Examiners' Report
Principal Examiner Feedback

Summer 2024

Pearson Edexcel International Advanced Level
In Decision Mathematics D1 (WDM11)
Paper 01

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

Summer 2024
Publications Code WDM11_01_2406_ER

WDM11 Summer 2024

Introduction

The paper proved to be accessible to almost all candidates, with many able to gain high marks on at least three of the first four questions. The final three questions differentiated well, challenging the most able candidates and producing a good spread of marks.

A key piece of advice to candidates is to ensure that they read the demands of the question carefully and to ensure that they answer the question as set. Many candidates lost marks by attempting to answer a different question to the one that had actually been set. Candidates must also realise that if a question asks them to give to give a reason for their answer, then they are expected to write a brief explanation.

Question 1

This question proved to be accessible with approximately 70% of candidates scoring at least 9/14 marks. In part (a) the majority of candidates gained all three marks for a correct answer, and almost all were able to make an attempt worthy of at least one mark. The most common error was to misplace 1.2, but some carelessly omitted one number and others duplicated one. Candidates would be advised to do a quick count as a rudimentary check. A few candidates mysteriously just calculated the lower bound. In part (b) many candidates gained full marks with the majority using middle right pivots. A common error was to fail to pivot from the sub-list {5.2 6.5}, presumably because it was already ordered. Only a few either found just one pivot per pass, or mixed middle left and middle right both of which are eligible for M1 only, losing three marks. Very few bubble sorts were seen (which scored M0). The few who carried out descending sorts were penalised two marks for a misread. In part (c) a surprisingly substantial minority used their ascending list without reversing it, so lost all three marks for a fictitious first fit increasing bin pack. Again, in correct attempts, 1.2 was most often seen misplaced. Part (d) was quite often simply omitted or there was a vague comment saying first fit decreasing produces a better solution than first fit. Some correctly calculated the lower bound but lost this dependent mark due to incorrect use of the increasing list in part (c). Very few candidates considered the amount of spare space in bins. Some candidates did not attempt part (e) of this question. A minority of candidates reverted to the unsorted list, rendering their binary sort meaningless. The mistake of retaining the pivot from a previous pass was less often seen than in the past. This topic seemed unfamiliar to a proportion of

candidates, some of whom initially included 3.0 in their list or later stated that it was present before 3.1, missing the essential point of the binary search. Those candidates who appeared to have been well drilled in clear presentation of their answer were, unsurprisingly, the most successful.

Question 2

This question proved to be accessible with approximately 80% of candidates scoring at least 6/10 marks. In part (a), most candidates were well prepared on this area of the specification and were able to complete the early event times and the late event times in the activity network correctly. An error that arose with some frequency was the appearance of '14' in the late event time at the end of D, likely due to the calculation of the late event time coming from a backward pass to D via H rather than via F; additionally a network finish time of 16 was seen on a number of occasions which likely resulted from over-simplistic forward and backward passes along the top, middle and bottom of the network with a failure to properly consider the activities running 'vertically' in the network. This type of error sometimes led to rogue values in the network and, where these were numerous, the loss of method marks. Almost all candidates who completed the activity network, were able to deduce that that the minimum completion time equalled the late event time at the end of M. Part (b) was usually completed using a correct method however, as this was not a follow through mark, a number of candidates lost a mark because their minimum completion time was incorrect. Other candidates completed a correct calculation but left their answer as a decimal rather than stating the lower bound as an integer. Part (c) proved to be challenging for some candidates. With limited leeway in the arrangement of the schedule to complete it for minimum workers in the minimum time, many candidates opted for an extra worker or two. This was permitted for most of the marks available. Few candidates exceeded the 'minimum time' determined by their activity network although, when this was the case, it was penalised heavily. Within the schedule itself, errors sometimes came from dependency of J and K on C, particularly when C was not placed to begin at time 0. Sometimes the necessary gap in the schedule following activity B caused issues as candidates were apparently reluctant to leave a blank space, therefore placing E directly after B which violated both E's earliest start time and also its dependence on A. A significant number of blank schedules were seen, which is interesting for question 2 on the paper and perhaps suggests a reluctance to invest time in this sort of task

early in the paper. In addition, there were a number of responses which included only an attempt at the five activities on the critical path - perhaps candidates were hoping to pick up some marks for the critical path but did not want to invest time on the rest of the schedule. A significant minority of candidates completed cascade diagrams charts rather than a schedule and this was not worth any credit. However, candidates who drew a cascade chart in order to assist in the completion of a schedule were not penalised. Finally, there were a number of candidates who missed off one (or sometimes more) activities in error. It would be sensible for candidates to devise a strategy to ensure that all activities are included.

