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Examiners' Report

January 2015

Pearson Edexcel International Advanced Level in Decision Mathematics D1 (WDM01/01)

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General

The paper proved accessible to the majority of candidates. The questions differentiated well, with most giving rise to a good spread of marks.

Report on Individual Questions

Question 1

A number of candidates who used the matrix form of Prim's algorithm lost marks by listing the arcs in the wrong order although the correct arcs had been selected in the matrix. 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. Common errors in the selection of arcs were seen when arc AB was selected before arc AC and/or arc AH was selected instead of arc AB.

Only a few candidates lost marks by listing only the vertices in order instead of the required arcs. It was pleasing to note that only a small number of candidates started from a different vertex than the required A, although some began at B, possibly due to arc BH being the shortest arc in the network.

Very few candidates appeared to reject arcs when applying Prim's algorithm. If the candidate answered part (a) successfully then they typically drew the minimum spanning tree correctly in part (b) although a minority of candidates did not state the weight of the tree. A number of candidates were able to recover from mistakes in part (a) to draw the correct minimum spanning tree and state a correct total. Some candidates clearly did not understand what was being asked of them in part (c). Examiners commented that they saw quite a few responses in which a definition of a tree was given. Others did not understand the meaning of 'unique', sometimes interpreting it as 'optimum' and others talked about paths and mentioned starting at other vertices. There were a number of candidates who did not provide enough detail in their answers. For example, responses along the line of "It is not unique because there is more than one minimum spanning tree" or "It is not unique because there is more than one arc with the same weight" did not score the mark.

Question 2

This was, in general, a well answered question with the exception of part (a). Candidates found part (a), in which they were asked to explain why it was not possible to find a complete matching, very demanding and the quality of candidates' responses was extremely varied. Examiners needed to see a fully correct statement and so something along the lines of "B can only do task 2 and F can only do task 6 therefore E will have no allocation as E can only do tasks 2 and 6" was required for this mark. The most common errors or incorrect reasoning in this part included:

- a large number of incomplete attempts, for example, "2 can only be done by B or E",
- several responses which were simply incorrect, for example, "4 and 5 can only be done by D",

- many responses which were lacking completeness – a common response seen was “B can only do 2, F can only do 6 and so E has nothing to do”,
- a small number of candidates were clearly unsure what was being asked in this part and so decided to define the terms ‘bipartite’ and/or ‘matching’.

There were though a good number of completely correct responses, which usually focussed on the workers B, E, F rather than the workers A and D.
The majority of candidates found the remaining parts of the question fairly straightforward and there were a large number of fully correct responses.

Most candidates found the two alternating paths in part (b) and managed to provide the two improved matchings in part (c). However, a significant number only provided one improved matching (usually the one they went on to use in part (c)). Some candidates provided neither improved matching instead they simply ‘changed status’ on their alternating paths (perhaps mistaking this for an ‘improved matching’). Others listed part of the improved matching (most often the matches from their change in status) but failed to include the pairings not included in the alternating path. In part (d), when applying the maximum matching algorithm, a number of candidates are still not making the ‘change status’ step clear. This can be done either by writing ‘change status’ or, more popularly, by relisting the path with the alternating connective symbols swapped over. This latter approach has the additional advantage of making the path very clear to examiners.

Question 3
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 their first bin rather than the most recent bin used. In this part a number of candidates placed the 0.9 in the second bin (and not the first bin) and others did not place the 0.2 in the first bin.

The majority of candidates were able to complete the first pass of the bubble sort in part (b)(i) however many took several lines to do so and a significant number carried out the full bubble sort when only the first pass was required. The vast majority started on the left-hand end of the list and sorted into descending order. Examiners reported seeing very few errors in this part. The responses however to part (b)(ii), in which candidates were asked to state the number of comparisons and swaps performed during the first pass, were mixed. Some candidates missed out this part completely, either not understanding what was being asked or just forgetting to answer this part. Others gave completely incorrect answers. In between these two extremes there were those candidates who painstakingly listed each comparison and whether the result was a swap or not but they failed to state how many comparisons and swaps there had been. A significant number only gave the number of comparisons.

Many correct solutions were seen in part (c), but a number of candidates did not choose their pivots consistently, switching between middle-left and middle-right pivots during the course of the quick sort algorithm. A number of candidates either lost an item or changed an item during the sort, and in a small number of cases only one pivot was chosen per iteration. Some candidates did not indicate that their sort was complete. This could have been achieved either by having at the end a 'list sorted' statement, or every item in the original list being used as a pivot or the final list being rewritten at the end. Common errors included the items 1.9, 1.1 and 1.7 being interchanged in the third pass or not choosing the 1.7 as a pivot for the fifth pass; candidates should be reminded that items should remain in the order from the previous pass as they move into sub-lists. Part (d) was, in general, more successfully attempted than part (a). Most candidates scored full marks although there were sometimes errors with the placement of the 0.9 or 0.7.

Question 4

In part (a), most candidates seemed to be confident and accurate in applying Dijkstra's algorithm. The most common errors were:

- errors in labelling – examiners reported seeing the same repeated labels a number of times, for example, A and B both labelled 1. On a number of occasions vertex E was labelled before vertex H,
- a small minority of candidates omitted working values at vertices B, D and G,
- a small minority of candidates made errors in the order of working values – usually at vertex J.
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Irrespective of earlier errors, most candidates were able to give the correct length of the route (sometimes on the follow through) and only in a few cases did candidates not state the correct shortest path.

