7, the linear programming simplex questions.

Question 1

This question proved an accessible start to the paper, with the majority of responses showing a clear familiarity with both the first fit, and first fit decreasing, algorithms and appropriate presentation of such. A large number of candidates gained full credit in both parts, with common mistakes in part (a) relating to missing out a value from the list or transcription errors.

A common mistake in part (b) was to misplace the final three items: 2.9, 2.8 and 1.4 with several candidates not realising there was space for 1.4 in Bin 2. Another common error was to misread 4.7 and 4.1.

A small number of candidates found it challenging to reorder the given list before applying the first fit decreasing algorithm, with a few using a sorting algorithm to achieve this. Candidates should be reminded that, unless explicitly asked to use a sorting algorithm, this is not necessary.

A small number of candidates attempted to use first fit increasing to place the items in part (b), which was a clear error.

Question 2

The quick sort proved a very accessible question with a large number of candidates performing an entirely correct sort. Candidates demonstrated a consistent approach to picking pivots, whether middle right or middle left, and generally recognised the need to perform iterations until only single-item sublists remained. A small number of candidates were inconsistent with their treatment of single-item sublists, choosing some as pivots but others not, and candidates should be reminded that a consistent approach in all algorithms is a key aspect of good practice in Decision Mathematics. As always, a minority of candidates sorted into ascending rather than descending order and this limited the number of marks available for their response.

Part (b) proved more challenging. A significant number of candidates had memorised the number of comparisons in the worst-case for bubble sort and quoted a correct result. Candidates should be reminded that Decision Mathematics is a ‘methods’ paper and therefore quoting results may not result in full credit (although this was condoned for this series) Candidates generally understood the need to consider the number of comparisons in each pass, although a common error was to start with n comparisons in the first pass rather than n -1. Other common mistakes included multiplying rather than summing the comparisons from each pass, or not reducing the number of comparisons after each pass.

Part (c) had a variety of approaches seen, with most candidates electing to start a new row in the table when a value was updated. The instruction "show the results obtained at each step of the algorithm" does not require candidates to use a new row for each step, although this is a valid alternative. In all cases, the table should be completed in "reading order", that is from left to right and top to bottom, such that the algorithm can be traced by reading the table. A common error, not penalised in this series, was to write the values for b one row higher than expected. As this did not alter the accuracy of the final output, this was condoned, and a significant number of candidates had this approach.

Common mistakes in applying the algorithm were achieving $\frac{3}{2}$ for d rather than $\frac{5}{2}$, and terminating the algorithm one iteration too soon.

Candidates worked with both fractions and decimals in this question, where candidates who worked with decimals occasionally made rounding errors.

Part (d) was not always completed by candidates who achieved an output from part (c), and a surprisingly large number of candidates rounded to 3 decimal places rather than 3 significant figures. A small number of candidates used the output as their 'true' value when calculating the percentage error, which is an incorrect method and did not gain credit.

Question 3

Part (a) was accessible to nearly every candidate with almost all of those who produced a completed table gaining both marks. Those who lost 1 mark often did so due to transcription errors. A small number of candidates transposed the table

In part (b) most candidates gained at least 3 marks. When errors occurred, it was usually down to arithmetical slips rather than a lack of understanding of the algorithm. Some candidates used shading or, worse, highlighter pen, to mark the row and column that were unchanged. Unfortunately, this made it difficult (or impossible in some cases) to read the candidates work. If a candidate wishes to mark the unchanged row and column in some way, this is better done using a large bracket which does not obscure the numerical values.

Part (c) (i) was answered well and did not rely on part (b) being correct. Errors in (ii) were typically in computing a time of 139 and not correctly reading off the distance values from the fifth iteration. However, in the final part a significant number of candidates failed to correctly interpret this cycle in terms of the actual villages visited, with many just requoting their answer to (i).

Question 4

Part (a) was generally well answered. Most candidates approached the algorithm confidently, followed the correct labelling conventions, and showed the necessary working values. A recurring issue was candidates mistakenly starting the algorithm at node J rather than A, which led to no marks. This was likely due to misreading the question and perhaps reflects the lack of similar practice questions in available resources. While nearly all candidates secured the initial method mark, full marks were often not awarded due to errors in updating working values or mislabelling. Nonetheless, most candidates found the correct route or at least its correct length.

Part (b) was attempted by most candidates with reasonable success. Most were able to identify the correct four odd-valency nodes (B, C, D, and K). However, errors frequently occurred in the calculation of route totals, with 25 and 42 often appearing instead of the correct 24 and 41. A significant issue was candidates listing only the node pairs rather than explicitly stating the arcs traversed twice. Many missed that DGFK is a shorter path than DK (18 vs 19), which affected route selection and overall accuracy.

