Pearson Edexcel

Mark Scheme (Results)

November 2021

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)	**(i)** 6.3 3.5 5.4 3.1 2.9 3.7 2.8 4.1 3.3 2.2 1.7	B1	1.1b
	(ii) Number of comparisons: 10 Number of swaps: 7	B1 B1	1.1b 1.1b
		(3)	
1(b)	Middle right pivot(s) 6.3 5.4 3.5 3.1 3.7 [2.9] 4.1 3.3 2.8 2.2 1.7 6.3 5.4 3.5 [3.1] 3.7 4.1 3.3 2.9 2.8 [2.2] 1.7 6.3 5.4 3.5 [3.7] 4.1 3.3 3.1 2.9 2.8 2.2 1.7 6.3 [5.4] 4.1 3.7 3.5 [3.3] 3.1 2.9 2.8 2.2 1.7 6.3 5.4 4.1 3.7 3.5 3.3 3.1 2.9 2.8 2.2 1.7 Middle left pivot(s) 6.3 5.4 3.5 3.1 [3.7] 2.9 4.1 3.3 2.8 2.2 1.7 6.3 [5.4] 4.1 3.7 3.5 3.1 2.9 [3.3] 2.8 2.2 1.7 6.3 5.4 4.1 3.7 3.5 3.3 3.1 2.9 [2.8] 2.2 1.7 6.3 5.4 4.1 3.7 3.5 3.3 [3.1] 2.9 2.8 [2.2] 1.7 6.3 5.4 4.1 3.7 3.5 3.3 3.1 2.9 2.8 2.2 1.7	M1 A1 A1	1.1b 1.1b 1.1b
		(3)	
1(c)	Bin 1: [6.3] [4.1] Bin 2: [5.4] [3.7] 2.2 Bin 3: 3.5 3.3 3.1 Bin 4: 2.9 2.8 1.7	[M1] A1 A1	1.1b 1.1b 1.1b
		(3)	
1(d)	Lower bound for the number of bins required is given by $\frac{6.3+5.4+4.1+3.7+3.5+3.3+3.1+2.9+2.8+2.2+1.7}{11.5}$ $=\frac{39}{11.5}=3.391...$ therefore the minimum number of bins is 4 So yes, the answer to (c) does use the minimum number of bins.	M1 A1	1.1b 2.4
		(2)	
			(11 marks)

Notes:

(a)

(i) B1: cao for first pass of bubble sort

(ii) B1: correct deduction of the number of comparisons

B1: correct deduction of the number of swaps

(b)

M1: Quick sort – pivots, p, selected and first pass gives >p, p, <p. If only choosing 1 pivot per iteration M1 only. Using bubble sort in this part is M0. If sorting into ascending order M1 only.

A1: Second and third passes correct

A1: cso – including fourth pass

(c)

M1: First four items placed correctly (the values in boxes) with at least eight values placed – allow cumulative totals for M1 only

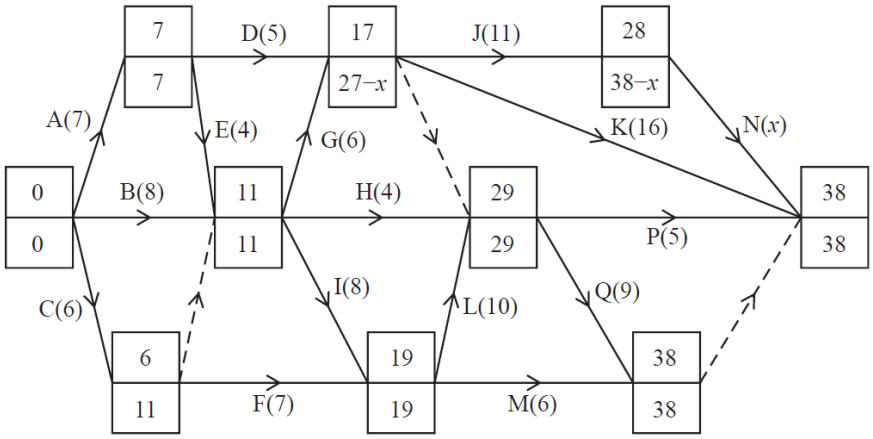
A1: First eight items placed correctly (the values in boxes and underlined) – all correct eleven values must have been placed in bins

