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Examiners' Report
Principal Examiner Feedback

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Pearson Edexcel International A-Level
Decision Mathematics D1 (WDM01/01)

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General Introduction

This paper proved accessible to the candidates. 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 are reminded that they should not use methods of presentation that depend on colour, but are advised to complete diagrams in (dark) pencil.
Candidates are also reminded that this is a 'methods' paper. They need to make their method clear, 'spotting' the correct answer, with no working, rarely gains any credit.
Some candidates are using methods of presentation that are too time-consuming, this was particularly true in question 4(c), the bubble sort, where many ran out of space (and possibly time) unnecessarily showing each comparison. 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 terms correctly. This was a particular problem in questions 3(b), 5(c) and 7(b).

Report on Individual Questions

Question 1

Question 1 was undertaken well by nearly all candidates and a large proportion scored full marks. The vast majority of candidates were able to carry out the identification of middle right pivots correctly and very few selected middle left pivots. Most were then able to reject the correct sublist (including the pivot). In some cases, candidates wrote 'reject 6 – 10' in the first pass but then had, in the second pass, a list which included 6.
Many candidates, throughout this part, did set out their work in a very logical manner by adopting one (or more) of the following approaches:
• explicitly writing out, at each stage, their calculation for the pivot and circling or making their pivot clear;
• writing out their reduced list after each pass.
It is advised that in this type of problem it is essential that the choice of pivot is made clear at each stage as should the new sublist which is to be used in the next pass.
Finally, when the search is complete it is important that the candidate provides a clear statement to the effect that the name being searched for has, in this case, not been found. Many candidates did not differentiate that the final name in the list (Hamilton) was not the name they were searching for (Hilbert) and in many cases candidates simply wrote that 'H had been found'.

Question 2

A number of candidates who used the tabular form of Prim's algorithm lost marks by listing the arcs in the wrong order although the correct arcs had been selected in the table. Candidates would be advised to scan all labelled columns, circle the smallest value and then write down the corresponding arc immediately before going on to label the next column. Trying to write down the arcs selected in order after completing the algorithm is far more demanding. Only a few candidates lost marks by either listing just the vertices in order or writing just the numbers across the top of the matrix instead of the required arcs. It was pleasing to note that only a small minority started from a different vertex than the required vertex A. Finally, very few candidates appeared to

reject arcs when applying Prim's algorithm. If the candidate answered part (a) successfully then they typically answered parts (b) and (c) correctly. A number of candidates were able to recover from mistakes in part (a) to draw the correct minimum spanning tree and state a correct weight.

Question 3

In part (a), the majority of candidates could identify the correct alternating path from A to 4 (or vice-versa) and this was then usually followed by a correct alternating path from E to 3 (or vice-versa) in part (c). There was nonetheless the usual loss of marks for some candidates due to a lack of the change of status being either stated or shown in both parts and/or failing to state the improved matching in part (a) or the complete matching in part (c). In some cases, candidates may have drawn the improved matching on diagrams which were not clear due to multiple arcs being drawn from individual vertices. If candidates are going to show these matchings on a diagram (rather than simply stating them) then only clean diagrams with the exact number of arcs will be accepted. Omission of the change of status and lack of stating the improved/complete matchings seem to be occurring less with each session but are unfortunately still evident. In part (a) some candidates did not read the question carefully and instead found an alternating path from A to 3 or from E to either 3 or 4 and so therefore lost marks.

Part (b) represented a challenge to many candidates. In this part the vast majority provided an explanation regarding workers A, D, E and tasks 2 and 6. Far less common, but equally valid were the longer, more elaborate arguments involving more than two tasks, for example, an argument based on workers B, C and F and tasks 1, 3, 4 and 5. In this type of question tasks/workers must be referred to explicitly by the corresponding number/letter and it must be made clear that certain tasks can **only** be completed by certain workers (or that certain tasks can **only** be completed by certain workers).

Question 4

Part (a) was generally very successfully attempted. The vast majority of candidates carried out a correct calculation and rounded their value up to give the correct lower bound. It was rare to see '178' (the total of all the numbers) divided by 9 (the number of suitcases).

Part (b) was nearly always correct.

In part (c) the majority of candidates knew how to carry out a bubble sort and nearly all did so correctly. Unfortunately, many candidates did not read the question carefully and either showed each comparison and swap during the first pass or during all subsequent passes. There were occasional errors including the loss of one number or one number morphing into a different number. A few candidates did not work consistently through the list of numbers. Finally, in this part, it was common for candidates to stop after a seventh pass due to the list appearing to be in the 'correct order'. With the bubble sort algorithm if the list finds itself ordered before the final two items in the list have been considered then either a suitable conclusion (that the list is sorted) or an additional pass is required.

In part (d), in which candidates now had to apply the first-fit decreasing algorithm to their ordered list from part (c), a significant number, who had sorted the numbers into ascending order earlier, then proceeded to attempt a "first fit increasing" method in this part. While the vast majority of candidates used the sorted list they had obtained in part (c) there were a minority of candidates who used the unsorted list. Otherwise, the most common errors were putting the 9 in either the third or fourth bin.

Part (e) was answered extremely well with the majority of candidates correctly arguing that five of the suitcases weighed more than half of the maximum weight capacity of a container and so therefore it was not possible to transport the suitcases using fewer containers than the number used in part (d).

