# Examiner's Report
# Principal Examiner Feedback

## Summer 2018

Pearson Edexcel International A Level
In Decision Mathematics D1 (WDM01/01)

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Summer 2018
Publications Code: WDM01_01_1806_ER

## 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. Furthermore, a number of students are using highlighter pens even though the front cover of the examination paper specifically mentions that this type of pen should not be used.

Students 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 students are using methods of presentation that are very time-consuming, this was particularly true in question 3(d), the application of Prim's algorithm, where a number of students ran out of space (and possibly time) unnecessarily completing the algorithm in tabular form. The space provided in the answer book and the marks allotted to each section 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 language correctly. This was a particular problem in questions 2(a) and 3(b).

## Report on Individual Questions

### Question 1

In (a) most students realised that the list needed to be sorted before using the binary search algorithm, but many failed to say explicitly into alphabetical order, instead using words such as 'ascending' or just 'in order'.

Almost all students went on to sort the list using either Quick Sort or Bubble Sort in (b), with quick, using middle right pivots, being the more popular choice. The majority were able to apply their chosen algorithm correctly, though sometimes the bubble sort was not completed with either a completion statement or a repeated row. Some students forgot to name their algorithm although only a small number made errors in their working. A few wrote out the list of names in alphabetical order, ready for (c). It was apparent that some students were not confident with the alphabet.

In (c) most students made an attempt at choosing the correct pivots for the binary search and then rejecting the appropriate sublists, although some made errors with their choice of second pivot. A significant number of students just assumed that, once they had discarded all the other items in the list, the one remaining item was Leslie and they did not make it explicitly clear that they were checking this and that Leslie had indeed been found. Those who started their search from an incorrect list scored no marks.

Many students struggled to answer the final part of the question, either omitting it or giving one of a variety of wrong calculations. Those students who did answer this successfully generally used logs to do so. Those working from 727 and halving each time were not usually successful.

### Question 2

As expected part (a) was met with varied success. A number of students had clearly learnt perfect definitions and were able to quote these accurately. Others however, were less successful and often lost marks due to imprecision or by missing the key points of the definitions. Nonetheless, in (i), where students had been asked to define an alternating path, many students were able to score a mark for 'unmatched to unmatched' but often did not mention arcs so lost the second mark. Some students confused arcs with vertices. In (ii) some students believed they were being asked to define a complete graph rather than a complete matching. Others failed to express that elements were 'paired' and many did not mention 'sets' but it was more common to award the second mark for 'all vertices from one set' than the first mark for 'pairing'. It was not uncommon to see (a) left blank.

Part (b) was generally more successfully attempted although a significant number of students did not notice that a path from F to 1 had been requested and instead stated alternative paths from F to 4, or from C to either 4 or 1. Most students either stated or showed the change of status step and most were able to state or draw the correct improved matching.

Part (c) was challenging for many students. Many were on the right track but they failed to give complete explanations (often neglecting to state that A could *only* do 5 or 3). Others, however, were clearly unsure of the reasoning required and gave irrelevant arguments such as "4 can only be done by B and 1 can only be done by E'.

Part (d) was again successfully attempted by many. Occasionally, examiners saw noted seeing incorrect paths from C to 3 or more surprisingly from C to F.

**Question 3**

Many students in (a) correctly answered the number of arcs to be 7, though some left this part blank and an answer of 17 was a popular alternative offering.

Examiners noted that a number of students made no attempt at (b). Others realised that the path could only contain 8 vertices but then failed to explicitly state that a vertex cannot appear more than once. The suggestion that a cycle would form scored no marks.

In (c) a few students gave a correct answer having calculated that the complete graph must contain 28 arcs, but others gave a wide variety of unexplained incorrect answers.

Examiners noted that a significant number of poor attempts to apply Prim's algorithm were seen in (d). Common errors were an incorrect choice of the third arc (e.g. DE instead of CH) or the fourth arc (e.g. DJ instead of EJ) leading to an error with the weight of the tree. A few students showed explicit rejections and a small number chose to start from A, limiting themselves to one mark, out of three, at best.

**Question 4**

This question was generally well attempted. The vast majority of students were clearly well prepared for Dijkstra's algorithm with the majority of errors in part (a) arising from slips rather than lack of understanding. Values at nodes B, C, E and G were generally correct with errors most commonly occurring at F or D. Most students were able to correctly state the shortest time and the quickest route. There were the standard errors in order of working values and/or extra or missing working values and examiners saw a number of cases where there was no replacement of working values whatsoever. As is often the case, handwriting presented something of a challenge when deciphering working values. Students should be reminded of the importance of working values in judging the application of the method by examiners and so students should ensure their presentation is clear (and they are once again reminded that working values should not be crossed out).

