Pearson Edexcel

Examiner's Report
Principal Examiner Feedback

Summer 2018

Pearson Edexcel GCE Mathematics

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Introduction

The majority of students demonstrated sound knowledge of all topics and were able to produce well-presented solutions, making good use of the tables and diagrams printed in the answer book. Students should be reminded of the importance of displaying their method clearly. Decision Mathematics is a methods-based examination and spotting the correct answer, with no working, rarely gains any credit. In a minority of cases many marks are lost due to poor quality of handwriting, particularly when students misread their own written numbers and capital letters. Most students were well prepared for the exam and there were very few blank pages. In the final question, it was, however, evident that some students ran out of time, a few made no attempt at all and many more stopped mid-solution.

Report on Individual Questions

Question 1

This question proved accessible to most students. In (a) most students had an idea of why the zero was required, although some could not express this using the correct language. Many, however, correctly referred to a degenerate solution or stated that $m + n – 1$ had not been satisfied. While most students gave the correct alternative cell B3, a number gave an answer of D3. Amongst those who gave a comprehensive (and in some cases excessive answer for what was only one mark) it was quite common to fail to offer an answer for the alternative cell.

In (b) most students went on to calculate correct shadow costs and improvement indices, with only occasional slips in their calculations. Only a small number used the initial allocation instead of the costs in their calculations, an error which has been quite common in past series. Some students lost a mark for their improvement indices because they were in a table containing more than 9 values, commonly mixed in with costs or zeros.

In (c) the majority of students attempted to find a stepping stone path using their most negative improvement index, although a number made errors in their path, where their thetas did not balance in either a row or a column. A small number changed the position of the zero from C2 to B3. Most stated the entry cell but some omitted the exit cell or made an error. Some were evidently confused by the presence of a zero as part of their stepping-stone route.

Question 2

Many students scored well in this question but very few scored full marks.

Part (a) was done well, with students finding correct row minimum and column maximum values, with very few errors. A significant number of students failed to either correctly identify the row maximin and column minimax, or state the corresponding play safe strategies.

In part (b) those students that had correctly answered (a) usually went on to state that the game was not stable with correct justification. Some of those who had not identified the maximin and minimax values in (a) did so here. Others made a correct statement about the maximin and minimax but failed to conclude that the game was not stable.

In (c) most students had the correct idea about row and column dominance, but very few stated both and gave the full justification, therefore very few students scored both marks in this part.

In (d) many students made the values in the reduced matrix non-negative and a good number went on to define the probabilities, the value of the game and stated that this was to be maximised. Those students that did augment the values correctly generally went on to give the correct inequalities, although some used rows instead of columns, and others reversed the inequality signs or added slack variables to produce equations. Students who failed to augment the matrix lost a considerable amount of marks in this part. Failing to augment the matrix was quite a common error, as was treating this as an allocation problem. A small number of students attempted to reduce the pay-off matrix further and to solve it using graphical methods.

Question 3

This question was often completed perfectly and examiners saw many excellent solutions from a high proportion of students. These students were able to deal with the unknown in cell D4 in one of two effective ways. The first method was in dealing with x directly which lead to $x - 34$ after row and column reduction and then finally $x - 38$ after two augmentation steps. The second method was to consider the range of values for the D4 entry i.e. '> 4' after row and column reduction and then '> 0' after augmentation. Either approach could lead to full marks in (a) except where arithmetical slip(s) occurred which would usually lead to the loss of two marks. For other students however, the unknown value caused some difficulties. Sometimes this value was ignored and the x was unaltered in all subsequent tables. Other approaches including assigning an arbitrary value to x followed by proceeding with the algorithm. This was costly and forfeited accuracy marks as although for this particular case it would lead to the correct allocation in general this method is incorrect. Other more catastrophic issues occurred where students did not reduce columns but instead proceeded directly with augmentation after reducing rows only. Often these responses were fraught with errors and students struggled to identify the correct number of lines required to cover zeros at each stage. Augmentation was also patchy for these students which some students performing a 'slow augmentation' so repeatedly setting 'e = 1' rather than selected the highest uncovered value. Arithmetical errors also appeared on a number of occasions and students also occasionally misread their own handwriting especially when values were covered by lines. However, it was pleasing to note that very few maximisation attempts were seen.

Most students were able to identify the optimum allocation and the minimum total cost and obtained the relevant marks provided they had used a correct method in (a).

