AQA

AS
Mathematics

MD01- Decision 1
Mark scheme

6360

June 2018

Version/Stage: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

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Key to mark scheme abbreviations

M	mark is for method
m or dM	mark is dependent on one or more M marks and is for method
A	mark is dependent on M or m marks and is for accuracy
B	mark is independent of M or m marks and is for method and accuracy
E	mark is for explanation
√or ft or F	follow through from previous incorrect result
CAO	correct answer only
CSO	correct solution only
AWFW	anything which falls within
AWRT	anything which rounds to
ACF	any correct form
AG	answer given
SC	special case
OE	or equivalent
A2,1	2 or 1 (or 0) accuracy marks
–*x* EE	deduct *x* marks for each error
NMS	no method shown
PI	possibly implied
SCA	substantially correct approach
c	candidate
sf	significant figure(s)
dp	decimal place(s)

No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

Otherwise we require evidence of a correct method for any marks to be awarded.

Q 1	Solution	Mark	Total	Comment
	I These paths may be in either order			
	Path starting $F - 6 + D$	**M1**		SCA
	$F - 6 + D - 4$	**A1**		may be reversed eg $4 - D + 6 - F$
	And path starting $E - 5 + A$	**M1**		may be reversed
	$E - 5 + A - 1 + B - 3$	**A1**		
	OR			
	THE FOLLOWING PATHS MUST BE IN THE CORRECT ORDER			
	II Path starting $E - 5 + A$	**(M1)**		may be reversed eg $4 - A + 5 - E$
	$E - 5 + A - 4$	**(A1)**		
	Followed by path starting $F - 6 + D$	**(dM1)**		may be reversed
	$F - 6 + D - 4 + A - 1 + B - 3$	**(A1)**		
	OR			
	III Path starting $E - 5 + A$	**(M1)**		may be reversed eg $4 - B + 1 - A + 5 - E$
	$E - 5 + A - 1 + B - 4$	**(A1)**		
	Followed by path starting $F - 6 + D$	**(dM1)**		may be reversed
	$F - 6 + D - 4 + B - 3$	**(A1)**		
	OR			
	IV Path starting $E - 6 + D$	**(M1)**		may be reversed eg $4 - D + 6 - E$
	$E - 6 + D - 4$	**(A1)**		
	Followed by path starting $F - 6 + E$	**(dM1)**		may be reversed
	$F - 6 + E - 5 + A - 1 + B - 3$	**(A1)**		
	Final matching: A1, B3, C2, D4, E5, F6	**B1**	**5**	Must be a 'list' not a 'diagram'
	Total		**5**	

Notes: ignore an initial wrong path if a candidate has 're-started'
Condone different notation eg F6D4, but it must convey the idea of a path not a string of separate 'pairs'

Q 2	Solution	Mark	Total	Comment
(a) (i)	(41 51 63 41 11 19 45)			
	51 41 63 41 11 19 45	**M1**		SCA: 1st pass correct
	63 51 41 41 11 19 45			
	63 51 41 41 11 19 45			
	63 51 41 41 11 19 45	**A1**		Correct to 4th pass
	63 51 41 41 19 11 45			
	63 51 45 41 41 19 11	**A1**		CSO
			3	
(ii)	5 comparisons	**B1**		
	4 swaps	**B1**	**2**	
(b)	$9 < x \leq 11$	**B2**		**B1** for each part
			2	
	Total		**7**	

Notes: **(a)(i)** ignore an extra identical row at the end
(a)(ii) condone 5, 4 for **B1B1** - but 4, 5 scores **0**
(b) condone separate inequalities for **B2**

<table>
<tr><th>Q 3</th><th>Solution</th><th>Mark</th><th>Total</th><th>Comment</th></tr>
<tr><td>(a)</td><td>
<table>
<tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th></tr>
<tr><td>(5)</td><td>(4)</td><td>13</td><td>9</td><td>1.444</td><td>0.085 / 0.086</td></tr>
<tr><td>13</td><td>9</td><td>31</td><td>22</td><td>1.409</td><td>–0.014 / –0.015</td></tr>
<tr><td>31</td><td>22</td><td>75</td><td>53</td><td>1.415</td><td>0.002</td></tr>
<tr><td>75</td><td>53</td><td>181</td><td>128</td><td>1.414</td><td>(–)0.000</td></tr>
</table>

