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AS

# Mathematics

MD01 Decision 1  
Final Mark scheme

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6360  
June 2017

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Version/Stage: v1.0

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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.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from [aqa.org.uk](http://aqa.org.uk)

**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	Solution	Mark	Total	Comment	
1	<b>(a) EITHER</b> Path starting $D - 3 + E$ or $4 - E + 3$ or $C - 2 + B$ or $6 - A + 1$  $D - 3 + E - 4$  $C - 2 + B - 1 + A - 6$  Matching A6, B1, C2, D3, E4, F5  <b>OR</b>  Path starting $6 - F + 5$ or $D - 3 + E$ $6 - F + 5 - E + 3 - D$ followed by $4 - E + 5 - F + 6 - A + 1 - B + 2 - C$  Matching A6, B1, C2, D3, E4, F5	M1		Paths should be listed, but allow on diagram provided one path per diagram and start/end clearly labelled	
		A1		Or reverse	
		A1		Or reverse	
		B1		Must be listed	
		(M1)			
		(A1)		Or reverse	
		(A1)		Or reverse	
		(B1)			
				4	
		<b>(b)</b>	As A wants to play 1, B must play 2	E1	
	C cannot now play 2 so full team is impossible.	E1dep		Or complete match is impossible	
	<b>OR</b>				
	As A wants to play 1, F must play 6	(E1)			
	So E must play 5				
	So no-one to play 4 so full team is impossible.	(E1dep)			
			2		
	<b>Total</b>		<b>6</b>		

**Notes:**

In part (a) allow different notations, e.g. C2B1A6 or  $C - 2 + B - 1$  or  $C - 2 + B - 1 + 1 + A - 6$  or  $C - 2 + B - 1 + A - 6$   
 i.e. any notation which preserves the idea of a continuous path, including different symbols

In part (b) the first mark is for a first (simple) consequence and the second is for a full explanation, which must include “full team impossible” (or complete matching impossible)

Cannot score 2<sup>nd</sup> E mark unless first E mark scored

Q	Solution	Mark	Total	Comment
2 (a)	$(A, C, E, G \text{ odd vertices})$  $AC + EG (= 10 + 10) = 20$ $AE + CG (= 12 + 14) = 26$ $AG + CE (= 13 + 12) = 25$  Route = $110 + 20$  $= 130 \text{ (m)}$	M1  A2,1,0  dM1  A1	5	These 3 pairs and added  -1 per error in final totals  PI 110 + lowest of their 3 totals  CSO Must have scored the first 4 marks.
(b) 3		B1	1	This answer might be in question script but answer space takes precedence.
	<b>Total</b>		<b>6</b>	

**Notes:**

(a) For any answer other than 130 the m/s applies exactly

**For an answer of 130, 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 130 scores 3/5

candidate has the correct 3 pairs, gives 3 totals, with two incorrect followed by an answer of 130 scores 2/5

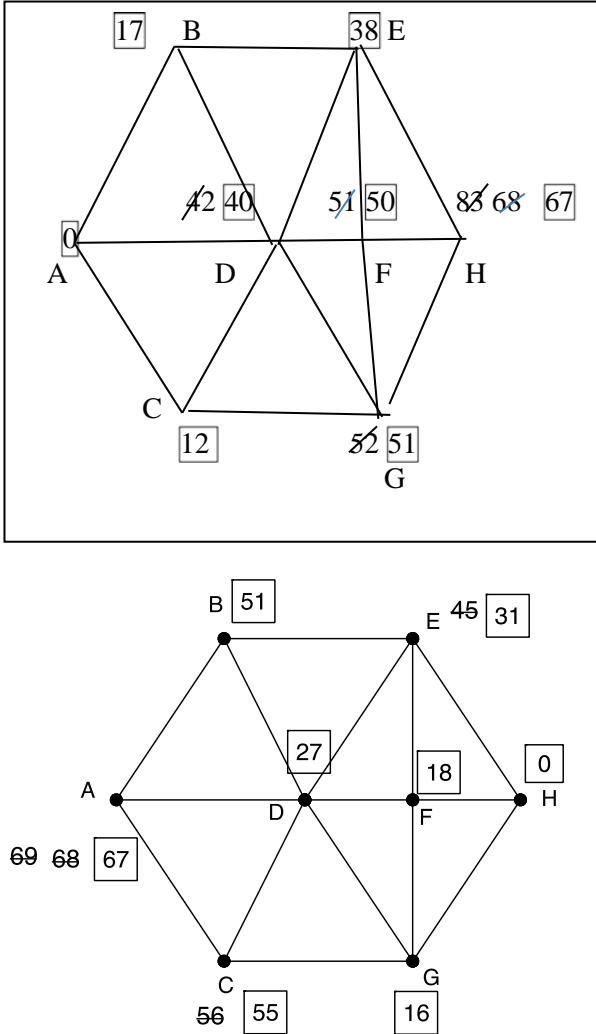
candidate has the correct 3 pairs, list the values but **does not give any totals** but merely an answer of 130

scores 3/5 – **SC**

candidate gives an answer of 130 with no working (or a route shown) scores 2/5 **SC**