Part (c) was almost always completed correctly and students who went astray in (a) were often able to recover here. A common error was to use the value in D4 (usually $x - 38$) rather than x in the equation for the revised minimum cost.

Question 4

This question was generally effective in producing a spread of marks and was accessible to most students.

In part (a) it was surprising to see a fairly high proportion of errors in stating the capacity of the cut. The value 27 including the capacity of EG was a common and perhaps expected error but 21 and various other incorrect values were seen.

In (b), most students clearly understood the need for flow to be conserved but some students unfortunately did not gain the mark as their answers were incomplete or imprecise often stating that the maximum flow into G was 6 without mentioning the numerical value of the flow out of G.

Most students were able to apply the labelling procedure to show the maximum flow along SBET however some omitted values, for example, the zero along BS and some did not attempt this part of the question at all. Many students did not state the value of the flow along this route on the answer line provided but stated the value in their working and were given credit.

In part (d), most students were able to find a number of valid flow augmenting routes (most commonly involving SADGT and SCFHT) and many achieved at least 3 out of 4 marks here. Some students however did not manage to state at least four consistent flows and corresponding values and some had total flows in excess of 13. A value of 15 was not uncommon and often led to fairly substantial loss of marks later.

Many correct answers of 13 were stated in (e) although a correct cut was a little more elusive. Often incorrect cuts began with DG or GT. In many cases cuts were not stated but instead were drawn on one of the network diagrams.

Part (f) proved to be something of a discriminator. There were a number of blank responses and some responses with both capacity and flow assigned to arcs. Furthermore, there were some consistency issues at nodes – for example at B. Some students with otherwise correct flows lost marks due to the omission of a zero along AB or BF. Generally though a lot of completely correct solutions were seen with a better overall rate of success than in recent sessions.

Question 5

This question discriminated between those who could do basic Simplex and those that understood what was happening as well as being able to cope with the algebra required. Few completely correct solutions were seen. As such, many students were able to complete the first iteration correctly but then struggled with the P row in the second.

Part (a) illustrated the importance of reading the question carefully. This clearly asked for three constraints to be written down as inequalities. Whilst students could gain one of the two marks for giving these correctly as equations with slack variables, students needed to write inequalities to gain both marks. It was clear that a number of students did not understand the role of slack variables, by including them in inequalities, and these students scored no marks in this part.

The first iteration in (b) was generally well done and many completely correct solutions were seen. A few students did try to pivot on a negative value resulting in the loss of all marks for this part.

For part (c), even with students having errors in (b), nearly all got this part correct.

The second iteration in (d) was not as successful, although often only the objective row was the issue, with students unable to deal with the algebra involved to include a variable in the row operation.

For (e), very few students realised that the inequality required was not strict unlike in (c). Those who had expressions in (d) generally produced an inequality compared to 0 and rearranged it to obtain an inequality for k. Some students considered all their inequalities and selected the correct upper bound but too often a strict inequality with 8 was seen.

In (f) most students obtained the second mark by reading off the values from their tableau but a few lost the mark by only listing some of the values and others gave the zero variables values from the P row. The mark for P was achieved less often mainly due to errors in (d).

Relatively few students scored both marks in (g), losing the final mark for an incorrect inequality sign, even where they had got both values of 160 and 200.

Question 6

Many good solutions were seen to this question with students often gaining full marks through a thorough understanding of the process and an ability to apply it accurately. Those that did not gain full marks usually made slips in arithmetic, missed S off the routes or missed one of the routes completely or a mixture of all three. Where errors occurred they were often due to selecting the adjacent value to the intended one from either their values or those given in the question.

Weaker students did not obtain the correct structure even with the start given. A few found optimal values but did not carry these values through to the next stage others subtracted them at the next stage, and a few even tried to work forwards. It should be noted, that students who do not carry through their optimal values, are unlikely to gain any marks since this is such a critical part of dynamic programming. Some responses were also seen where students were grouping their rows by destination rather than state. Very occasionally students lost marks for finding either the minimum or maximin values or missing out the appearance fees.

There were a few cases where the optimal expected income was stated as £97 or £97000. However, most students identified both optimal schedules. Any loss of marks here was usually for only identifying one of the two schedules, or failing to realise that the route included starting and finishing at Jonathan's home, S. It was pleasing that few errors came from untidy working. It is often the case that scruffy work results in copying errors but this was uncommon on this occasion.

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