The vast majority of candidates did not realise the connection between part (a), in which the shortest distances from vertex A to any other vertex had been found and part (b). Therefore many candidates went on to make at least one error in the totals for the pairings in part (b). Most candidates stated the repeated arcs correctly although there were a few who simply stated "AF, EJ". Very few candidates failed to give three distinct pairings and totals in this part. Part (c) was well answered especially the length of the route. Most candidates who attempted the route were successful but in a number of cases it was left blank.

Part (d) proved to be a good discriminator with a significant number of candidates continuing to consider vertex A even though it was no longer an odd degreed vertex. Of those who were considering the correct vertices many were unsure how to proceed and while a number of candidates listed one correct pairing of starting and finishing points they failed to give a second pairing. The majority of candidates who gave a length for the route usually gave an incorrect answer of 104 after neglecting to subtract 7, the total of the arcs incident to vertex B.

Question 5

Candidates generally showed a good understanding of the process of constructing an activity network from a precedence table, using arcs drawn with arrows and labelled for activities. Some scripts lacked a sink node at the end and a small number did not have a single source node. Some of the diagrams and labels were challenging to read, especially when they were very small and/or drawn with lines that crossed over. It was also common to see arrows missing from some (or all) of the activities although the arrows were often seen on the dummy activities. Some candidates were unsure about the placement of their dummies with many having an unnecessary dummy at the end of activities F and G (believing that a dummy was required so that activity K could be begin) or not having a dummy separating activities H and I. A very small number of candidates put activity on node, and some failed to check that they had all activities present; J and K being the activities that were missing most often.

Those candidates who scored full marks most easily in part (b) were those who used their diagram from part (a) as a guide to when dummies might be needed in an activity network. Only a few candidates were able to accurately describe why dummies are needed in the general sense. While most candidates used the correct terms of 'dependency' and 'uniqueness' in their description, many were then unable to go on to accurately describe what these words meant in the context of dummies on activity networks.

Question 6

This question proved to be a good discriminator and it was rare for candidates to score full marks. Most candidates gave a correct answer in part (a) although it was not uncommon to see $x + y \leq 30$. Most candidates either left part (b) blank or misunderstood what they were being asked to do and instead attempted to write one of the provided constraints in words. There was a minority of candidates who incorrectly gave strict inequalities here.

Drawing the lines proved, on the whole, to be a successful source of marks but the line $2y - x = -30$ seemed to cause the most problems. Most candidates who drew all three lines correctly selected, and labelled, the correct feasible region although there were some who selected the small triangle under the line $2y + x = 40$ and some candidates did not label the feasible region at all. The drawing of an objective line caused problems for a significant number of candidates. The most common errors included the failure to draw an objective line, the drawing of an objective line that was too short to be of any practical use in finding the optimal vertex of the feasible region, the drawing of an objective line with reciprocal gradient or the drawing of an objective line with an incorrect gradient. Candidates struggled with finding the correct optimum point and it was fairly common to see the answers of (20, 10) or (0, 30). Those who identified the correct vertex of the feasible region rarely identified the optimum integer values for x and y. Most commonly, candidates looked at $x = 35$ or $x = 36$ rather than $x = 34$. Some candidates incorrectly gave their answers for x and y as non-integers.

It was often the case that the final part of this question was left blank. Those candidates who did attempt this part usually scored at most 2 marks as they had failed to find the correct optimum point in part (d). Many candidates in part (e) attempted to combine the two relationships, which involved the total cost of the hats and the relative costs of the two types of hats, into one step. While many candidates completed this successfully, a significant number made errors confusing $green = 3(red)$ with $red = 3(green)$. A number of candidates in part (e) stated an incorrect equation that related their objective function with the total cost of the hats. This meant that the equation $red + 3(green) = x + y \leq 107.50$ was often seen by examiners. Finally a number of candidates made no use of the total cost of the hats in any part of their solution.

Question 7

Part (a) was generally answered well although the incorrect answer of $y = 5$ was fairly common.

In part (b) the most common error was a value of 9 in the bottom box at the end of activity A and sometimes errors in the top box at the end of activity C.

A number of candidates decided in part (c) to sum the durations of all the activities even though this total was given in the question. A number of candidates who did sum all the activities then went on to make a mistake due to either an error in their own arithmetic or due to earlier error(s) from part (a). Occasionally candidates divided the minimum completion time of the project by the number of activities or did not round their answer to 3.

A number of candidates may have run out of time on this question as there were a number of incomplete cascade diagrams seen. Those diagrams that were complete were often completed to a good standard. Examiners reported seeing only a small number of scheduling diagrams. Most errors seen were those that were carried over from parts (a) and (b). However, activity I was sometimes drawn as a critical activity and occasionally a number of activities were missing.

Part (e) proved to be a good discriminator and it was rare for candidates to score both marks in this part. Many candidates either failed to list the activities or did not make reference to time even though the question asked for a specific reference to both activities and time. A number of candidates gave an answer based on scheduling the activities to workers even though the question said that their answer should relate to the cascade diagram. Finally, many candidates thought four workers and not five were required.

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