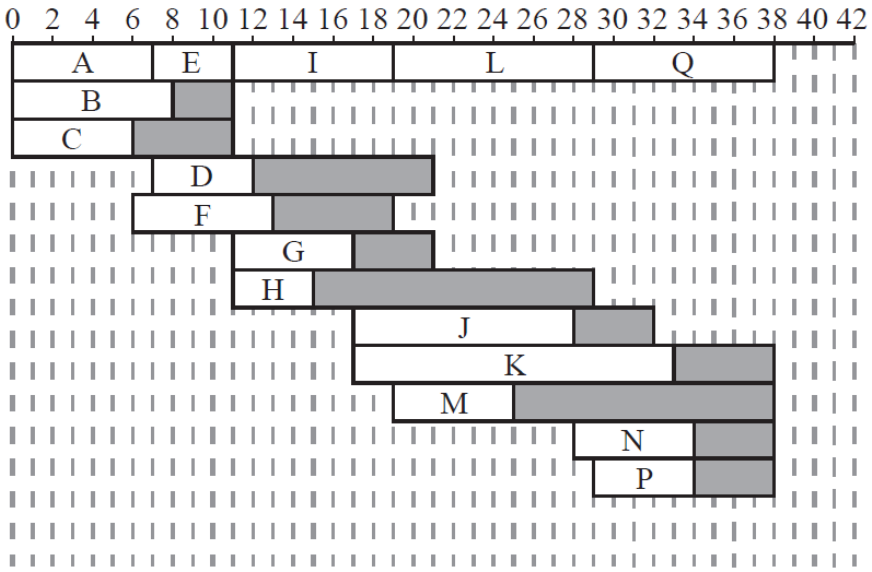
A1: cso (therefore no repeated values)

(d)

M1: Lower bound calculation attempted ([32.7,45.3] / 11.5)

A1: cso correct calculation (rounded or truncated to at least one decimal place) and correct mathematical argument for why the answer to (c) does use the minimum number of bins. **This mark is dependent on the correct bin packing in (c)**

Question	Scheme	Marks	AOs
2(a)	<table><tr><th>Activity</th><th>Immediately preceding activities</th></tr><tr><td>A</td><td>-</td></tr><tr><td>B</td><td>-</td></tr><tr><td>C</td><td>-</td></tr><tr><td>D</td><td>A</td></tr><tr><td>E</td><td>A</td></tr><tr><td>F</td><td>C</td></tr></table> <table><tr><th>Activity</th><th>Immediately preceding activities</th></tr><tr><td>G</td><td>B, C, E</td></tr><tr><td>H</td><td>B, C, E</td></tr><tr><td>I</td><td>B, C, E</td></tr><tr><td>J</td><td>D, G</td></tr><tr><td>K</td><td>D, G</td></tr><tr><td>L</td><td>F, I</td></tr></table> <table><tr><th>Activity</th><th>Immediately preceding activities</th></tr><tr><td>M</td><td>F, I</td></tr><tr><td>N</td><td>J</td></tr><tr><td>P</td><td>D, G, H, L</td></tr><tr><td>Q</td><td>D, G, H, L</td></tr></table>	B1 B1	1.1b 1.1b
		(2)	
2(b)		M1 A1 M1 A1	2.1 1.1b 2.1 1.1b
		(4)	
2(c)	Critical activities are A, E, I, L and Q	B1	2.2a
		(1)	
2(d)	$(38-x)-17-11=4 \Rightarrow x=6$	B1	3.4
		(1)	

Question	Scheme	Marks	AOs
2(e)		M1 A1 A1 A1	2.1 1.1b 1.1b 1.1b
		(4)	
			(12 marks)

Notes:

(a)

B1: 8 rows correct (not including A, B, C)

B1: All 16 rows correct

(b)

M1: All top boxes completed, number generally increasing L to R (condone one "rogue")

A1: cao (top boxes)

M1: All bottom boxes completed, number generally decreasing R to L (condone one "rogue")

A1: cao (bottom boxes)

(c)

B1: cao

(d)

B1: Correct calculation for x

(e)

M1: At least 10 activities including at least 6 floats

A1: All correct critical activities present and 5 non-critical activities correct

