Pearson Edexcel

Mark Scheme (Results)

Summer 2024

Pearson Edexcel GCE
In AS Further Mathematics (8FM0)
Paper 27 Decision Mathematics 1

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL GCE MATHEMATICS
General Instructions for Marking

1. The total number of marks for the paper is 40.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes.

- bod – benefit of doubt
- ft – follow through
- the symbol $\surd$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- $*$ The answer is printed on the paper
- ⌐ The second mark is dependent on gaining the first mark

4. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

5. Where a candidate has made multiple responses and indicates which response they wish to submit, examiners should mark this response.
   If there are several attempts at a question which have not been crossed out, examiners should mark the final answer which is the answer that is the most complete.

6. Ignore wrong working or incorrect statements following a correct answer.

7. Mark schemes will firstly show the solution judged to be the most common response expected from candidates. Where appropriate, alternatives answers are provided in the notes. If examiners are not sure if an answer is acceptable, they will check the mark scheme to see if an alternative answer is given for the method used.

Question	Scheme	Marks	AOs
1(a)	Middle right pivot(s) 4 6.5 7 1.3 2 [5] 1.5 6 4.5 6 1 6.5 7 [6] 6 5 4 1.3 2 [1.5] 4.5 1 6.5 [7] 6 6 5 4 [2] 4.5 1.5 1.3 [1] 7 6.5 6 6 5 4 [4.5] 2 1.5 1.3 1 7 6.5 6 6 5 4.5 4 2 1.5 1.3 1 Middle left pivot(s) 4 6.5 7 1.3 2 [5] 1.5 6 4.5 6 1 6.5 [7] 6 6 5 4 1.3 [2] 1.5 4.5 1 7 6.5 [6] 6 5 [4] 4.5 2 1.3 [1.5] 1 7 6.5 6 6 5 4.5 4 2 1.5 [1.3] 1 7 6.5 6 6 5 4.5 4 2 1.5 1.3 1	M1 A1 A1	1.1b 1.1b 1.1b
		(3)	
1(b)	Bin 1: [7] 2 1 Bin 2: [6.5] 1.5 1.3 Bin 3: [6] 4 Bin 4: [6] Bin 5: [5] [4.5]	M1 A1 A1	1.1b 1.1b 1.1b
		(3)	
1(c)	Lower bound for the number of rolls required is given by $\frac{4 + 6.5 + 7 + 1.3 + 2 + 5 + 1.5 + 6 + 4.5 + 6 + 1}{10}$ $= \frac{44.8}{10} = 4.48$ Therefore the minimum number of bins is 5 Yes, the solution is optimal	M1 A1	1.1b 2.2a
		(2)	
1(d)	e.g. The lowest two values should be in the two far right positions, and they are not. OR 1.6 is not in the correct position	B1	3.1a
		(1)	
			(9 marks)

Notes:

(a)

M1: Quick sort – pivots, p, selected and first pass gives >p, p, <p/ If choosing 1 pivot per iteration, award M1 only. Using bubble sort is M0. If sorting into ascending order, pivots chosen for second pass M1 only. If inconsistent with middle left / middle right M1 only.
A1: Second and third passes correct.
A1: CSO – including fourth pass.
Miscopy/misread can score a maximum of M1A0A0

Candidates may put the 6 pivot "second", if they do, there is an additional pivot required for both middle left and middle right:

Middle right pivot(s)

4	6.5	7	1.3	2	[5]	1.5	6	4.5	6	1
6.5	7	[6]	6	5	4	1.3	2	[1.5]	4.5	1
6.5	[7]	6	6	5	4	[2]	4.5	1.5	1.3	[1]
7	6.5	[6]	6	5	4	[4.5]	2	1.5	1.3	1
7	6.5	6	6	5	4.5	4	2	1.5	1.3	1

Middle left pivots

4	6.5	7	1.3	2	[5]	1.5	6	4.5	6	1
6.5	[7]	6	6	5	4	1.3	[2]	1.5	4.5	1
7	6.5	[6]	6	5	[4]	4.5	2	1.3	[1.5]	1
7	[6.5]	6	6	5	4.5	4	2	1.5	[1.3]	1
7	6.5	6	6	5	4.5	4	2	1.5	1.3	1

(b)

M1: First six items placed correctly (the values in boxes) with at least eight values placed – allow cumulative totals for M1 only.
A1: First nine items placed correctly (the values in boxes and underlined).
A1: CSO (therefore no repeated values)

