Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

October 2021

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

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 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 1(a), 5(c) and 7(c).

Report on Individual Questions

Question 1

Part (a) had a variety of responses – the best responses contained the key ideas that a path consists of a finite sequence of edges, such that the end vertex of one edge in the sequence is the start vertex of the next and in which no vertex appears more than once. Candidates need to use the correct technical language such as ‘nodes’ or ‘vertices’, rather than points, dots, people, data, etc. A number of candidates incorrectly implied that the path needed to contain all the vertices and many gave an answer along the lines of ‘a path is a walk in which no vertex appears more than once’ without explaining what a ‘walk’ was.

Part (b) was usually very well done with most candidates applying Dijkstra’s algorithm correctly. The boxes at each node in part (b) 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 G or J). The path was usually given correctly, and most candidates realised that whatever their final value was at J, this was therefore the value that they should give for the length of their path. As noted in previous reports because the working values are so important in judging the candidate’s proficiency at applying the algorithm it would be wise to avoid methods of presentation that require values to be crossed out.

Part (c) was done extremely well with many giving both the correct path and its corresponding length.

Question 2

Most candidates correctly translated the three bullet-points into the correct inequalities $y \geqslant 3x$, $z - x \geqslant 50$ and $y \leqslant 120$. A number of candidates failed to then re-formulate these inequalities in just x and y by using the fact that in a triangle $x + y + z = 180$. Also, a number of candidates failed to state the objective as the need to maximise the expression $x + y$.

Question 3

This question was answered extremely well by most candidates. In (a) 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 (a) usually went on to correctly state the weight in (b). In (c) most candidates correctly doubled the weight of their MST from (b) to obtain an initial upper bound for the total cost of the route.

Part (d) required candidates to show that there were two nearest neighbour routes that began at A. It should be noted that routes derived from nearest neighbour (and hence the corresponding upper bounds) should begin and end at the same node (so creating a Hamiltonian cycle for the network) – many candidates only gave the routes in (d) as A – E – G – D – H – B – F – C and A – E – G – D – H – F – C – B. Part (e) was answered well with most realising that the best upper bound was the one with the least weight from their two answers to (d). In (f), in which a lower bound for the total cost 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. Therefore, a correct answer of 232 with no indication of where this value came from did not score all the marks in this part. The responses to (g) were mixed with some candidates giving an inequality in which the upper bound was less than the lower bound and some failed to use their values correctly from the previous parts.

Question 4

Part (a), in which candidates had to complete the precedence table, was often done extremely well. Errors occasionally occurred in activities H, L and/or M. However, either full marks or one mark out of two was common in this part.

Parts (b) and (c) were answered extremely well with most candidates correctly stating the correct values of v, w, x, y, and z in (b) and correctly calculating the lower bound in (c).

Part (d) was answered well with many fully correct scheduling diagrams seen with four workers. Very few candidates failed to include all the activities (although some did try to schedule with only three workers believing that as this was the lower bound it was possible to schedule with this many). There were a few slips with lengths of activities and some issues with precedence.

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 critical path (ACFK) or the new completion time (27).

Question 5

This question on route inspection was answered extremely well with many candidates scoring full marks in the first two parts. In part (a) nearly all candidates correctly paired the four odd nodes (A, C, D, and E) and, with varying degrees of success, obtained the correct totals for the three distinct pairings. Most candidates explicitly stated that cycle lanes AD, CG, GH and EH had to be traversed twice and that the length of the route was 181 km. In part (b) most candidates realised that vertex C would appear 3 times in the corresponding route. Part (c) discriminated well and although many correctly realised that the route should finish at E and the new length of the route was 173 km, many did not explicitly state that the path from C to D via G was the path of least weight that did not include A and so was therefore the one that needed to be repeated.

Question 6

Most candidates were able to draw the required lines correctly in (a) 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. Furthermore, a significant number of candidates were unable to select (or even label) the correct feasible region.

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

Most candidates in (b) correctly stated the coordinates of V and the corresponding value of P at V.

Very few candidates correctly attempted part (c) and of those that did many did not make their method and working clear (although explicitly asked for in the question). Although this part could be done using an objective line approach (by considering corresponding gradients) the most successful candidates considered the value of the objective function at the different vertices of R which, if correct, lead to the two inequalities $10k + 60 > 42k + 44$ and $60k + 20 > 42k + 44$.

Question 7

The responses to part (a) were mixed; while many candidates correctly considered the expression $\frac{228}{n}$ (the total sum of all values divided by the size of each bin) together with the value of 4 (the given lower bound) many did not realise that the range of possible values of n had to satisfy the inequality $3 < \frac{228}{n} \leq 4.4$

Many correct solutions were seen in part (b), but several candidates did not choose their pivots consistently, switching between middle-left and middle-right pivots during the quick sort algorithm. Several 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. As stated in previous examiners' reports candidates must make it clear that the sort is complete by either explicitly stating that the sort is complete or by choosing each item as a pivot or by rewriting the final list. Pivots were usually chosen consistently although the spacing and notation on some solutions made these difficult for examiners to follow. Some candidates over complicated the process by insisting on using a different 'symbol' to indicate the pivots for each pass. Those candidates who sorted into ascending order usually remembered to reverse their list at the end to gain full credit although several candidates left their list in ascending order.

Many candidates struggled with part (c) and very few came up with a complete justification for why the value of n was 72. Even though the question clearly asked candidates to explain their reasoning fully many gave a completely mathematical justification that examiners, at times, found very difficult to understand or decipher. As a minimum for full marks an argument along the lines of, 'as the 13 does not fit in Bin 1 in the first-fit decreasing case therefore n is less than 32 + 28 + 13 so is therefore at most 72, but the total of Bin 1 in first-fit is 72 implying that n = 72' was required.