Examiners' Report

Principal Examiner Feedback

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Pearson Edexcel GCE AS Mathematics (8FM0)

In Decision Mathematics 1 Paper 27

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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 very poorly presented work was seen and some of the writing, particularly numbers, was very difficult to decipher. Candidates should ensure that they use technical language correctly. This was a problem in questions Q1(b), Q1(c) and Q3(b).

Report on Individual Questions

Question 1

As a 'new specification' question, this was met with varying degrees of success on the part of candidates. There were some perfect or near perfect responses but also many responses which lacked understanding and/or knowledge. While most were able to draw K_5 in part (a), others were clearly confused by the terminology. Some drew a pentagon, others drew K_6. Some candidates missed out a single arc and many other subgraphs of K_5 appeared here.

In part (b)(i), most candidates were familiar with the term 'semi-Eulerian', however often definitions fell short of the rigour required. It was common to see comments which did not imply 'exactly' two nodes of odd order. Examiners often commented that the phrase 'at least two odd nodes' was seen on a number of occasions. Many candidates also provided non credit-worthy descriptions involving the ability to 'traverse each arc'.

Part (b)(ii) was often well answered, even when part (a) had not been. Most candidates drew semi-Eulerian subgraphs of K_5 but were sometimes let down by both graphs having the same number of arcs. Others incorrectly drew graphs with multiple arcs between pairs of nodes and some drew graphs with fewer than 5 nodes. Examiners noted that a few Eulerian graphs were provided here as well as some non-semi-Eulerian graphs with multiple nodes of order 1.

Part (c) discriminated well. It was common to see no response here and extremely common to see incorrect attempts. Nonetheless, the most able candidates were able to provide coherent and concise arguments which focussed on the key issues – most usually, the number of arcs required for a tree with the stated orders compared to the number of arcs on a tree with five nodes. Examiners noted that some candidates gave arguments based on the direct connection between the vertex of order 4 and each of the other vertices together with the resulting need for all other nodes to have order 1 for a tree. Other valid arguments were rarer but also appeared from time to time. For some candidates, there was a lot of confusion between arcs and nodes and many stated that there must be 6 nodes on a graph with the stated orders. Other candidates incorrectly deduced that 'because the graph is Semi-Eulerian' it could not be a tree, and some candidates seemed to think that there was only one odd node here. There were a substantial number of candidates who were able to pick up one mark out of two here for making some progress towards a correct explanation.

Question 2

Examiners commented on the fact that many fully complete and correct responses were seen to this question. However, they further commented that a number of applications of the algorithm in part (a)(i) went wildly awry. This was often precipitated by the first application of stage 10. Most candidates who ended up with approximations to I running into the tens and hundreds of thousands did not seem perturbed, perhaps indicating a lack of engagement with the problem. There were many approaches employed when completing the table and some candidates wasted time filling in every cell for A, B, N, H and C for the first several rows; this did not lose marks but certainly lost time. Others spread their values out across the table with one entry per row which was acceptable. Unfortunately, some candidates omitted key elements of the first and second row completely – quite often, 0 was missing from line one and sometimes 1 from line two. Most candidates worked with decimals with a significant minority using the fraction equivalents. Most candidates kept the output exact following their table, but some used a rounded value in part (b) which usually lost the final accuracy mark. More worryingly, some miscopied or lost digits transferring their answer from part (a) to part (b). It seems evident that candidates are less well prepared for questions such as these involving the application of relatively straightforward (but unseen) algorithms.

Part (b) asked for the evaluation of a definite integral and the calculation of the percentage error for their approximation from part (a). The vast majority were able to determine the exact value of I although there were a significant number who did not use their calculator and either spent longer than necessary calculating the value or made errors in the integration. Candidates should be advised that in such cases calculator use is perfectly acceptable and, indeed, is advisable.

It was surprising the number of candidates who were unable to calculate the percentage error correctly. Despite being GCSE level work, candidates seemed stumped and were creative with their own version of the percentage error formula. Often, the denominator was the approximation rather than the exact answer. Sometimes, candidates simply found the ratio of the exact and approximate value. Others were not alarmed by huge percentage errors obtained by incorrect answers from part (a). The question requested that answers were given to 3 significant figures and a small number of candidates fell at this final hurdle giving answers to just 2 significant figures.

Question 3

Candidates were on more familiar territory here and most candidates were able to earn a good number of marks in part (a). Most candidates were completing 'activity on arc' networks, although examiners noted several 'activity on node' networks - probably more than was the case with the legacy specification. Furthermore, examiners noted that several networks had more than one source node, no finish node and networks with fewer than two dummy activities.

Usually candidates were able to pick up the first two marks and errors usually arose either with the first two precedence dummies or with the omission of activity H or activity K. Whilst most candidates now seem to be aware of the importance of arrows on dummies, there are still some candidates who make the costly mistake of not having arrows on their dummies. This makes it impossible to determine the preceding activities for H, I, J and K and ultimately lost three marks.

Usually, candidates were able to place the uniqueness dummy for activities I and J although this was omitted on several occasions. Some lost the final accuracy mark for lack of arrows on activities (excluding dummies): Some candidates placed arrows only on dummies whereas others made slips and missed out one or two arrows along the away. Some candidates peppered their networks with extra dummies, often at the end of B or H or K. These candidates seem reluctant to extend their activities in order to meet the required event and instead place a dummy to 'fill the gap'. Of course, while not strictly incorrect it is inefficient.

