Pearson Edexcel

# Examiner's Report
# Principal Examiner Feedback

## Summer 2018

Pearson Edexcel GCE Mathematics

In AS Furher Decision 2 Paper 8FM0_28

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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 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 were unfamiliar with this new topic (not previously seen in either legacy modules 6689/01 or 6690/01) and a number of blank or low-scoring responses were seen by examiners.

## Report on Individual Questions

### Question 1

This question on applying the Hungarian algorithm to obtain an allocation which minimised the total time proved to be accessible to nearly all students with the majority scoring all 5 marks. When errors were seen these were usually down to numerical slips rather than errors in method as nearly all students correctly applied row and column reduction followed by an augmentation of 2.5. A small number of students failed to deduce the optimal allocation from the location of the zeros in their final table.

### Question 2

While the vast majority of students correctly explained what the term ‘zero-sum game’ meant a number of students got confused and used the term ‘value’ (e.g. the value of the game to both players is zero) in their definition. A minority of students implied that the gains of both players are equal in a zero-sum game.

The reminder of this question was in the context of two teams (A and B) taking part in a quiz and it was clear that some students, when faced with a familiar looking question, go straight to answering the parts of the questions without first reading the set-up to the problem. This was clearly evident in (b) as an answer of –7 (rather than 3) was far too common.

Students found (c) extremely demanding and very few could explain why subtracting 5 from each value in the table would model the situation as a zero-sum game. Although it was rare to see, those students who used an algebraic approach starting with the assumption that if team A gained $x$ points then team B would gain $10 - x$ points were nearly always successful.

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

In part (ii) those students that had correctly answered (i) 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 (i) did so here. Others made a correct statement about the maximin and minimax but failed to conclude that the game was not stable. A number of students in (d) failed to read the question carefully and instead found the Row minima and Column maxima for the values in the original table and not for the zero-sum game. For these students only one mark was available in (d) although examiners did allow these students to score all the mark in (e) on the follow through.

In (e) the majority of students set up three correct probability expressions (though some had errors when simplifying these expressions) and then most subsequently went on to draw a graph with 3 lines; a few students attempted to just solve three pairs of simultaneous equations, scoring no marks. It was noted that some graphs:

- were poorly drawn without rulers,
- went beyond the axes at $p < 0$ and $p > 1$,
- had uneven or missing scales on the vertical axes,
- were so cramped that it was difficult to identify the correct optimum point.

Most students attempted to solve the pair of equations for which they considered to be their optimal point from their graph. Those that solved the correct pair usually went on to list the correct options for team A (that is, that team A should play Mischa with probability 2/3 and Noel with probability 1/3) although a number did not state their answer in context.

Even though most students had the correct value of $p$ in (e) most did not realise that part (f) specifically asked for the expected number of points awarded, per round, for both teams and instead went into ‘auto-pilot’ and simply calculate the value of the zero-sum game for both teams.

**Question 3**

In part (a) nearly all students correctly calculated the value of both cuts with the most common error being the inclusion of the 30 (from arc FE) in the capacity of cut $C_2$.

In (b) most students realised that the maximum flow through the system was linked to the smaller of the two values found in (a) but many did not explicitly state that the maximum possible flow is <u>less than or equal to</u> 145 litres per minute.

Even though (c) specifically told students that they did not have to apply the labelling procedure to find a flow of 120 litres per minute from S to T many still did so. Of those students that realised that 120 must flow along SB most went on to show a correct flow. Students are reminded of the following two points when showing a flow on a diagram.

- There should only be one number on each arc and
- all arcs should be assigned a value (even if this value is zero).

Both of these points were condoned by examiners this session but this may not be so in the future.

Part (e) discriminated well and while many students correctly deduced one of the two maximum possible flows through the system very few could give both flows together with the corresponding range of possible values of $x$.

**Question 4**

As stated in the introduction, the responses to this question on the new topic of recurrence relations were mixed. While many students scored full marks a significant number made very little progress after (a). In part (a) many students correctly stated the value of $N$ but many gave the value of $r$ as either 1.02 or 0.02 (instead of the correct 2).

The most successful attempts in solving the recurrence relation for $u_n$ was to first state the complementary function as $A(1.02)^n$ (where $A$ is an arbitrary constant) and then to consider a trial solution of the form $u_n = \lambda$ (so equal to a constant as the right-hand side of the recurrence relation once re-arranged was a constant too). This then should lead to a general solution of the form $A(1.02)^n - 2500$ and most students who got this far then correctly used the condition that $u_1 = 560$ to obtain the correct answer of $u_n = 3000\left(1.02\right)^n - 2500.$ The most common error was by those students who believed that $u_0 = 560.$ Of those students who attempted to use a geometric progression with first term 50 and common ratio 1.02 many correctly arrived at the result that $u_n = \left(1.02\right)^n\left(u_0 + 2500\right) - 2500.$ However, these students then had to use $u_1 = 560$ and the original iterative formula to find $u_0$, and very few did so correctly.

For those students who had correctly solved the recurrence relation in (b), many then determined correctly using logarithms (by solve the inequality $\left(1.02\right)^n > \frac{11}{6}$) that it would be 31 years before the model first predicting that the population would be in excess of 3000. A number of students used methods involving trial and improvement even though the question specifically demanded that an algebraic method be used.

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