Examiners' Report

Principal Examiner Feedback

Pearson Edexcel International A Level

In Decision Mathematics D1 WDM01/01

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General Introduction

This paper proved accessible to the students. The questions differentiated well, with most giving rise to a good spread of marks. All questions contained marks available to the E grade students and there also seemed to be sufficient material to challenge the A grade students. Students are reminded that they should not use methods of presentation that depend on colour, but are advised to complete diagrams in (dark) pencil. Students 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 students are using methods of presentation that are too time-consuming (this was particularly evident in question 3(c)) and are therefore reminded that the space provided in the answer book, and the marks allotted to each part, should assist students 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. Students should ensure that they use technical terms correctly. This was a particular problem in questions 2(c), 3(a) and 3(d).

Report on Individual Questions

Question 1

Part (a) was generally very successfully attempted. The vast majority of students carried out a correct calculation and rounded their value up to give the correct lower bound. It was rare to see '19.1' (the total of all the numbers) divided by 11 (the number of pieces of wood).

Examiners reported that a significant number of students struggled in applying the first-fit bin packing algorithm in part (b). This was mainly down to not applying the algorithm correctly. First fit is just that; students 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 students placed the 1.4 in the second bin (and not the first bin) and others did not place the 0.3 in the second bin.

Many correct solutions were seen in part (c), but a number of students 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 students 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 students did not complete a fifth pass in which the 0.4 was used as a pivot as it was probably (incorrectly) assumed that as the list was in the 'correct' order after a fourth pass the sort was complete. Common errors included the items 2.5, 3.1 and 3.9 being interchanged in the first pass and/or the 1.4 and 1.5 not being interchanged in the fourth pass; students should be reminded that items should remain in the order from the previous pass as they move into sub-lists. There were only a few instances where students selected the first or last items as the pivot. Pivots were usually chosen consistently although the spacing and notation on some solutions made these difficult for examiners to follow. Some students over complicated the process by insisting on using a different 'symbol' to indicate the pivots for each pass. Those students who sorted into ascending order usually remembered to reverse their list at the end to gain full credit although a number of students left their list in ascending order.

The first-fit decreasing in part (d) was well carried out with only a small minority failing to attempt this part. There were a large number of wholly correct answers. A small number performed first-fit increasing therefore scoring no marks. A small minority of students lost both marks by placing the 1.9 in the 4th rather than 2nd bin (so failing to apply the algorithm at its first real test). Some students wrote totals in the bin rather than the next value. A variety of different layouts were used but in nearly all cases were easy to read and decipher.

Question 2

A number of students 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. Students 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 students lost marks by either listing just the vertices in order or writing just the numbers across the top of the table instead of the required arcs. It was pleasing to note that only a small minority started from a different vertex than the required vertex S. Finally, very few students appeared to reject arcs when applying Prim's algorithm. If the student answered part (a) successfully then they typically answered part (b) correctly. A number of students were able to recover from mistakes in part (a) to draw the correct minimum spanning tree and state a correct weight. Part (c) discriminated well with only a minority of students correctly stating that Prim's algorithm always selects arcs that bring a vertex not in the tree into the tree, so cycles cannot happen. Many students failed to score this mark and only gave generic comments regarding Prim's algorithm or gave arguments that were difficult for examiners to follow.

Question 3

Nearly all students gave the correct answer of ‘bipartite’ in part (a) although the spelling of this key term in decision mathematics still leaves a lot to be desired.

Part (b) was well attempted and most students were able to write down an alternating path from B to 2. It is important that examiners can clearly identify the alternating path so it should be listed (rather than drawn) separately (rather than left as part of a ‘decision tree’ of potential paths). A number of students 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. A significant number of students did not state the complete matching after stating their alternating path. If students are going to display their complete matching on a diagram then it must be made clear that only a diagram with the exact number of required arcs going from one set to the other set will be accepted.

In part (c) the majority of students either correctly stated or found the second complete matching for this problem. Many students did not realise that the word ‘state’, and the fact that there was only one mark available for this part, meant that it was not necessary to apply the maximum matching algorithm a second time to find this second complete matching.