A1: Any 8 non-critical activities correct

A1: cso

Question	Scheme	Marks	AOs
3	Maximise $P = 1.5x + y + 1.25z$	B1	3.3
	Subject to $x + z = 48$	B1	3.3
	$3x \geq 5y$	M1	3.3
	$\frac{2}{5}(x + y + z) \geq z \quad (\Rightarrow 2x + 2y \geq 3z)$	M1	3.3
	$\frac{x}{60} + \frac{y}{45} + \frac{z}{35} \leq 1 \quad (\Rightarrow 21x + 28y + 36z \leq 1260)$	M1	3.3
	Two of $3x \geq 5y$, $\frac{2}{5}(x + y + z) \geq z$ and $\frac{x}{60} + \frac{y}{45} + \frac{z}{35} \leq 1$	A1	1.1b
	$z = 48 - x$ substituted into objective and constraints gives	M1	3.1a
	Maximise $P = 0.25x + y + 60$ subject to	A1	1.1b
	$3x \geq 5y, \quad 5x + 2y \geq 144, \quad 15x \geq 28y + 468$	A1	2.5
		(9)	
			(9 marks)

Notes:

B1: cao (for objective) – must contain 'maximise'

B1: cao ($x + z = 48$)

M1: $3x \square 5y$ – where $\square$ is any inequality or equals (allow $5x \geq 3y$ for this mark)

M1: $\frac{2}{5}(x + y + z) \square z$ oe – where $\square$ is any inequality or equals

M1: $\frac{x}{60} + \frac{y}{45} + \frac{z}{35} \square 1$ oe – where $\square$ is any inequality or equals

A1: Any two of the three inequalities in *x*, *y* and *z* (or *x* and *y* only) stated correctly

M1: Eliminating *z* from the objective and at least one constraint using $x + z = 48$

A1: Any two of the four correct (objective and three constraints) in *x* and *y* only

A1: cao (all four parts but do not penalise lack of 'maximise' for a second time)

<table>
<tr><th>Question</th><th>Scheme</th><th>Marks</th><th>AOs</th></tr>
<tr><td>4(a)</td><td>66</td><td>B1</td><td>1.1b</td></tr>
<tr><td></td><td></td><td>(1)</td><td></td></tr>
<tr><td>4(b)</td><td><table><tr><th>Arc</th><th>Weight</th></tr><tr><td>AB</td><td>25</td></tr><tr><td>AC</td><td>37</td></tr><tr><td>AD</td><td>45</td></tr><tr><td>BC</td><td>10</td></tr><tr><td>BE</td><td>31</td></tr><tr><td>CD</td><td>7</td></tr><tr><td>CF</td><td>28</td></tr><tr><td>CG</td><td>39</td></tr><tr><td>DG</td><td>28</td></tr><tr><td>EG</td><td>12</td></tr><tr><td>FG</td><td>3</td></tr></table></td><td>B1
B1
B1</td><td>3.1b
1.1b
1.1b</td></tr>
<tr><td></td><td></td><td>(3)</td><td></td></tr>
<tr><td>4(c)</td><td>Shortest path from A to G: ABCFG</td><td>B1</td><td>2.2a</td></tr>
<tr><td></td><td></td><td>(1)</td><td></td></tr>
<tr><td>4(d)</td><td>Prim’s algorithm gives: 25 + 10 + 7 + CE + EF + 3 = 80
Shortest path from A to F via E which is ABEF gives: 56 + EF = 67
EF = 11 and CE = 24</td><td>M1
M1
A1</td><td>2.1
3.1b
2.2a</td></tr>
<tr><td></td><td></td><td>(3)</td><td></td></tr>
<tr><td colspan="4">(8 marks)</td></tr>
</table>

Notes:

(a)

B1: cao

(b)

B1: AB, AC and AD correct

B1: Any other four arcs correct

B1: All correct

(c)

B1: cao

(d)

M1: Use given information regarding Prim's algorithm to set up an equation for CE and EF (using the weight of the correct arcs from (b) so AB + BC + CD + CE + EF + FG = 80)

M1: Use given information regarding shortest path from A to F via E (using the path ABEF) to get an equation for EF (AB + BE + EF = 67) – this mark can be awarded for correctly stating EF as 11

A1: cao for both CE and EF