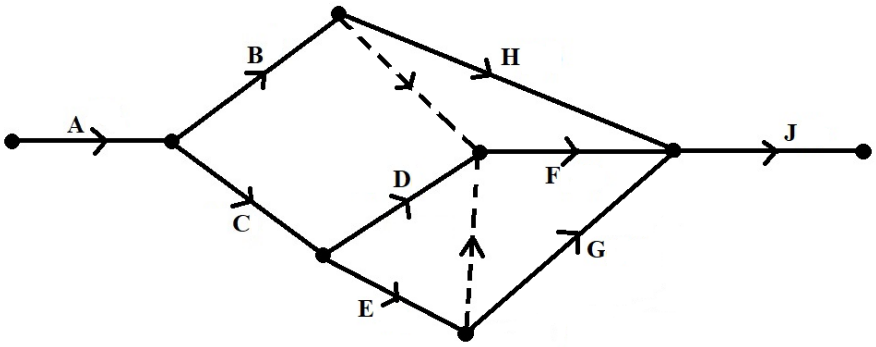
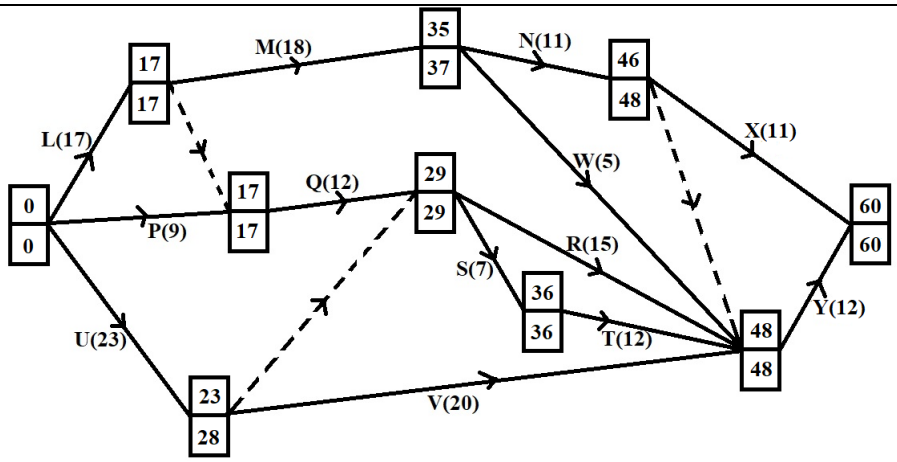
(c)

M1: Either Lower bound calculation attempted ([37.5,51.8] / 10) (accept sight of 4.48)
or Total wastage calculation attempted and compared with 10
or Total space used and compared with 50
or a clear statement that four values are over half the bin capacity **and** one is equal to half, therefore the minimum number of bins must be 5.

A1: CSO **This mark is dependent on the correct bin packing in (b).** Requires two things;
a statement "minimum 5 bins" is sufficient **and** a correct numerical argument.
This could be **either** a correct calculation (4.48)
or a correct numerical justification for why the answer to (b) does use the minimum number of bins.

(d)

B1: Allow candidates to only consider the right-hand end of the given list (i.e. condone omission of considering the left-hand end).
Must mention either the two smallest values being in the tenth and eleventh positions is not the case, or clearly state that the second smallest value (1.6) is not in the correct position.
Alternatively, may consider both ends with statement e.g. the two (largest) numbers not in order at one end and the two (smallest) numbers not in order at the other end.

Question	Scheme	Marks	AOs
2(a)		M1 A1 (E,F,H) A1 **(3)**	1.1b 1.1b 1.1b
2(b)		M1 A1 A1 **(3)**	2.1 1.1b 1.1b
2(c)	The critical activities are L, Q, S, T and Y	B1 **(1)**	1.1b
2(d)	7:33pm	B1 **(1)**	3.2a
			(8 marks)

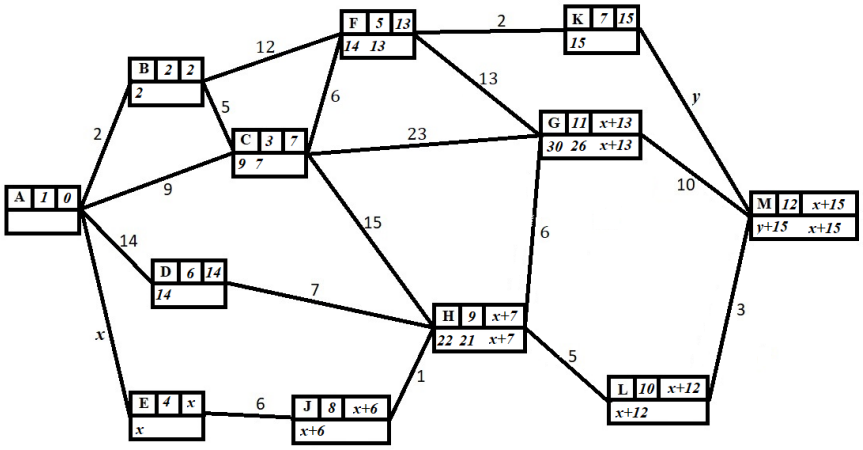
Notes:

(a)
'Dealt with correctly' means that the activity starts from the correct event but need not necessarily finishes at the correct event, e.g. 'F dealt with correctly' requires the correct precedences for this activity, i.e. B, D and E labelled correctly and leading into the same node and F starting from that node but do not consider the end event for F.
M1: Any four activities of E, F, G, H, J added (labelled) (condone missing arrows).
A1: Activities E, F and H (labelled) and one dummy (including correct arrow) dealt with correctly (Ignore lack of or incorrect arrows on E/F/H for this mark only)
A1: CAO Completely correct diagram with all labels and arrows placed correctly on activities and dummies, one finish and exactly two dummies (no additional nodes or activities)

(b)
M1: All boxes completed, number generally increasing L to R (condone one "rogue") and decreasing R to L (condone one "rogue" or missing 0 in first box).
A1: CAO (all top boxes correct)
A1: CAO (all bottom boxes correct)

(c)
B1: CAO (L, Q, S, T and Y)

(d)
B1: CAO, can also say 19:33. Do NOT accept 7:33 (without the pm)

Question	Scheme	Marks	AOs
3(a)	A tree is a connected graph with no cycles	B1	1.2
		(1)	
3(b)(i)		M1 A1 (A,B,C, E,F,K) A1 (D,J,H) A1ft (G,L,M)	1.1b 1.1b 1.1b 1.1b
(b)(ii)	Shortest route from A to M is AEJHLM Length of shortest route is $x + 15$	A1 A1ft	2.2a 2.2a
		(6)	
3(c)	Arcs HL and LM need to be traversed twice	B1	1.1b
		(1)	
3(d)	H would appear 3 times	B1	2.2a
		(1)	
3(e)	$139 + x + y + 5 + 3 = 172$ $x + y = 25$ $x = 12, y = 13$	M1 A1	1.1b 2.2a
		(2)	
			(11 marks)

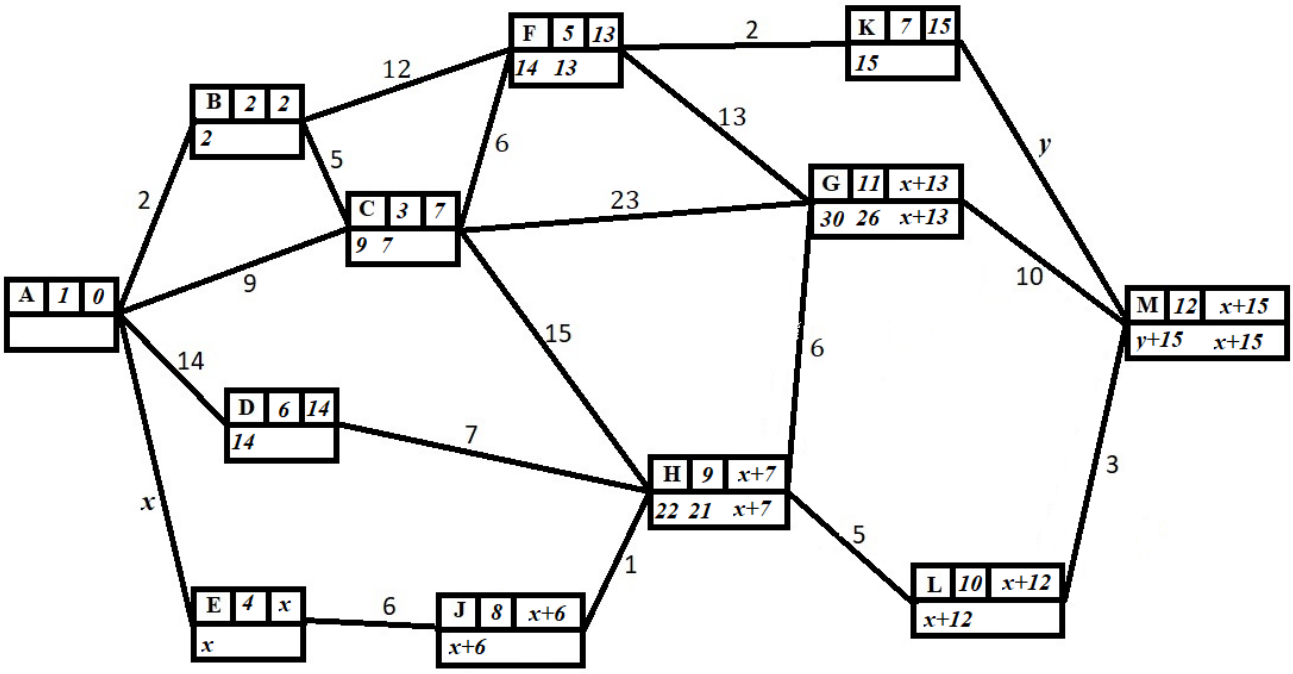
Notes:

