Examiners' Report
Principal Examiner Feedback

Summer 2022

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

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June 2022
Publications Code WDM11_01_2206_ER

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 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 questions 2(c), 3 and 6(d).

Report on Individual Questions

Question 1

Overall, this question was accessible to all candidates with the majority able to access all parts. There were many perfect solutions seen.

Most candidates answered (a) very well, showing sufficient working. Very occasionally candidates forgot to round their answer up to 4. The odd, rare case tried to explain using full bin method or divided by a number other that 300 e.g., 10.

There was a definite improvement in the quality of responses seen in (b) compared to previous years. A minority of candidates did not sort into descending order and instead sorted into ascending. Several candidates used a quick sort rather than the requested bubble sort. A few candidates are still unaware of how to end the algorithm; too many assumed that once the values in the list were in the correct order, they did not need to complete a sixth pass.

Part (c) was also extremely well answered with most candidates correctly applying the first-fit decreasing bin packing algorithm to allocate the crates to four trucks. Occasionally the 125 and/or the 20 was placed in the fourth truck.

Question 2

This question was found to be very accessible to most of the candidates although full marks was rare.

Part (a) was answered well, with most candidates correctly stating the value of x as 10 and showing sufficient working for how to derive the given value of 7 for y.

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 final accuracy mark in this part.

Part (c) was generally completed well, with few scheduling diagrams seen. Errors were occasionally seen following through from incorrect algebra seen in (a) and there were some errors in the drawing of activities I, J, K and M. Many candidates picked up at least one of the final two marks in (c) by correctly stating the activities and number of workers. Some lost both marks though for not stating the number of workers even though they had correctly identified the activities and the time. Many candidates stated the number of workers with no reasoning or tried to create a mini schedule of activities to support their answer. Some candidates tried to calculate the minimum number using the total duration and critical path length, ignoring the fact that the question asked for times and activities. A significant number of candidates made no attempt at this final part of (c) at all.

Question 3

In (a) most candidates were able to gain full marks for correctly applying Kruskal's algorithm. Those candidates who sorted the arcs in to order of size first were the most successful. Some candidates listed the accepted and rejected arcs separately and lost marks as the order of selection (and/or rejection) was therefore unclear. Most candidates were able to select the correct MST, with the most common errors being the omission or poor ordering of one or more of the rejections. Probably the most common way to score no marks in (a) was to not show any rejections.

In (b) 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 just showed their working on the given table. Those that obtained the correct MST in (b) usually went on to correctly state the weight in (c). In (d) most candidates correctly doubled the weight of their MST from (c) to obtain an initial upper bound for the length of the route.

Part (e) required candidates to apply the nearest neighbour algorithm starting at W. 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 (e) as W – C – P – B – A – H – M – L – Y – S. Those that did find the correct route usually stated the corresponding upper bound. Part (f) was answered well with most realising that the best upper bound was the one with the least weight from the upper bound given in the stem and their answers to (d) and (e). In (g), 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 W and all its arcs have been deleted) and then show the addition of the weight of the two smallest arcs incident to W to give the required lower bound. The responses to (h) were mixed with many candidates clearly not understanding the need to state the actual towns visited from W to W, in the correct order. The simplest and clearest way of doing this was to state it as a list of vertices (WCPBAHMLYSACW); many candidates just stated that A, C and W would be visited twice which was not specific enough.

Question 4

Due to the unfamiliar nature of this question (solving a three-dimensional LP problem algebraically) the responses seen by examiners were very mixed. The question was structured in such a way that if the candidates followed the given instructions, then scoring full marks was easily achievable (and many therefore did). However, it was clear that some candidates did not read the demand of (a)(i) carefully and therefore simply tried to solve the inequalities by either ad-hoc or mathematically unsound methods. Those candidates who did reduce the three constraints to $-x + y \leqslant 1$ and $x + 6y \leqslant 27$ the majority then realised that the maximum value of P had to be 1. It was slightly disappointing (but still not totally unexpected) that those candidates who correctly found the values of x and y in (b) failed to also give the corresponding value of z too.

Question 5

Compared to previous sessions, candidates appeared to be better prepared to approach the construction of an activity network as required in this question. The overwhelming majority made a good attempt at this question and most picked up at least three marks. It was less common than in previous sessions to see the previously frequent and persistent errors of arcs without arrows, dummies without arrows and non-unique activities. Only a handful of candidates attempted activity on node diagrams, and it was very rare for networks to have more than one start. More common errors this session included missing off an activity, often J, or leaving the network with multiple end points. For some candidates, there was a tendency to use either a dummy or an extra activity to connect the network together to one end event. Otherwise, extra unnecessary dummies were rare and provided they did not affect the immediate precedences of activities they were penalised with just the final accuracy mark.

Candidates should be advised to draw their activity networks large enough to enable them to complete their diagram accurately. Some candidates' diagrams were incredibly small and therefore undoubtably difficult to construct and certainly difficult to follow.

In part (b) most candidates correctly stated the minimum completion time for the project, the critical activities and the total float on activity K. Very few though correctly stated the total float for activity G as 3 (with many insisting that this was in fact 1).

Question 6

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 session 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 "3". The most common error in working values was the omission of either the 74 or 73 at vertex H. Candidates should be reminded that examiners are checking working values and their order and so the order in which they are written into the working value box should be clear and unambiguous. Furthermore, working values should not be crossed out unless they are incorrect.

The first part of (b) testing route inspection was answered extremely well with many candidates scoring the first four 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 is made. Many candidates realised that they could find a lower bound (of 24) for x but only the most able realised the significance of why the box at J had been completed for them in (a) and it was this information which then provided an upper bound on the value of x too.

Parts (c) and (d) were answered well with many stating a possible route in (c) and deriving the value of x in (d).

Question 7

This question was answered extremely well with many candidates scoring full marks (although several blank responses were noted by examiners too). In (a) many correctly set up the relevant simultaneous equations to find the points *A* and *B*. Surprisingly, at this level, several candidates failed to then find the correspond equation of the line that passed through these two points. Those that did find the equation of this line correctly usually went on to state all the inequalities that defined the feasible region.
Part (b) was answered well with many realising the significance of *C* in determining the greatest possible value of *k*.