<u>1.414</u></td><td>M1

A1

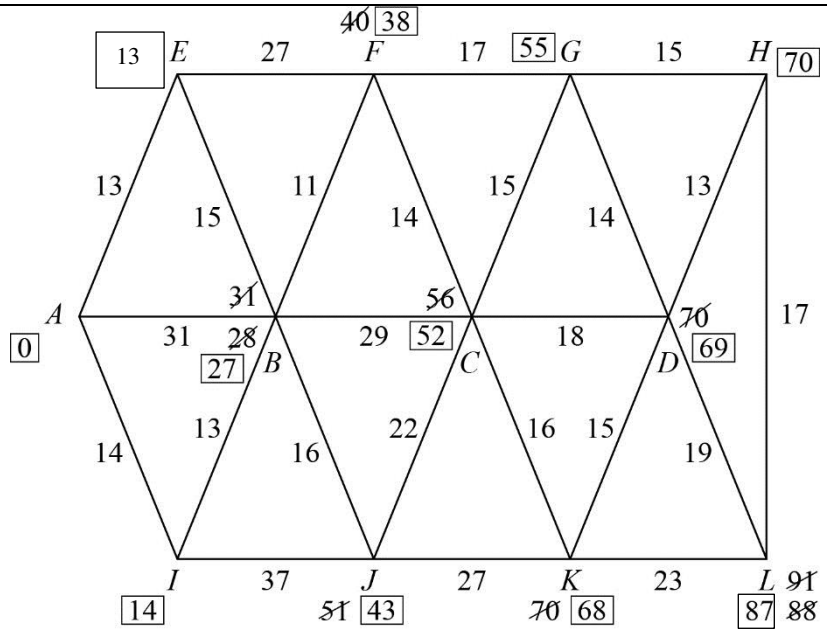
A1

B1</td><td>4</td><td>Trace as far as 1st value of F

Accurate as far as 3rd value of F

All correct

Indication of print of the value 1.414</td></tr>
<tr><td>(b)</td><td>The value of F controls when the algorithm (prints and) stops.</td><td>E1</td><td>1</td><td>OE</td></tr>
<tr><td></td><td>Total</td><td></td><td>5</td><td></td></tr>
<tr><td colspan="5">Notes:</td></tr>
</table>

Q 4	Solution	Mark	Total	Comment
S		**M1** **A1** **A1** **A1**		SCA: one value at *E* and *I* and three at *B* Correct values at *F* and *J* Correct values at *C* and *D* All correct, including boxing Condone omission of 0 (boxed or not) at *A*
	87 at *L*	**B1**	**5**	
(ii)	*AIBFGHL*	**B1**	**1**	Or reverse
(b)(i)	Length = (their) 52 + distance from *C* to *L* = 52 + (18 + 19) = 89 [km]	**M1** **A1**	**2**	Eg 52 + 16 + 23 (or 91)
(ii)	*AIBFCDL*	**B1**	**1**	Or reverse
	Total		**9**	

Notes: (a) Allow, if a candidate has used different notation, as long as you are convinced

The 87 at *L* doesn't have to be boxed, but it must be their final value at *L* for **B1**, but it would be **A0** if not boxed
It is possible to score **M1A0A1** then **A0** and **B0** or **B1**

(b)(i) 89 scores 2/2
For **M1** candidate must add a 2-edge route ie 16 + 23 or 18 + 19 **NOT** *CGHL* (or 47)

Q 5	Solution	Mark	Total	Comment
(a) (i)	(Odds *A, C, K, I*)			
	AC (+) *KI* (=70 + 60 =) 130 *AK* (+) *CI* (= 45 + 100 =) 145 *AI* (+) *CK* (= 60 + 65 =) 125	**M1**		These 3 pairs of odds stated
		A2, 1		3 correct totals, 2 correct totals
	Length = 574 + 125	**dM1**		574 + *their* min of 3 totals
	= 699 [m]	**A1**		**CSO**
(ii)	125 [m]	**B1F**	**6**	*their* min of 3 totals
(b)	619 [m]	**B1**		
	C and *I*	**B1**	**2**	Either order
	Total		**8**	

Notes:
For any answer other than 699 the m/s applies exactly

For an answer of 699, this scores:
5/5 for NO errors/omissions
4/5 IMPOSSIBLE
3/5 for ONE error/omission
2/5 for TWO or more errors/omissions
eg
candidate has the correct 3 pairs, gives 3 totals, with one incorrect followed by an answer of 699 scores 3/5
candidate has the correct 3 pairs, gives 3 totals, with two incorrect followed by an answer of 699 scores 2/5
candidate has the correct 3 pairs, list the correct values but **does not give any totals** but only an answer of 699 scores 3/5 – **SC**
candidate gives an answer of 699 with no working (or a route shown) scores 2/5 **SC**

(b) allow a 'complete' route that starts/finishes at **C/I** for second **B1**

<table>
<tr><th>Q 6</th><th>Solution</th><th>Mark</th><th>Total</th><th>Comment</th></tr>
<tr><td>(a)</td><td>
<table>
<tr><th></th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th><th>G</th></tr>
<tr><td>A</td><td>2</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>B</td><td>1</td><td>0</td><td>2</td><td>1</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>C</td><td>0</td><td>2</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>D</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>E</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>F</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>G</td><td>0</td><td>0</td><td>0</td><td>2</td><td>1</td><td>0</td><td>0</td></tr>
</table>
</td><td>B1

M1

A1</td><td>3</td><td>“2” in AA (top left) cell

SCA: ignore AA cell, labelled 7×7 grid with numbers in each cell (condone a ‘-‘ or equivalent for the leading diagonal)

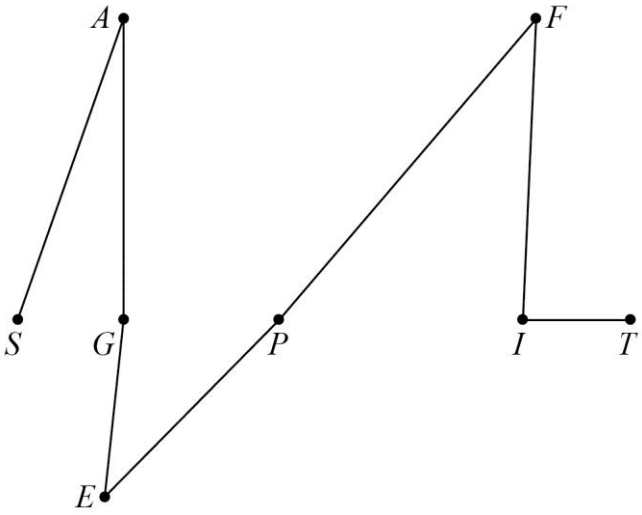
All correct, but ignore value/ ‘no value’ at ‘AA’ cell, but must have zeros in the other leading diagonal entries</td></tr>
<tr><td>(b) (i)</td><td>1 edge from each of 2 left vertices to 2 adjacent right vertices</td><td>B1</td><td></td><td></td></tr>
<tr><td>(ii)</td><td>1 edge from a left vertex to a right vertex</td><td>B1</td><td>2</td><td></td></tr>
<tr><td>(c)</td><td>An odd vertex has an odd number of edges meeting it.
As sum of odd number of odd numbers must be odd,
an odd number of odd vertices will have an odd total number of edge ends meeting at them.</td><td>E1</td><td></td><td>O.E, considering an odd number of odds</td></tr>
<tr><td></td><td>An edge has two ends, so an odd number of edges will produce an even number of ends.

(Hence not possible)</td><td>E1</td><td>2</td><td>O.E, considering that each edge must have 2 (even) ends</td></tr>
<tr><td></td><td>Total</td><td></td><td>7</td><td></td></tr>
</table>

Notes:

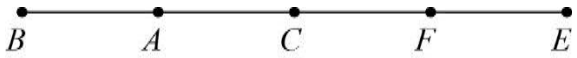
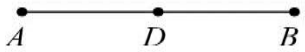
(a) A candidate has a correct matrix but has 1 in AA cell, scores **B0M1A1**
A candidate has a correct matrix but has - in AA cell, scores **B0M1A1**
A candidate has 2 in AA cell, and a 2 in BB cell, and numerical entries in other cells, scores **B1M1A0**

(c) The two **E** marks can be earned in either order. Be generous for **E1** but strict for **E1E1**

Q 7	Solution	Mark	Total	Comment
(a) (i)				
		M1		SCA: At least 5 numbers circled and 5 parallel lines
		A1		7 numbers circled and 7/8 parallel lines
		A1		*EG* and *GA* circled (maybe *GE* and *AG*)
		A1		Correct, including order of vertices shown (but condone absence of *T* line)
(ii)	757 (km)	**B1**		
(iii)		**B1**	**6**	Including labels
(b) (i)	AG or GA	**B1**		
(ii)	FP or PF	**B1**	**2**	
(c)	$100 - 72$ (or better)	**M1**		*PG* added and *PE* removed
	£420	**A1**	**2**	
	Total		**10**	

	A (3)	E (1)	F (6)	G (2)	I (7)	P (4)	S (5)	T (8)
A	-	127	227	53	333	153	88	529
E	127	-	225	69	261	72	200	457
F	227	225	-	187	108	171	309	285
G	53	69	187	-	280	100	135	476
I	333	261	108	280	-	188	415	196
P	153	72	171	100	188	-	235	385
S	88	200	309	135	415	235	-	612
T	529	457	285	476	196	385	612	-

Notes: (a)(i) but not EG, AG circled
The numbering on the vertices might be (0), 1, 2,…7 ie *G* is labelled as 1 (as the start is given as *E*)
The order that vertices are added must be seen on the table and **not** just as a list
(c) an answer of £420 scores 2/2 If **M0** scored, an answer of 420 scores **SC1**
An answer of (£)1500 scores **SC1**