Question 5

Part (a) required candidates to recognise A, C, E, and J as the odd vertices and once this was achieved they then needed to write down the three pairings of these four odd nodes which nearly all did correctly. Most candidates are aware of the need for the totals of these three pairings to be given although errors in these totals did occur. Candidates once again are losing unnecessary marks by not stating the edges they need to repeat but instead are just writing down one of the three pairings. The most common error with regards to stating the repeated tracks was to state AF, EF, CG, FG, FI, and IJ three times (due in part to all three pairings giving the same total) rather than just stating these tracks once.

Most candidates in part (b) had spotted that the total weight of the network had been given under the network in the question and successfully added on their least from part (a). There were very few instances of the route not starting and ending at A. Those candidates who correctly identified the repeated arcs usually went on to identify a correct route. Unfortunately some candidates did not state a route.

Part (c) required the candidates to justify their answer and very few successfully stated that as the new track would make vertices A and C even, only a path between E and J would need repeating. Many candidates correctly found either the length of the new route (130.9) or the extra distance (24.2) that would need to be travelled but many did not state that this would increase Angela's route by 0.5 km.

Question 6

Part (a) was usually well done with most candidates applying Dijkstra's algorithm correctly. The boxes at each node in part (a) were usually completed correctly. When errors were made it was either an order of labelling error (some candidates repeated the same labelling at two different nodes) or working values were either missing, not in the correct order or simply incorrect (usually these errors occurred at nodes C, D, F, and/or H). The most common errors were seen at vertex H (due to two of the arcs leading into H having weights in terms of x) with many candidates not having the three correct working values of 37 $13+2x$ and $21+x$. This question also highlighted, yet again, the need for candidates to read the question carefully as almost 10% of candidates started the application of the algorithm from vertex C rather the correct vertex A. Furthermore, the question explicitly asked for candidates to: *Use Dijkstra's algorithm to find the possible routes that minimise the driving time from A to H. State the length of each route, leaving your answer in terms of x where necessary* – very few stated all three routes and their corresponding lengths.

The most common incorrect response in part (b) was to have $21+x=13+2x+2$ which gives $x=6$ which scored no marks as the question explicitly stated that $x>7$.

Question 7

Parts (a), (c) and (e) were generally well answered with many candidates scoring full marks in all three parts. The most common error in part (a) was to have an incorrect value at the end of either activity E or J, and in part (e) the most common error was a failure to correctly sum the length of all fifteen activities. Part (b) was extremely challenging with very few candidates scoring any marks in this part. It was expected

that candidates would realise that one of the marks in this part was for explaining what was meant by 'critical' and the other mark was for explaining the word 'path'. The delay on activities J and M were well understood and a lot of correct answers were given in part (d). Some candidates' responses were more succinct than others and a significant number of candidates described the effect these delays would have on the activity which followed, or on the float time and did not, as requested, comment on the effect on the project completion date. For part (f) quite a few candidates drew a Gantt chart instead of a scheduling diagram, and so scored no marks. There were also quite a few instances of this part being left blank. For candidates who knew what a scheduling diagram was this part was generally well answered, although candidates should be reminded to check that they include all the activities in the network and that the activities have the correct lengths. In this part many candidates did not include all fifteen activities, or they scheduled using five (or three) workers rather than the correct four. Some candidates made a good attempt but failed to fully check the precedencies for each activity. There were some good solutions seen to this part, with a number of different but valid solutions seen.

Question 8

In part (a) the objective function was often found correctly but the absence of the word 'minimise' meant that the first mark could not be awarded. The first constraint (the requirement that there be a total of at least 50 pens) was usually correct. The next constraint based on the fact that there needed to be at least twice as many rollerball pens as fountain pens was almost always correct with the most common incorrect answer being $2y \geq z$. The other two constraints were either dealt with very well or not attempted at all. Simplified inequalities were not always seen and, on occasion, coefficients were left as fractions rather than integers.

Most candidates were able to draw the required lines correctly in part (b) although some were unable to draw lines sufficiently accurately (some drew lines without a ruler) or sufficiently long enough. As stated in previous reports the following general principle should always be adopted by candidates:

- lines should always be drawn which cover the entire graph paper supplied in the answer book and therefore,
- lines with negative gradient should always be drawn from axis to axis.

The rationale behind this is that until all the lines are drawn (and shaded accordingly) it is unclear which lines (or parts of lines) will define the boundary of the feasible region. If candidates only draw the line segments that they believe define the boundary of the feasible region then examiners are unaware of the order in which the lines were drawn and therefore it is unclear to examiners why some parts of the lines have been omitted. In general the lines $x + y = 40$ and $y = 20$ were drawn correctly. Furthermore, a significant number of candidates were unable to select (or even label) the correct feasible region.

In part (c), the majority of candidates drew the correct objective line, however, a line with reciprocal gradient was sometimes seen or, in a number of cases, no objective line was drawn (and therefore no marks could be awarded in this part). Some used obscure constant values to plot the objective line and some candidates did not label the optimal vertex clearly.

In part (d) many candidates did not state in context the number of ballpoint pens and rollerball pens that the manager should order and the cost of the order was often given incorrectly as £100 (as the cost of the 10 fountain pens was often not included).

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