Question 3

This question also proved to be accessible with approximately 75% of candidates scoring at least 5/8 marks. Part (a) of this question was generally well completed. There were the usual errors in the application of the algorithm, in particular in the order of working values, missing working values (particularly the first working value at H coming from G and the third or fourth working value at D) and errors in order of labelling – usually due to repeated labels and sometimes omission of order of labelling labels. Handwriting caused difficulties in some cases but there were perhaps fewer candidates heavily crossing out their working values when replacing them which was an improvement on previous series. Almost always, candidates were able to deduce the shortest time to travel from A to J for their network and when the network was completed correctly, the quickest route was almost always correct. Part (b) provided something of a challenge for some candidates. Notwithstanding a minority of candidates who appeared to grasp at straws to provide an answer here by, for example, doubling 74, the majority appeared to understand, or at least guess, that the answer was ‘74’. However, many candidates simply stated ‘74’ which on its own was not creditworthy. Other candidates incorrectly believed that the sum of the lengths of the arcs in the tree was sufficient ‘reason’. Other candidates attempted more pertinent explanations, but missed the mark slightly by focusing on the lack of cycles rather than the fact that the shortest route visited all nodes. It was more common for candidates to earn this mark for mentioning the inclusion of all nodes rather than for identifying that the shortest route was, in fact, the minimum spanning tree. Some candidates were unable to access the marks in this part of the question if their route from (a) had not included all nodes.

Question 4

This question also proved to be accessible with over 60% of candidates scoring at least 8/14 marks. However, understanding exactly what was required for some parts of the question proved challenging for some candidates. Part (a) and (b) were generally well-attempted with the majority of candidates scoring full marks. Some candidates performed the algorithm correctly on the distance matrix but did not actually list their arcs, or did so incorrectly, thus losing the final mark. A small number, somewhat surprisingly, did not attempt this part, thus losing further marks throughout the question also. Many candidates who did not achieve the M mark in part (a) were still able to score the mark in part (b). There was a slight rising trend in those not putting numbers across the top of the table, which meant that a slip in listing arcs could cost all of the marks. Part (c) was the biggest discriminator on this question. Whilst a pleasing number of candidates did recognise the need to add the shortest route between C and H, many of these did not find the optimal value of 58. A significant number of candidates, however, missed the intention of the question and attempted the route inspection algorithm across C, E, F and H, scoring no marks. Other candidates missed the point of the question even further and decided to add the shortest distance between E and F. A significant number did not attempt this. Part (d) saw an improvement over the same topic in the January paper. Those who had already paired nodes in part (c) often didn't attempt this part of the question. Most though did, but a significant number attempted it with nodes other than A, E, F and H, the alternative of C, E, F and H being the most common alternative. Using C, E, F and H did gain some credit being treated as a misread. Those who selected the correct nodes often completed this part successfully, although a surprising number of candidates managed not to use the table of shortest distances and made errors in finding shortest differences. Many candidates were able to list the correct arcs to be repeated. Part (e) was often completed successfully even when other parts of the question had proved challenging, with many candidates successfully using the Nearest Neighbour algorithm. The most common error seen was not returning to B, with candidates either stopping at J or returning to A instead. Many candidates obtained the correct answer to part (f), although the vast majority failed to realise that this was linked to the answer to part (b). Instead of adapting their earlier answer, many candidates attempted to calculate the RMST and then add the shortest two arcs from C. Unfortunately, some made errors in calculating the RMST and were penalised.

