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INTERNATIONAL A LEVEL MATHEMATICS • DECISION 1 (WDM11)

Decision 1 Practice Paper 2

Mark Scheme

AIMING FOR A

Written in the style of the Pearson Edexcel International Advanced Level paper (WDM11/01) • 75 marks

Every question marked line by line the way an examiner marks it, with notes on the common errors

Mark every line, not just the answer. Method marks are given for a correct method even when the final answer is wrong. If you lost marks, find the *first* line where your working differs from the scheme. That is the thing to fix.

Code	Meaning
M1	Method mark: for knowing a correct method and attempting to apply it. Small slips in the working do not lose this mark.
dM1	Dependent method mark: can only be given if the method mark before it has been given.
A1	Accuracy mark: for a correct answer or line of working. It depends on the method mark before it.
B1	Independent mark: for a correct result or statement, whatever method was used.
*	The answer is given in the question. Every step must be shown, and the answer must follow from correct working (cso).
cao / cso	Correct answer only / correct solution only, with no errors anywhere in the working.
ft / oe	Follow through from your own earlier answer / or any correct equivalent form.
awrt	Answers which round to the value given, so 21.52… earns “awrt 21.5”.

How decision marks work. Decision Mathematics is a methods paper. Method marks need the algorithm to be applied in the right way and the working to be seen: the order arcs are chosen, the working values, the pivots, the bins. An answer with no working rarely earns more than one mark. Accuracy marks then need the values to be right, and a correct answer reached by the wrong algorithm earns nothing.

Rough grade guide (out of 75): A **53** • B **46** • C **39**

Based on recent WDM11 grade boundaries. Real boundaries change every series, so treat this as a guide, not a grade.

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What to revise next

Write in your score for each question. Where you dropped marks, tap the chapter to practise ten more exam questions on it.

Q	What it tested	Marks	Practise it	Score
1	Tracing a flow chart with exact fractions; the purpose of an algorithm	7	Ch 1 Algorithms	
2	Quick sort, first-fit decreasing and deducing a bin size	8	Ch 1 Algorithms	
3	Prim's algorithm on a matrix; changing the tree; degrees	9	Ch 3 Algorithms on Graphs Ch 2 Graphs and Networks	
4	Dijkstra's algorithm feeding a route inspection	10	Ch 3 Algorithms on Graphs Ch 4 Route Inspection	
5	Bounds for the travelling salesman with an unknown distance	10	Ch 5 Travelling Salesman Ch 3 Algorithms on Graphs	
6	Drawing an activity network with dummies	8	Ch 6 Critical Path Analysis	
7	Event times, a cascade chart and a schedule for three workers	12	Ch 6 Critical Path Analysis	
8	Formulation, an integer optimum and a range of objective coefficients	11	Ch 7 Linear Programming	
	Total	**75**		

Where did the marks go? Paper 2 joins chapters, so a lost mark often comes from the link and not the method: a Dijkstra value not used in the route inspection, a tree arc compared with the wrong new arc, or a condition from an earlier part left out of a range. If the first marks of a question went, revise that chapter's key skills page. If only the last ones went, check every condition the question gave you, and write each one down before you combine them.

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Question 1

7 marks

Part	Scheme	Marks
(a)	Row 1: $x = 3$, $y = \frac{10}{3}$, $z = \frac{19}{6}$ $\lvert z - x \rvert = \frac{1}{6}$, No Row 2: $x = \frac{19}{6}$, $y = \frac{60}{19}$, $z = \frac{721}{228}$, $\lvert z - x \rvert = \frac{1}{228}$, Yes Output $\boxed{\frac{721}{228}}$ *Decimals in place of exact fractions lose the second and third A marks. Returning to "Let $y = \frac{N}{x}$" without updating x scores M1 only.*	M1 A1 A1 A1 (4)
(b)	It finds an approximation to $\sqrt{N}$ (the square root of N)	B1 (1)
(c)	$\boxed{-\frac{721}{228}}$ Every value is the negative of the run in (a), so it finds the negative square root, $-\sqrt{10}$	B1 B1 (2)
		Total for Question 1: 7 marks

Question 2

8 marks

Part	Scheme	Marks
(a)	Pivot 18: 23 31 26 35 21 **18** 9 14 7 12 Pivots 26, 7: 31 35 **26** 23 21 **18** 9 14 12 **7** Pivots 35, 21, 14: **35** 31 **26** 23 **21** **18** **14** 9 12 **7** Pivot 12: 35 31 26 23 21 18 14 12 9 7, every item now a pivot or alone *The pivot is the middle item, or the item to the right of the middle for an even number of items. Using a different rule consistently is allowed. Sorting into ascending order scores M1 A0 A0.*	M1 A1 A1 (3)
(b)	Box 1: 35, 14 Box 2: 31, 18 Box 3: 26, 23 Box 4: 21, 12, 9, 7	M1 A1 (2)
(c)	12 goes in box 1: $35 + 12 = 47 \leqslant L$ 14 did not go in box 1: $35 + 14 = 49 > L$ (the larger pieces give weaker conditions) $\boxed{L = 47 \text{ or } L = 48}$ *The later pieces 9 and 7 do not fit either, which needs $L < 56$ and $L < 54$: both are already true.*	M1 M1 A1 (3)
		Total for Question 2: 8 marks

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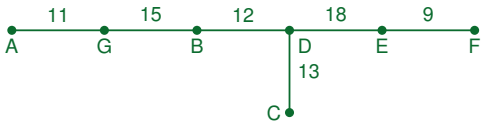
Question 3

9 marks

Part	Scheme	Marks
(a)	AG 11, BG 15, BD 12 CD 13, DE 18, EF 9 *Listing the arcs in order of size (Kruskal) scores M0.*	M1 A1 A1 (3)
(b)	Tree drawn  Weight 78 km	B1 B1 (2)
(c)	The tree path from A to C is $AGBDC$, whose longest arc is $BG = 15$: the tree changes when $x < 15$ BG leaves the tree	B1 B1 (2)
(d)	Count the entries in each row: degrees A 2, B 4, C 3, D 4, E 4, F 3, G 4 Exactly two odd vertices (C and F), so the network is semi-Eulerian	M1 A1 (2)
		Total for Question 3: 9 marks

Question 4

10 marks

Part	Scheme	Marks
(a)	A larger working value replaced by a smaller one A 1, 0; C 2, 9; B 3, 16 (17, 16); D 4, 18; F 5, 20 E 6, 24; G 7, 33 (41, 33); H 8, 41 Route $ACEH$, length 41 km	**M1** **A1** **A1** **A1** **(4)**
(b)	Odd vertices A, B, D, G: three pairings considered $AB+DG = 16+21 = 37$, $AD+BG = 18+31 = 49$, $AG+BD = 33+26 = 59$ Repeat AC, CB, DF, FG $175+37 =$ 212 km *$AB = 16$ comes from (a): the shortest path from A to B is ACB, not the arc AB (17). Using 17 gives 213: A0 A0.*	**M1** **A1** **A1** **A1** **(4)**
(c)	Repeat only the shortest of the three pair distances, $AB = 16$: start and finish at D and G $175+16 =$ 191 km	**M1** **A1** **(2)**
		Total for Question 4: 10 marks

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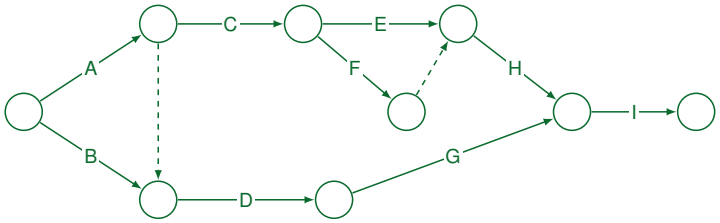
Question 5

10 marks

Part	Scheme	Marks
(a)	From C the nearest unvisited town must be E, so x is less than $CB = 33$, $CD = 30$ and $CF = 29$ Hence $x < 29$	M1 A1 (2)
(b)	$18 + x + 19 + 22 + 24 + 33$ $\boxed{116 + x}$	M1 A1 (2)
(c)	Minimum spanning tree of A, C, D, E, F: AC 18, DE 19, CE x, DF 28, total $65 + x$ Add the two least arcs from B: BD 22 and BF 24 $\boxed{111 + x}$ *CE is in the tree because $x < 28$, so it is chosen before DF.*	M1 M1 A1 (3)
(d)	$111 + x \leqslant 141$ and $116 + x \geqslant 141$ $25 \leqslant x \leqslant 30$ With $x < 28$: $\boxed{25 \leqslant x < 28}$ *The final A1 needs the condition from (c). The lower bound $111 + x$ is only valid for $x < 28$.*	M1 A1 A1 (3)
		Total for Question 5: 10 marks

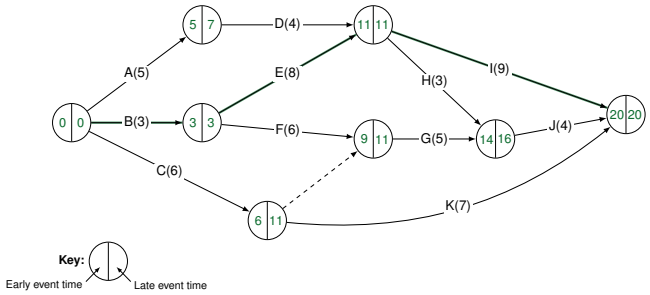
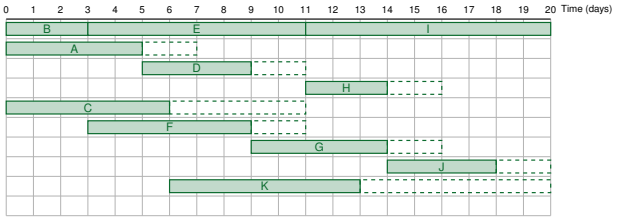
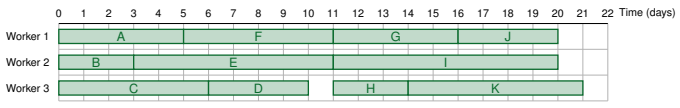
Question 6

8 marks

Part	Scheme	Marks
(a)	A and B from the start event, C from the end of A	**M1**
	Dummy from the end of A to the end of B; D from the end of B	**A1**
	E and F from the end of C, with a dummy so that they do not share both events	**M1**
	H after E and F (the dummy)	**A1**
	G after D; I after G and H	**A1**
	One finish event, arrows on all activities and exactly two dummies 	**A1**
		(6)
(b)	First dummy: D depends on A and B, but C depends on A only	**B1**
	Second dummy: without it E and F would start and finish at the same events, so they could not be identified uniquely	**B1**
		(2)
		Total for Question 6: 8 marks

Question 7

12 marks

Part	Scheme	Marks
(a)	Early event times 0, 5, 3, 6, 11, 9, 14, 20 Late event times 0, 7, 3, 11, 11, 11, 16, 20  *The late time at event 3 is 11, from the dummy, not* $20 - 7 = 13$ *from* K.	**M1 A1** **A1** **(3)**
(b)	Critical activities B, E, I; minimum completion time 20 days	**B1** **(1)**
(c)	Critical activities in one row; at least six others with correct start times Floats correct on four non-critical activities All correct: A 2, C 5, D 2, F 2, G 2, H 2, J 2, K 7 	**M1** **A1** **A1** **(3)**
(d)	$\frac{5+3+6+4+8+6+5+3+9+4+7}{20} = \frac{60}{20}$ 3 workers	**M1** **A1** **(2)**
(e)	Three workers, every activity once, no precedence broken A valid schedule, for example the one below 21 days  *The bound in (d) cannot be met: with 60 worker-days in 20 days no worker may ever be idle, which the precedences do not allow. Any valid 21-day schedule earns full marks.*	**M1** **A1** **A1** **(3)**
		Total for Question 7: 12 marks

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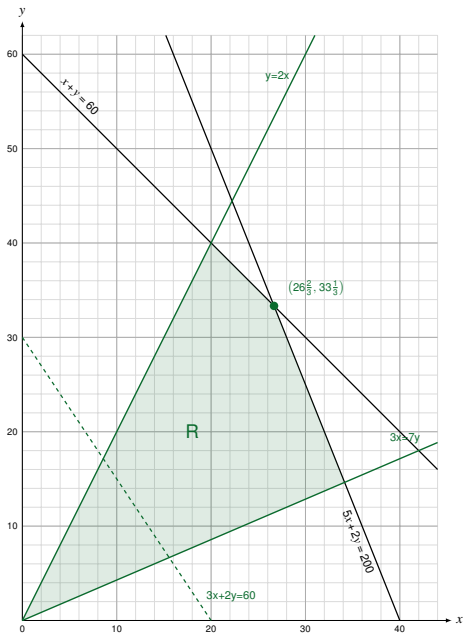
Question 8

11 marks

Part	Scheme	Marks
(a)	$\boxed{x+y \leqslant 60}$	**B1**
	$\boxed{5x+2y \leqslant 200}$	**B1**
	$y \geqslant 0.3(x+y)$, so $0.7y \geqslant 0.3x$: $\boxed{3x \leqslant 7y}$	**B1**
	$\boxed{y \leqslant 2x}$	**B1**
		(4)
(b)	Lines $3x = 7y$ and $y = 2x$ drawn through the origin	**B1**
	R correct, with vertices $(0,0)$, $(20,40)$, $\left(26\frac{2}{3}, 33\frac{1}{3}\right)$, $\left(34\frac{6}{41}, 14\frac{26}{41}\right)$ 	**B1**
		(2)
(c)	Objective line $3x+2y = k$: the optimal vertex is $\left(26\frac{2}{3}, 33\frac{1}{3}\right)$, which is not a whole number	**M1**
	Test whole-number points nearby: $(27,33)$ is not feasible $(5\times 27+2\times 33 = 201)$; $(26,34)$ gives £14 600	**M1**
	$\boxed{\text{26 hectares of wheat and 34 of barley, profit £14 600}}$	**A1**
	Rounding the vertex to $(27,33)$ breaks the fertiliser constraint: M1 M0 A0.	
		(3)
(d)	The objective $kx+200y$ has gradient $-\frac{k}{200}$, which must lie between $-\frac{5}{2}$ and -1	**M1**
	$\boxed{200 \leqslant k \leqslant 500}$	**A1**
		(2)
		Total for Question 8: 11 marks

TOTAL FOR PAPER: 75 MARKS

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