Part (d) differentiated well with very few students scoring both marks in this part. Even though the question specifically directed students to consider the workers who must be allocated to particular tasks many just gave vague answers without any references to specific tasks or workers. All that was required was an understanding that workers A, B, D and E can only be allocated to activities 2, 5, 3 and 1 respectively and workers C and F can both be allocated to the two tasks of 4 and 6 (therefore meaning that there is exactly two different complete matchings).

Question 4

Part (a), in which students had to complete the early event and late event times, was often done extremely well. Errors occasionally occurred in the early event times at the end of H or D or with a number of the late event times (most notable at the end of A and/or the end of C). However, either full marks or three marks out of four were common in this part.

Students nearly always stated the correct critical activities in (b) but a number did not state the length of the critical path. Most students were confident in calculating the total float on activity D in part (c) and the majority gave the calculation in full.

Part (d) was answered well with many fully correct diagrams seen following correct answers in part (a). Very few students failed to include all the activities. There were a few slips with lengths of activities and/or floats. Those with errors in part (a) were usually able to get at least six non-critical activities correct and so could score at least three marks in this part.

Part (e) proved to be a good discriminator and it was rare for students to score both marks in this part. Many students 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 students 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 students thought four workers and not five were required.

Question 5

This was probably the most challenging question on the paper for the majority of students, with very few scoring full marks. Part (a) was almost always answered correctly and most students 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 mentioned in previous examiners' reports the following general principle should always be adopted by students:

- 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 students 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 $x = 25, y = 60$ and $5y + 2x = 250$ were correctly drawn and were errors occurred they tended to be with the line $5x - 3y = 150$. Furthermore, a significant number of students were unable to select the correct feasible region.

A significant minority of students omitted part (c) and examiners commented that the incorrect answer of $3x + y$ was seen relatively often.

For part (d), it is clear that many students did not read the question carefully and failed to find the exact coordinates of all the vertices of the feasible region. Many students only found the coordinates of the optimal vertex by applying the objective line method even though the question specifically required the use of the vertex method.

Another common error was to round the exact answers either to 1 decimal place or to the nearest integer answer, and to use these approximate answers when evaluating the objective function, without considering whether these new points are still in the feasible region. Only the most able students

- correctly found all four vertices exactly,
- evaluated all four vertices in a correct objective function,
- concluded that the optimal vertex was $\left(\frac{1500}{31}, \frac{950}{31}\right)$,
- tested clearly and accurately the integer coordinates about this optimal vertex in the correct pair of inequality constraints,
- evaluated any feasible integer solutions in a correct objective function,
- concluded that there should be 48 junior prizes and 31 senior prizes.

Question 6

In part (a), most students 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, C and H both labelled 5. On a number of occasions vertex C was labelled before vertices F and H,
- a small minority of students omitted working values at vertices F, H, C and B,
- a small minority of students made errors in the order of working values – usually at vertices H and B.

Irrespective of earlier errors, most students were able to give the correct length of the path (sometimes on the follow through) and only in a few cases did students not state the correct shortest path.

Students found part (b) demanding with very few realising that the shortest path from A to C could be found using their answer to part (a).

Part (c) required students to recognise B, E, G, and H 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 students are aware of the need for the totals of these three pairings to be given although errors in these totals did occur. Students 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.

Parts (d) and (e) proved to be good discriminators with many stating a correct route in (d). However, the calculation of its length was often incorrect as many students forgot to subtract the weight of the three arcs that were incident to vertex C in the original network. Part (e) was often left blank but for those that attempted it many correctly stated that G would be the finishing vertex for Faith's route and that the difference in lengths of the routes would be 10 km.

Question 7

Students 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 students were unsure about the placement of their dummies with many having an unnecessary dummy at the end of activity B (believing that a dummy was required so that activity H could be begin) or not having a dummy separating activities J and K. A very small number of students put activity on node, and some failed to check that they had all activities present; J and/or K being the activities that were missing most often.

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