In (b) it is important that all values at each node are checked very carefully – the order of the working values must be correct for the corresponding A mark to be awarded e.g. at H the working values must be 22 21 x+7 in that order (so x+7 22 21 is incorrect).
It is also important that the order of labelling is checked carefully – some candidates start with a label of 0 at A (rather than 1) – which is fine. Also the order of labelling must be a strictly increasing sequence – so 1, 2, 3, 3, 4, … will be penalised once (see notes below) but 1, 2, 3, 5, 6, … is fine. Errors in the final values and working values are penalised before errors in the order of labelling.

(a)
B1: Must state connected graph and must state no cycles. Paths and/or loops are NOT correct, ignore any extras unless incorrect.

(b)
M1: A working value in at least three of the boxes and a larger numerical value replaced by a smaller numerical value in at least two of C, F, G and H.
A1: All values in A, B, C, E, F and K correct. Condone lack of 0 in A's working value. Penalise order of labelling only once per question. (A, B, C, E, F and K must be labelled in that order).
A1: All values D, J, H correct and the working values in the correct order. (For the labelling, check that D, J and H are labelled in that order and D is labelled before K).
A1ft: All values/expressions in G, L and M correct on the follow through and the working values in the correct order. To follow through M check that the working value at M follows from the candidate's final values from their feeds into M (which will come from nodes G, K and L (in the order in which the candidate has labelled them)) and that the final value, and order of labelling, follows through correctly. Note that an additional working value of x+23 after the x+15 is not an error so x+15 x+23 is fine, however, any other number or x+23 x+15 in this order is incorrect and scores A0 in this part
Do not award ft if candidate has used numerical values, the final answer must be an expression.

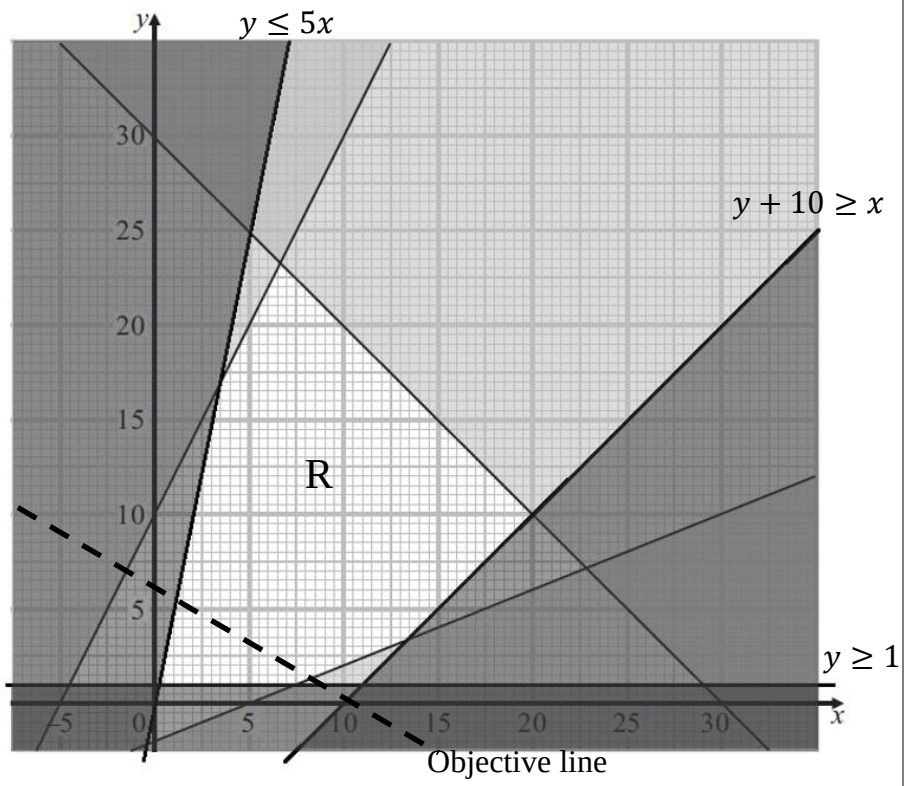
A1: CAO - correct path from A to M (AEJHLM)
A1ft: ft their final value at M only (must be an expression).