Q 8	Solution	Mark	Total	Comment
(a)	$D\ \ B\ \ A\ \ C\ \ F\ \ E\ \ D$ $(6\ \ 3\ \ 5\ \ 13\ 11\ \ 9)$	**M1** **dM1** **A1**		Tour from *D ../* *… visiting all vertices …* *… in correct order*
	47 (km)	**A1**	**4**	**CSO** If **M0** scored, **SC 2** for 47
(b)	Spanning tree connecting *A, B, C, E, F* **AND** 2 (different) edges/values from *D*	**M1**		
		**A1**		Correct minimum spanning tree
		**A1**		Correct edges (not values) from *D* (maybe seen in a diagram but NOT in a table)
	46 (km)	**A1**	**4**	**CSO** If **M0** scored, **SC 2** for 46
(c)	As part (a) is a tour of length 47 (km) the upper bound for the minimum length of a tour for Bradley is 47 (km).	**E1**		**FT,** but their (a) > their (b)
	Although 46 km is a lower bound for Bradley's tour it is not actually a tour so there may not be one of this length.	**E1**	**2**	**FT,** but their (a) > their (b)
	Total		**10**	

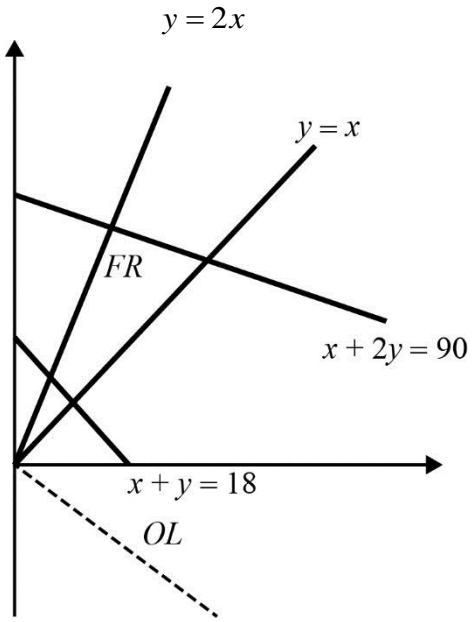
Notes: (a) (b) Ignore working on table UNLESS the candidate re-draws a table in the answer space

(a) For **M1** the table must have all vertices numbered with *D* clearly start and finish vertex. Other marks as above

(b) Table must be without *D*, or *D* clearly crossed out.
M1 4 values circled + 2 values/edges from *D*, **A1** 3, 5, 11, 13 circled/highlighted **A1A1** as above

(b) For **M1**, Accept a list of 4 edges for the spanning tree, but not a list of values
(c) In general, generous for either **E1**, but strict for **E1E1.** To score 2/2 each answer MUST be in context

If **E0** scored, then 46 < Tour ≤ 47 or 46 ≤ Tour ≤ 47 scores **SC1**. (**FT** still applies)
But 46…Tour < 47 scores 0
Allow x, T etc for tour
If their (a) = their (b) then **SC1** for stating that an optimal tour has been found

Q9	Solution	Mark	Total	Comment
(a)	$y \geq x$ and $y \leq 2x$	**B1**		OE
	$50x + 200y + 300z \leq 13500$	**B1**		OE, e.g. $x + 4y + 6z \leq 270$
	$2x + 2y + 3z \geq 54$	**B1**		OE
			3	
(b)(i)	$z = ¼ (x + y + z)$	**M1**		OE
	Substituting explicitly using $3z = x + y$			
	eg			
	$x + 4y + 2(x + y) \leq 270$, $x + 2y \leq 90$	**A1**		Must be convinced
	$2x + 2y + (x + y) \geq 54$, $x + y \geq 18$	**A1**		Must be convinced
			3	
(ii)		**B1** **B1** **B1** **B1**		$y = x$ thro' $(0, 0)$ and $(30, 30)$ and $y = 2x$ thro' $(0, 0)$ and $(20, 40)$ $x + y = 18$ thro' $(18, 0)$ and $(0, 18)$ $x + 2y = 90$ thro' $(0, 45)$ and $(40, 25)$ FR correct, clearly indicated and labelled (must have scored previous **B3**)
			4	
(c)	$(T =) 3x + 4y + 6z$	**M1**		Or $5x + 6y$
	⇨ Line of gradient –5/6	**A1**		Drawn on graph
	(Minimum) £99	**B1**		Including £
	9 plain, 9 fruit, 6 chocolate	**B1**	**4**	
	Total		**14**	

(a) If a candidate has used strict 'equivalent' inequalities **throughout** penalise by 1 mark
(b) (ii) lines ruled and accurate to 0.5 square horizontally and vertically
(c) Gradient of line accurate by eye '–1 < gradient < –0.6'