Question 5

This question proved to be challenging to many candidates, with only 35% scoring at least 5/10 marks. The first four marks in part (a) proved the most accessible marks on this question, with those who attempted it gaining at least some of them and often all of them. Candidates were able to turn the information given into inequalities in terms of x, y and z and obtain a correct relationship between x and z; although some applied the ratio incorrectly, which meant only one more mark was available in part (a). When it came to using that relationship to eliminate z from their inequalities there was a lot of good work by those who attempted to do so, sometimes negated by the fact they had no objective or occasionally an incorrect objective. This meant the last 3 marks in part (a) proved harder to achieve. Those who did attempt the remainder of (a) and didn't penalise themselves with an incorrect or absent objective function, generally obtained the correct formulation. One common mistake seen was with the objective function being stated as $P = 7x + 5y$. In part (b) candidates were required to substitute into at least two constraints to achieve a value for x. Unfortunately, many candidates only substituted into one constraint. Others ignored the fact this was a linear programming problem and merely found the values by deduction which gained no credit. Where candidates substituted into more than one constraint, often all three and stated $x = 30$, they usually gained full marks for this part of the question.

Question 6

This question also proved to be challenging to many candidates, with only 30% scoring at least 7/10 marks. However, many candidates made a reasonable attempt at part (a) with good networks seen. There were some issues, however, for some candidates, in the legibility of their network and candidates should be advised to draw large networks and to label the arcs clearly. If possible, arcs that cross each other should be avoided. Furthermore, arrows should be very clearly marked, sometimes these were squeezed at the end of an arc at a node where multiple arcs met making it difficult to ascertain the presence or otherwise of an arrow. Dummies were completed fairly well although the uniqueness dummy for K and M was sometimes omitted. In some cases, the layout that was initially chosen became unwieldy as arcs were added to the network and this led to errors in precedence. For example, when B was not placed in the middle of A and D, it was difficult for candidates to place the dummies correctly so that all the precedences for I, C, E, G and F were upheld. It would perhaps be

advisable in these circumstances to redraw the network with a different layout to minimise the risk of precedence violations. There were some networks seen which included a number of unnecessary extra dummies. This is not an overly costly error as, provided precedence relationships are upheld correctly, only the final mark is withheld. However, the more dummies added, the greater the risk of introducing incorrect precedence. Very few activity on node diagrams were seen or networks with two or more 'starts'. Networks with more than one 'finish' were seen more often. Part (b) was very successfully attempted, with virtually all candidates obtaining this mark. Part (c) is now familiar to candidates and most understood, as asked in the question, that they needed to provided detail of time and activities, however not all candidates did so. Some also omitted the answer "4" or incorrectly stated "3". Most candidates seemed to realise that the important activities were G, C, E and I but quite often the time was stated incorrectly as $8 < t < 10$ or $9 \leq t \leq 10$. A minority of candidates attempted a schedule here rather than using the cascade diagram to find a specific time/range of time to determine the minimum number of workers required. This was not a creditworthy approach. Part (d) was challenging for the majority of candidates. The most successful responses set up an equation using the maximum float of the form $19 - x - 10 \leq 7$ to find the lower limit, however sometimes the '19' was misread as '20' from the cascade chart. The lower limit 2, was nonetheless more readily achieved than the upper limit. Quite often, however, '2' was incorrectly set as the upper limit together with a lower bound of '0'. The calculation of a correct upper limit was more elusive, perhaps because candidates did not realise that the float of L could be set to zero. A significant minority believed the upper limit of the duration of L was instead '7' taken from the question although this was in fact the upper limit of the float of L.

Question 7

This question had a wide variety of responses, with some candidates not attempting the question at all. Approximately 40% of candidates scored at least 6/9 marks. In part (a) many candidates recognised the need to determine the equation of the line through A and D, and went on to successfully obtain it, though some made arithmetical errors. The most popular and successful method used was to first determine the gradient and then use this with one point to find the intercept. This was slightly less error prone than finding the equation of a line through two points or setting up simultaneous equations, and then solving for gradient

and intercept. Many candidates then went on to find the correct four inequalities, although some lost a mark for using strict inequalities. A minority just identified the three inequalities arising from the equations given on the graph and gained only one of the four marks, omitting the fourth line completely. In part (b) many candidates gained the first mark for stating the correct objective expression(s), in terms of k, at one or more vertices. A good proportion of candidates went on to correctly compare B as minimum point and D as maximum point to find $k \leqslant \frac{13}{7}$. Only a minority of candidates also considered A as minimum and C as maximum to find $k \geqslant \frac{11}{14}$. Some assumed B was the minimum and compared it with all three other points. A few used 2 or ½ on the wrong side of their inequality. Algebraic manipulation errors often occurred, possibly due to time pressure as this was the final question. A small number of candidates incorrectly split their solution into two parts, considering $k < 1$ and $k > 1$ as separate regions.

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom