Examiners' Report
Principal Examiner Feedback

January 2023

Pearson Edexcel International Advanced Level
In Decision Mathematics 1 (WDM11) Paper 01

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 enough 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. Furthermore, several candidates are still using highlighter pens even though the front cover of the examination paper specifically mentions that this type of pen should not be used.

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. Some candidates are using methods of presentation that are very time-consuming; they are reminded that 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 question 5 parts (a) and (b).

Report on Individual Questions

Question 1

Part (a) required candidates to apply the nearest neighbour algorithm starting at A. It should be noted that the route derived from nearest neighbour (and hence the corresponding upper bound) should begin and end at the same node (so creating a Hamiltonian cycle for the network) – many candidates only gave the route in (a) as either A – B – D – F – C – E – G or A – B – D – F – G – E – C. Those candidates that did find the correct route(s) usually stated the corresponding upper bound(s).

In (b), in which a lower bound for the length of the route was required, candidates are reminded that they must make their working clear and so should clearly state the weight of the RMST (that is the weight of the minimum spanning tree once A and all its arcs have been deleted) and then show the addition of the weight of the two smallest arcs incident to A to give the required lower bound. It was clear that a number of candidates thought the answer to this part was based on their answer to (a) (by removing A from the cycle found in this part) which is an incorrect method and could only score 1 of the 3 marks available (that is the mark for adding on the two smallest arcs incident to A to the weight of their (incorrect) residual spanning tree).

The final part of the question differentiated well with only the most able being able to give a correct interval (with corresponding correct inequalities or equivalently correct notation).

Question 2

Dijkstra was a very comfortable start to this question and most candidates were very well prepared here. The errors in working values are becoming fewer with each series and generally errors are slips rather than incorrect application of the algorithm. Although there was the occasional costly error when no replacement of working values whatsoever was demonstrated. Sometimes candidates made mistakes with the order of labelling with repeated labels, for example B and C both labelled “2”. The most common error in working values was the omission of one or more values at either F and/or J. Candidates should be reminded that examiners are checking

working values and their order, therefore the order in which they are written in the working value boxes should be clear and unambiguous. Furthermore, working values should never be crossed out unless they are incorrect.

Part (b) was answered extremely well with many candidates correctly using the answer to part (a) (the shortest path from A to J) and adding on the path from A to H (by working backwards from H) to obtain the correct shortest path and its corresponding length.

Part (c) tested the route inspection algorithm and was answered extremely well with the majority of candidates scoring the method mark and some of the following accuracy marks. Candidates are once again reminded that when applying the route inspection algorithm that all relevant pairings of the odd nodes must be stated, and the corresponding totals should be stated too. Even if the total for one pairing is 'obviously' bigger than the total for another one the algorithmic nature of the problem requires all totals to be found and then a comparison of the totals to be made. Candidates are reminded that when stating the arcs that need to be repeated that they must do just that and therefore an answer of AE, FG does not gain credit.

Part (d) discriminated well with very few giving a reason for their answer as explicitly stated in the question. For full marks candidates had to explicitly state that EF should be repeated as it is the shortest path between two odd nodes excluding G; many candidates simply said that 'EF was the least' which is not technically correct. However, those that realised what was required in this part usually scored the first and final mark (of the three) for determining that the total length of the route that would need to finish at A was 206 miles.

Question 3

In part (a) most candidates demonstrated a good familiarity with the first-fit bin packing algorithm though it was relatively common to see the 0.6 placed in the wrong bin (usually in bin 3).

The majority were able to successfully perform one pass of the bubble sort in (b). Many did this in one line, but some candidates clearly spent a good deal of time rewriting their list after each swap, or even performing the complete sort, in spite of being asked for only one pass. Many candidates did state that 10 and 6 were the required number of comparisons and swaps respectively, however, some candidates stated only one of these numbers and therefore it was unclear what this single number related to.

The quick sort in (c) was well performed by most candidates, with marks sometimes lost due to slips or inconsistent pivot choice. Almost all candidates used middle right pivots, with just a few using middle left. A few candidates lost a significant number of marks due to failing to pivot on the four items, which happened to be in the correct order, to the right of the initial pivot value of 1.4 (and therefore were only pivoting on a single value per iteration). Some did omit the last pivot (2.4 for middle-right), losing the final mark in this part. A few candidates, in error, carried out the sort on the original list or their list obtained in (b)(i).

The first-fit decreasing bin-packing, in (d), was more often correct than first-fit in (a), but here again the most common error was to misplace the 0.6.

Question 4

A good number of candidates did extremely well in part (a) scoring full marks. Mistakes were most common at J and Q, usually in the form of omissions through overlooking the effect of the preceding dummies. The most common mistake at G, H and I was the omission of A, for the same reason. More candidates than expected

seemed to find this surprisingly difficult with some only getting the immediately preceding activities correct for activities N, P and R.

Part (b) was answered well with most candidates scoring the two method marks for completing the forward pass and the backward pass through the activity network. There were the standard errors across the dummy activities and on the backward pass which meant that many candidates did not score the two accuracy marks in this part.

The most common error in part (c) was to add activity A to the correct list of critical activities (C, E, G, K and N).

In part (d) the calculation for the total float on activity J was generally done well, with most candidates either showing the correct working or correctly following through from their answer to part (b).

In part (e) the majority of candidates knew how to calculate the lower bound, but errors such as having the minimum completion time as 41 rather than 43 were seen. It was surprising how many candidates spent time adding up all the durations instead of using the total given in the question.

There were a few cascade charts seen in part (f), but most candidates (who attempted this part) did attempt to schedule the remaining fourteen activities. Some candidates, it would seem, ran out of time, and left this part blank, even when the other parts of the question were well done. When attempted well, the most common place for errors to occur was with the placing of activity Q in particular (being dependent on four other activities), which in many cases could have been swapped with activities M or P with very little adjustment. If an activity was omitted, it wasn't unusual for this to be activity R.

Question 5

In part (a) many candidates based their reasoning on the fact that the sum of the orders wasn't a multiple of 8 (the number of vertices), rather than it simply wasn't even. For the one mark available it was sufficient for candidates to simply state that a graph cannot have an odd number of odd vertices or that it is not possible to have a graph with three odd vertices.

In part (b) for the two marks available candidates had to specifically say that the given example was not a path on T because vertex C appears twice. Some candidates mentioned the fact that you cannot repeat a vertex or that a path cannot contain a cycle. While these types of responses gained some credit, for both marks either node C, or the corresponding cycle (C – D – E – C), had to be explicitly mentioned. Furthermore, some candidates seemed to be confused and gave responses that implied that a path must pass through all the vertices in a network which is not correct. Finally, in this part, some candidates used incorrect terminology (e.g., 'circle' for 'cycle') which meant that full marks could not be awarded.

In (c) many correctly applied Prim's algorithm (starting from the given node A) and stated the arcs in the order in which they were added to the minimum spanning tree (MST). A minority either only stated the nodes in order or seemed to apply Kruskal's algorithm instead. Those that obtained the correct MST in (c) usually went on to draw the correct tree in (d).

A few candidates unfortunately interpreted x as the increase in part (e), rather than the increased value. Many tried associating x with the total of all the arcs in the MST. While some candidates realised that x < 25 very few also realised that x > 21 too.

Question 6

In part (a) many candidates stated the correct expression for the objective but omitted 'minimise'. The next two inequalities $275x + 200y + 100z \leqslant 5500$ and $5x + 2y + 3z \leqslant 70$ were usually done extremely well, as was the constraint that $x + y + z \geqslant 18$. Dealing with the time constraint was either overlooked or tackled incorrectly as $x \leqslant 15, y \leqslant 20$ and $z \leqslant 30$.

Part (b) was generally answered well, with a predictable number of candidates getting the relationship the wrong way round. It was most unusual for this to be answered without reference to the context. Although a surprising number did not attempt this part.

The graph in (c) was regularly well done with the feasible region generally receiving the label R as instructed. Most candidates were able to draw the required lines correctly 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.

It was clear in part (d) that a number of candidates found the correct optimal vertex from their graph either by point testing or by inspection and many failed to draw an objective line on their graph (and as mentioned at the beginning of the report this is a methods-based examination and without the evidence of a correct method having been applied no marks could be awarded in this part). Those that could have earned marks for the final calculations often failed to do so through either not giving the context for x, y and z, or for not calculating z, or for selecting the wrong vertex (0, 12).

Although part (e) was often omitted this part was still answered well by those candidates who had the correct graph in (c) and a correct objective line from (d).