Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

October 2020

Pearson Edexcel Advanced Subsidiary
In Further Mathematics (8FM0)
Paper 27: Decision Mathematics

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Introduction

This paper proved accessible to most candidates although examiners noted that a significant number of candidates are still struggling to cope with the new content not previous seen in the legacy module 6689/01, and some had difficulty with the problem-solving nature of some of the questions (which forms part of the assessment objectives for this qualification). However, the questions differentiated well, with most giving rise to a good spread of marks. All questions contained marks available to the E grade candidates and there also seemed to be sufficient material to challenge the A grade candidates.

Candidates 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. The space provided in the answer book and the marks allotted to each section should assist candidates in determining the amount of working they need to show. Some poorly presented work was seen and some of the writing, particularly numbers, was very difficult to decipher at times. Candidates should ensure that they use technical language correctly. This was a problem in question 3(a).

Report on Individual Questions

Question 1

Examiners reported that a significant number of candidates struggled in applying the first-fit bin packing algorithm in part (a). This was mainly down to not applying the algorithm correctly. First fit is just that; candidates must decide if the current item under consideration will fit in the first bin rather than the most recent bin used. In this part several candidates placed the 1.9 in the second bin (and not the first bin) and so failed to score any marks in this part. Those candidates who did place the 1.9 in the first bin usually went on to score all three marks. Part (b) required candidates to determine the order of the first-fit bin packing algorithm by considering the worst case. Although the question asked candidates to make both their method and working clear a significant number simply stated that the order was quadratic. For those candidates that attempted to show algebraic working many assumed that there were $1 + 2 + 3 + \ldots + n$ comparisons in total and therefore gave an incorrect answer of $\frac{1}{2}n(n+1)$. The correct approach was to realise that in the worst case the second number must be compared with the first number so one comparison, then the third number must be compared with the first and second numbers so two comparisons and so on giving in total $1 + 2 + 3 + \ldots + (n - 1)$ comparisons leading to the correct answer of $\frac{1}{2}n(n-1)$ and hence quadratic order.

Question 2

This question on critical path analysis was answered extremely well by many candidates.

Part (a) required candidates to complete the precedence table for the given network and while the vast majority scored at least one mark for correctly completing five rows of the given table errors were sometimes seen on the immediately preceding activities for activities G, H and/or J.

Part (b), in which candidates had to complete the early event times and late event times, was often done extremely well. Errors occasionally occurred in the event times at the beginning of G and/or J. However, either full marks or two marks out of three were common in this part.

Nearly all candidates correctly stated the minimum project completion time and critical activities in part (c).

Part (d) required candidates to calculate the maximum number of hours by which activity H could be delayed without affecting the shortest possible completion time of the project and nearly all candidates realised that this calculation was equivalent to the total float for activity H and therefore was extremely well answered.

Part (e) was generally very successfully attempted. Most candidates carried out a correct calculation and rounded their value up to give the correct lower bound for the number of

workers. It was rare to see ’22’ (the minimum project completion time) divided by 11 (the number of activities).
Most candidates in part (f) were well-versed in how to construct a cascade chart and examiners saw very few scheduling diagrams. Most floats were drawn in the standard way (as shown in previous mark schemes) and critical activities were almost always seen drawn along the top of the cascade chart although this was not always the case. Cascade charts were usually completed accurately and neatly with most errors occurring following through from errors in (b). From time-to-time activities were mis-plotted – for example, sometimes at the start of I and K. Examiners noted that some responses had missing activities. The three critical activities were rarely incorrect.
Part (g) required the candidates to explain why it was not possible to complete the project in the shortest possible time using the number of workers found in part (e). The most common approach seen by examiners was to realise that at time 8.5 activities E, D, F & H must be happening, so it is not possible to complete the project with three workers. Candidates are reminded that simply stating the activities that must be happening (together) without a specific reference to a time will not be credited with full marks.

Question 3

Part (a) was found to be particularly demanding and very many candidates seem to suggest erroneous arguments along the lines of:

• ‘an extra odd node would have no other node to pair with’: These candidates often stated that an even number of vertices of odd degree were required to apply the route inspection algorithm

• Many candidates stated that ‘an odd number of odd degrees would make it impossible to traverse the graph’: These candidates often also stated that the graph would not be semi-Eulerian and sometimes argued that there would be half an arc with no end point

• Many candidates stated simply ‘handshaking lemma’ but usually with little success as it was often accompanied by little or no supporting comment or argument

• Some candidates attempted an induction-based argument stating that if there are only even degreed vertices then every arc added must create two vertices of odd degree

Stronger candidates were able to score one of two marks – usually the first mark for stating a relationship between the number of arcs and the sum of the order of the vertices. There were also a significant minority of candidates who were able to provide clear and precise arguments and gain both marks.

In part (b) candidates had to use the information about the order in which the arcs were added to the minimum spanning tree using Prim’s algorithm to find the smallest possible range of values for *x*. Therefore, because arc AD, not AB, was added to the tree first this implies that the weight of arc AB must be greater than the weight of arc AD and hence $2x + 10 > 3x - 2 \Rightarrow x < 12$.
Furthermore as the final arc added to the tree was BD this implies that's the weight of BD must be less than the weight of all the other arcs incident to B and hence $2x + 10 > 20 \Rightarrow x > 5$.

The final part of this question required candidates to use an appropriate algorithm, in this case the route inspection algorithm to determine the value of *x* given the time taken to traverse the route was 318 minutes. Most candidates who attempted this part realised that the network had four odd nodes C, E, F & H and correctly formed all three pairings of these four of nodes and many then went on to obtain the correct answer that *x* = 6.

Question 4

It was noted by examiners that this final question was attempted by most candidates and thus indicated that time pressure was unlikely to have been an issue for many. Some responses were incomplete but most of the time it seems that candidates completed as much as they were able to do.

This question provided a variety of responses due to its unfamiliarity when compared to what has been seen on previous assessments. Candidates were given a linear programming problem in two variables graphically, the value of the objective at the optimal vertex, and were then asked to form the linear programming problem in algebraic form. Most candidates who attempted this question realised that they had to find the equations of the lines and hence inequalities that defined the feasible region. The most common errors were with forming the equation of the line passing through the points (7, 2) and (9, 8) and with incorrect inequality signs.

While many candidates correctly found the inequalities that defined the feasible region only a small percentage could find the correct expression for the objective function. Most candidates believed that because the given objective line passed through 5 on the *y*-axis and 3 on the *x*-axis that therefore the objective function was simply $5x + 3y$ when in fact the objective could be any multiple of this expression (also candidates should have realised that if the objective was $5x + 3y$ then the information given in the question regarding the value of the objective at *V* was 556 was therefore irrelevant). What candidates had to do was to find the exact coordinates of the optimal point, substitute these values into $5x + 3y$ and solve $P = k(5x + 3y)$ with $P = 556$ which would have led them to the correct objective function of $P = 60x + 36y$. Finally candidates are reminded that when they are asked to define a linear programming problem that they must state whether the objective is to be maximised or minimised (in this case maximised).

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