(c)
B1: CAO (arcs HL and LM NOT H(L)M) do NOT accept if extra arcs included.

(d)
B1: CAO (3 times) **NOT dependent on the correct repeated arcs in part (c)**

(e)
M1: setting the total weight of the network (139 + x + y) plus 8 (or their repeated arcs) equal to 172
A1: CAO both values clearly assigned; x=12, y=13. **Dependent on the correct repeated arcs [accept as a minimum sight of H and M and 8 (5+3) here] in part (c)**
If you just see x=12, y=13 stated with no working, M0A0.

Question	Scheme	Marks	AOs
4(a)	$x + y \leq 30$ $y \leq 2x + 10$ $5y \geq 2x - 10$	M1 A1 A1	3.3 1.1b 2.5
		(3)	
4(b)	$y \geq 1$ $y + 10 \geq x$ $y \leq 5x$	B1 B1	3.3 3.3
		(2)	
4(c)		M1 A1ft A1	1.1b 1.1b 1.1b
		(3)	
4(d)(i)	Objective line drawn $3x + 5y = constant$ (m = $\frac{-3}{5}$) Optimal point $\left(\frac{20}{3}, \frac{70}{3}\right)$	M1 A1	2.1 2.2a
4(d)(ii)	Consideration of integer coordinates around the optimal vertex. 7 orange fish and 23 blue fish Total value $3(7) + 5(23) = (£)136$	dM1 A1	1.1b 3.2a
		(4)	
			(12 marks)

Notes:

(a)

M1: One correct inequality in any form e.g. $y - 2x - 10 \leq 0$. Condone strict inequality. Must be simplified to three terms only but coefficients do not need to be integers.

A1: Two correct inequalities in any form e.g. $y - 2x - 10 \leq 0$. Condone strict inequalities. Must be simplified to three terms only but coefficients do not need to be integers.

A1: All three inequalities correct with three terms and integer coefficients. Must **not** be strict inequalities.

SC: M1A0A0 for two correct "equations", either with = or inequality reversed

The graph does NOT show $x \geq 0$ and $y \geq 0$, so these will not be accepted. Ignore any reference to these.

(b)

B1: Any one of $y \geq x - 10$ or $y \leq 5x$ in any form (accept strict inequalities)

B1: All three correct in any form. Must **not** be strict inequalities.

(c)

M1: One line drawn with gradient 1 or gradient 5 (or 1/5). Condone dashed line.

A1ft: Either $y \geq x - 10$ or $y \leq 5x$ drawn correctly, with correct shading. Condone dashed line. ft their stated inequalities from part (b), but allow recovery.

A1: CAO All three correct inequalities drawn correctly with solid lines and the correct region *R* labelled. Penalise any poorly drawn lines (e.g. not straight).

Accuracy within 1 small square.

$y \geq x - 10$ passes through (10,0) and (20,10).

$y \leq 5x$ passes through (0,0) and (5,25).

(d)(i)

M1: Objective line drawn accurately. Parallel to a line passing through (0,6) and (10,0). Accuracy within 1 small square. (Minimum passing through (0,3) and (5,0)).

Accept reciprocal gradient for M mark only.

A1: Correct optimal point $\left(\frac{20}{3}, \frac{70}{3}\right)$ oe. Accept $x = \frac{20}{3}$ and $y = \frac{70}{3}$

(d)(ii)

dM1: Dependent on 1st M1 and correct objective line. Consideration of integer point(s) around the optimal vertex. Candidate must have tested at least two of (6,23), (6,24), (7,23) and (7,24).

A1: CAO Clear statement including 7 orange (fish) and 23 blue (fish) and (total value) (£)136

Integer points for consideration:

x	y	$x + y \leq 30$	$y \leq 2x + 10$	$3x + 5y$
6	23	✓	×	133
6	24	✓	×	138
7	23	✓	✓	136
7	24	×	✓	141

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