Part (b), where attempted, was generally well done, although often it was not answered. Errors arose from the omission of F in the route or with the addition of J at the end of the route. In some cases, students wrote down the route but did not state the length. This part was often calculated from scratch with few students making use of (a).

In (c), most students were able to identify the correct four odd nodes and most paired them correctly. There were thankfully few students who made the error of considering less than the three pairings.

There were however, perhaps surprisingly, fairly frequent errors in the pairing totals. A common error arose in the pairing AJ + DF where students obtained 71 rather than 70. However, errors in the totals often did not affect the choice of repeated arcs which were usually stated correctly. Students should however note the requirement for repeated *arcs* rather than repeated *pairings* as there were a number of students who lost a mark for stating simply AF + DJ. Some students were clearly on 'autopilot' and stated the length of the route here rather than (or as well as) in (d).

A correct route in (d) was quite common for those students who attempted this part of the question. In some cases, though, routes didn't begin and end at G (sometimes A instead) and occasionally the route lacked some arcs – usually when the repeated arcs in (c) had not been stated correctly. The length of the route was usually correct (or followed through correctly) when stated.

Part (e) differentiated well and in fact some students did not attempt this part at all. Of those who did, a significant number were able to identify the four odd nodes C, D, F and J. Some students though were not able to identify all four. It was, however, relatively rare to see the correct starting and finishing points identified. Students focused on determining the arcs with least weight but either did not go on to state the starting and finishing points or perhaps just stated one of the two possibilities. Clearly, some students believed that the starting and finishing points needed to be the same. A correct length for the route was more frequently seen but a common incorrect answer of 287 was often seen where students failed to remove the two arcs from B.

**Question 5**

In part (a) most students scored both marks for correctly completing the precedence table, with only a few eccentric attempts, some involving event numbers rather than activity letters.

Part (b) was answered extremely well with many students correctly complete the diagram with the early event and late event times. When errors did occur they mostly occurred at the ends of activities B, C and/or E.

Examiners noted that parts (c), (d) and (e) were generally answered correctly provided the corresponding diagram in (b) was correct.

Most students did attempt to produce a schedule in (f). However a significant proportion of students tried to construct a schedule with only 3 workers (possibly due to their answer for (e)), therefore scoring only one mark and completely disregarding the significance of the Immediately Preceding Activities (IPA). Of those students who did have 4 workers in their schedule, a pleasing number were correct, though errors were sometimes seen in either the duration, time interval or IPA for one or more activities. It was pleasing to note that cascade charts were rarely seen.

Many students correctly calculated the revised timing and new critical activities in (g), although sometimes B was still stated as a critical activity.

**Question 6**

Given that this was the last question on the paper it was attempted almost in full by the majority of students suggesting that time constraints were not an issue for most of the cohort. Whilst (a) was attempted successfully by most students, it was somewhat alarming to see the number of students who made errors in their substitution of $z = 15 + x - y$ into $-7x + 4z \leq 36$ to obtain $-3x - 4y \leq 24$ and then attempting to fudge their working to obtain the required constraint of $3x + 4y \geq 24$. Equally alarming was the number of students who believed it was sufficient to state $-7x + 4(15 + x - y) \leq 36$ and jump straight to the required inequality. Students should note the need to demonstrate sufficient working especially for 'show that' questions.

The objective function was almost always correct although examiners noted that an answer of $P = 4x + 5y + 50$ was relatively common.

Most students were able to draw the required lines correctly in (b) 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 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. Examiners noted a number of responses where students had drawn the line $y = 1$ rather than $x = 1$. Generally, the lines $4x + 3y = 30$ and $3x + 4y = 24$ lines were drawn correctly as was the line $-x + y = 5$ line although this line was occasionally omitted or drawn with negative gradient. Most students attempted to label the correct region clearly although some selected the triangular region above the $-x + y = 5$ line.

Despite being asked to use the objective line method, there were a surprising number of students who did not draw an objective line. Omission of an objective line was a costly error in terms of subsequent marks. Usually those that did draw an objective line managed to do so correctly although examiners noted a significant number who drew the reciprocal line or drew a line from (0, 2) to (8, 0) which often led to identification of an incorrect optimum vertex and ruled out many of the later marks.

In (d), most students used the correct equations to determine the coordinates of the optimum vertex. However, in many cases, students did not show the level of working to justify both marks. The question had specified that algebra be used to calculate the coordinates and so the use of a calculator alone was not sufficient for both marks. It was not uncommon for the value of $P$ to be omitted.

In (e), most students who were still involved and still eligible for the marks managed to state the correct values for $x$ and $y$ but many neglected to state the value of $z$. The correct value of $P$, however, was commonly seen.

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