Whilst most responses were clearly set out and often resembled the version given in the printed mark scheme or a correct equivalent, there were several candidates who had multiple arcs crossing over each-other. This is condoned but can make it difficult to see exactly where activities start and finish. It may be advisable for candidates to sketch out a rough diagram in order to see the best placement of activities before completing their final diagram. A word of caution however, sometimes when candidates do exactly this, they fail to copy their initial diagram accurately and miss off arrows and sometimes, more disastrously, activities.

In part (b), many candidates could clearly identify the reasons why activity B is not critical. However, articulating these reasons sometimes proved to be more of a challenge. Common responses which were insufficient for the mark included statements such as: "because F and G depend on B and C" which did not draw attention to the fact that C also depends on A; or "B is not on the shortest path" which did not give enough detail. Similarly, "B does not have a zero float" which was also too vague and was perhaps purely a learned definition for a critical activity. The most successful responses highlighted the dependency of C on A and the dependency of other activities (F and G) on both C and B. Other successful responses involved discussion of event times and the duration of A + the duration of C compared to the duration of activity B.

Part (c) was challenging for many candidates and it was relatively rare to see a correct answer here perhaps highlighting a lack of understanding of critical paths. Usually, candidates listed several activities. Some candidates were almost correct but incorrectly believed that K was not critical – perhaps failing to spot the path through K from A.

Overall this question was successful in providing both access for less able candidates and differentiation amongst the more able ones.

Question 4

Most candidates were able to earn at least some of the marks in part (a) for applying Dijkstra's algorithm for the network at least up to vertex E. There were the usual issues with order of working values with issues occasionally cropping up at C, F and G. Also, order of labelling was sometimes problematic with repeated labels occurring, from time to time at B and D or F and G. Up to vertex E was, however, comfortable territory for most and correspondingly well completed. The introduction of the algebraic weights for CE and GH was, of course, less familiar and some candidates were unsure how to proceed. A good proportion however, were unfazed and correctly stated working values at E and H. Sometimes only one working value was given at H (and the other two often shown later in working) probably because candidates had been told that the three paths to H have equal length. Sometimes 36 made an appearance at E and this was penalised. Of course, earlier errors in the network sometimes led to incorrect expressions at E and/or H.

Some candidates believed that they had completed part (a) with the diagram and did not proceed to determine the values of x and y. Those that did however, were often successful provided they had managed to identify the expressions for the three paths. Occasionally, an extra value of 44 appeared at

H which sometimes led to incorrect calculations. Other times, candidates did not identify the three different lengths of the paths and so ended up with a single equation to solve in two variables.

It was surprising to examiners that part (b) seemed to be problematic for so many. The majority of candidates were able to identify the four vertices with odd degree, but many had not read the question carefully and did not see that the route would start at A and end at H. Thus requiring, only, the repeat of arcs from B to D. Often, candidates proceeded down the usual route inspection method of pairing odd vertices and choosing the pairing of smallest weight – usually AD and BH. Candidates should perhaps be advised to consider the amount of work required in relation to the number of marks available and this may have been a flag to re-read the question. It was indeed rare to see the correct answer stated here.

Part (c) also presented a challenge for many candidates and it was uncommon to see the correct answer of '4 times' stated here. An answer of 8 appeared frequently for candidates who appear to be counting the number of times an arc incident to C would be travelled along rather than the number of times C itself would be visited. An answer of 3 was also quite common.

Due to a lack of success with part (b), the correct answer was relatively rarely seen in part (d). The value of 91 was often given which related to AD and BH (BC, CG, GF, FH) being repeated.

Question 5

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 gave rise to a mixed bag of responses. Despite involving three variables, the work required, at least initially in part (a), was standard and the question gave rise to the usual errors that have been observed over many previous sessions.

Almost all candidates worked with the provided variables x, y and z. Some candidates initially began formulating the problem in terms of r, p and h although usually they switched to x, y and z and rewrote their work with the required variables. Those that didn't convert their variables usually petered out before getting very far with the question.

Most candidates stated the objective function correctly and many remembered to 'minimise' although this was certainly not universally the case. Many candidates were able to state the equality constraint for the total number of flowers although some candidates believed there were 100 flowers rather than the given 1000. As is usually the case, the inequality constraints were generally more problematic. Most candidates had success with the roses constraint and many immediately deduced that $x \geq 600$. Sometimes though, this inequality was in the wrong direction and les able candidates gave other incorrect interpretations including $3x \geq 5(y+z)$. By far the most challenging constraint was the hydrangea/peony constraint which was often incorrect. It was common to see the incorrect inequality $2y \geq 3z$ but also $3y \leq 2z$ or $2y \leq 3z$. Sometimes all the constraints were stated as equations with no inequalities and examiners also observed strict inequalities being used from time to time.

Often candidates did not seem to realise that they had been asked to eliminate z and many simply worked with the constraints in all three variables. Of those that did attempt to eliminate z however, some candidates set the hydrangea/peony constraint to be an equality and used this to eliminate z rather than using the correct $x + y + z = 1000$ constraint. Some candidates who did make headway eliminating z from the constraints, neglected to eliminate z from the objective function.

Often candidates were able to pick up marks in part (b) despite incomplete responses to part (a). Most recognised the need for the total number of flowers to equal 1000 and correspondingly stated values to fit their constraints. Occasionally though, the minimum value of x was not used as had been stipulated and quite often candidates did not state their solution in context despite being asked for the number of each type of flower. Indeed, some candidates seemed to become muddled with the variables and flowers and stated solutions that were not compatible with their constraints - seemingly mixing up hydrangeas and peonies. On several occasions, examiners saw responses where candidates had only stated the required values for x and y and omitted the value for z. Occasionally the total cost was not stated. Overall, the question performed well providing a wide range of marks and the opportunity for differentiation amongst the candidates.

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