Part (c) was poorly answered across the board. Although many candidates made attempts, few demonstrated understanding of the task. Most failed to use the shortest route to J (which is 45) or neglected to include the correct number of arcs. Overall, this section revealed a lack of understanding on what the question required.

Question 5

Part (a) was generously marked and candidates earned the mark here for any indication that the origin was not a feasible solution. This was rarely explicitly stated by candidates, but often candidates were along the right track with statements such as 'the inequalities for x, y and z should be ≥ 0' or even 'because $z \leq -3$' which was accepted here.

Part (b) was well-attempted by most candidates. Those who gave equations with slack variables rather than inequalities were only penalised with one mark and this was seen in perhaps approximately 50% of responses. In other cases, marks were usually lost for forgetting to transform the objective function in terms of Q, or for algebraic slips made in the simplification of the substitutions.

Part (c) was not as well answered, and many candidates were unable to successfully extract the profit equation from the tableau. Often there were sign errors or a missing 'Q', or indeed no attempt made.

Part (d) was also challenging for most candidates. Overwhelmingly, candidates referred to 'a negative in the profit row' or stated that 'Z is negative' and some others stated that 'increasing Z will *decrease* profit so not optimal'. It was rare to see a correct response given.

The tableau in part (e) was generally well attempted. There were some blank tableaux seen but, in most cases, candidates were able to at least complete the pivot row correctly. There were some numerical errors seen and occasional issues with the statement of row operations (but this seemed greatly improved on previous series). From time to time the bottom row of the tableau was missing and it is unclear whether this was due to a lack of understanding or a lack

of time. In (e)(ii) candidates were asked to find the optimum value of P and the corresponding values of x, y, z. In most cases candidates were able to read off values for Q, X, Y and Z correctly from the tableau and only very rarely were e.g. $X = Y = Z = 0$ seen (taken from the bottom row). Occasionally however, candidates forgot that the tableau was in terms of X, Y, Z and Q rather than x, y, z and P and so lost marks for stating e.g. $P = 83/2$. Others made mistakes making the simple transformations of values from the tableau back into values for x, y, and z and sometimes one or more of the values were omitted which lost both marks here. Either decimal or fraction form was accepted here, and both were equally seen and equally accurate.

Question 6

Part (a) was mostly well done. Most candidates showed an understanding of activity dependencies, although many missed out on including all necessary predecessors for activities L and M, specifically failing to include activity A in some cases.

In part (b) the activity network diagram was generally completed well. Most candidates achieved full marks, and when errors did occur, they were often limited to a single miscalculated event time. A frequent mistake was recording 13 instead of 10 as the late event time for a activity F.

In part (c) the Gantt chart was also completed well and better than in previous series. Only a small number of candidates submitted no response, and most mistakes stemmed from errors in part (b) that carried forward. Very few attempted a scheduling diagram, and most followed the standard format. Overall, this was one of the strongest parts of the question.

Part (d) was not well answered and was often left blank. When candidates did attempt it, many managed to gain at least one or two marks, but fully correct responses were rare. Some candidates attempted to fill in the activities on the resource histogram itself, which would have been time consuming and often still resulted in no marks.

Question 7

In part (a) the majority of candidates attempted to set up the initial tableau, mostly with reasonable success. Some marks were lost owing to (minor) slips in translating from their equations to the tableau. A small number of candidates confused which equations needed slack variables versus which needed surplus and artificial variables. A small number of candidates added surplus variables and subtracted artificial variables, rather than the reverse. Most understood the process of employing big-M, with occasional slips in gathering terms leading to an incorrect objective function, although some did not form an objective function of the right format. Populating the table correctly was achieved by many candidates – with errors in correct identification of basic variables in each row indicated perhaps a lack of depth of understanding of the overall approach and what the simplex tableau is achieving.

Part (b) was less well answered. A good number of candidates did score full marks, or just lost one mark, if they did not show consideration of both inequalities. Most arrived at the equation for P and scored the first mark, and some wrote at least one correct inequality. If they used a correct inequality, candidates generally chose $k = 11/3$ as their value of k to substitute into their equation, meaning if a value for P was found it was often 88/3. Some considered both inequalities but then chose the wrong range, using $k = 16.5$. A small number of candidates used the expression from the a_2 column to form an inequality, which was incorrect. Some candidates decided that k needed to be an integer and typically chose $k = 3$ as the greatest integer less than 11/3. This could score full marks, as could the very small number of candidates who stated a range of possible values for P. Several candidates decided to use the original graph to answer this part of the question instead of the simplex tableau. Although this was a valid approach, it involved significant additional work and generally restricted the candidate to a maximum of 4 out of 5 marks as they only compared one vertex with the optimal point. Candidates should be reminded that questions are designed to be answered from the information provided, which in this case was the simplex tableau.

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