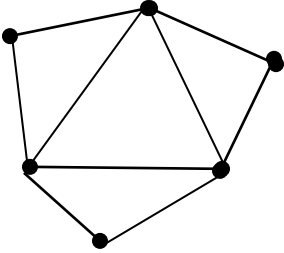
Q	Solution	Mark	Total	Comment
3 (a)	18 3 45 17 1 26 43 22 16			
	18                                  1                                  16			
	3                                  26			
	45                                  43	<b>M1</b>		SCA: use of these 4 sub lists (which may be written down already sorted)
	17                                  22			
	1 3 43 17 16 26 45 22 18	<b>A1</b>		This line must be seen
	1           43           16           45           18			
3           17           26           22	<b>dM1</b>		Correct use of 2 sub lists (which may be written down already sorted)	
1 3 16 17 18 22 43 26 45	<b>A1</b>		Must see ‘merged’ list	
1 3 16 17 18 22 26 43 45	<b>A1</b>	<b>5</b>	All correct	
(b)				
	6	<b>B1</b>	<b>1</b>	This answer might be in question but answer space takes precedence.
<b>Total</b>			<b>6</b>	

**Notes:**  
 (a) The accuracy marks can imply the method marks  
**dM1** can be earned for a candidate who has scored **M1** but **A0**  
 Ignore any ‘shuttle’ interim sorts seen  
 If a candidate sorts the numbers into descending order then only the **M** marks are available

Q	Solution	Mark	Total	Comment
<p>4 (a)(i)</p>	 <p>(M1) SCA 2 values at E, 1 at F, G  (A1) correct values at B, C, D  (A1) all correct as above  (B1) 67 at A</p>	<p>M1</p> <p>A1</p> <p>A1</p> <p>B1</p> <p>B1</p> <p>B1</p>	<p>5</p> <p>2</p> <p>7</p>	<p>SCA 2 values at D, only 1 value at B, C</p> <p>Correct values at E, F, G</p> <p>All correct including crossing through, boxing. Condone missing/unboxed 0 at A.</p> <p>67 final value at H</p> <p>If working in reverse</p> <p>Or reverse</p> <p>Or reverse</p>
(ii)	ACDGH	B1		Or reverse
(b)	ABDGH	B1		Or reverse
	68 (km)	B1		
<b>Total</b>			<b>7</b>	

**Notes:**

(a) Candidates might use different notation eg '3-box method', crossing out required for 2<sup>nd</sup> A mark

Q	Solution	Mark	Total	Comment
<p><b>5 (a)</b></p> <p><b>(b)</b></p>	<p>26 (cm)</p> <p>Minimum spanning tree = 25 (3, 4, 4, 5, 9 or 3, 4, 5, 5, 8) Seen on a diagram not just as a list</p> <p>A connected graph with 6 vertices and 9 edges, labelled with the 9 values given</p> <p>Graph is simple</p>	<p><b>B1</b></p> <p><b>B1</b></p> <p><b>M1</b></p> <p><b>A1</b></p>	<p><b>1</b></p> <p><b>3</b></p>	<p>Edges throughout need not be straight.</p>
<p><b>(c)</b></p>	<p>e.g.</p> 	<p><b>M1</b></p> <p><b>A1</b></p>	<p><b>2</b></p>	<p>Simple, connected graph with 6 vertices and 9 edges</p> <p>Vertices of order 4, 4, 4, 2, 2, 2</p>
<b>Total</b>			<b>6</b>	
<b>Notes:</b>				



Q	Solution	Mark	Total	Comment
6 (a)(i)	<i>YB</i>	<b>M1</b>		SCA first 2 edges correct Allow <i>BY</i> for <i>YB</i> etc
	<i>DN</i>			
	<i>KS</i>			
	<i>SF</i>	<b>A1</b>		Correct as far as <i>SF</i>
	<i>NB</i>			
	<i>DT</i>	<b>B1</b>	7 edges, not values PI by spanning tree	
	<i>ST</i>	<b>A1</b>	Completely correct	
(ii)	117 (miles)	<b>B1</b>		This answer might be in question script but answer space takes precedence.
(iii)		<b>B1</b>		All correct including labelling. Diagram must be shown separately not just highlighted over diagram in question on script.
(b)(i)	<i>BY</i>	<b>B1</b>		Accept <i>YB</i>
(ii)	<i>SF</i>	<b>B1</b>		Accept <i>FS</i> This answer might be in question script but answer space takes precedence.
			<b>2</b>	
	<b>Total</b>		<b>8</b>	

**Notes:**

- (a) The three parts may be in any order  
You must be convinced that the order of the edges given is clear eg list with edges on 2/3 lines
- (b) Must be an edge not a vertex

Q	Solution	Mark	Total	Comment
7 (a)	50 (miles) Any <b>tour</b> is an upper bound    OE	<b>B1</b> <b>E1</b>	<b>2</b>	
(b)(i)	$C\dots C$ $CAEDBC$ 48 (miles)	<b>M1</b> <b>A1</b> <b>B1</b>		A tour including all 5 vertices (once only) starting from C
(ii)	$AEDBCA$	<b>A1F</b>	<b>4</b>	Or reverse If <b>M0</b> scored, a correct tour from A of the same length as (b)(i) scores <b>SC1</b>
(c)	<p style="text-align: center;"> <math>((7 + 8 + 10) + (6 + 9) =) 40</math> (miles)                 </p>	<b>M1</b>  <b>A1</b>  <b>A1</b>		Any ST, not including A, plus 2 edges from A, indicated in diagram, writing or table, by edges and/or values  Correct tree, with correct edges (not values) stated or in labelled diagram (not table)  Correct edges from A, with correct edges (not values) stated or in labelled diagram (not table)
(d)	'their' $40$ (miles) $< L \leq 48$ (condone $x$ , $T$ etc for $L$ )	<b>B1</b>  <b>B2F</b>	<b>4</b>  <b>2</b>	Ft only if $LB \leq UB$ Ft $UB =$ their lower of (a) and (b)  If 0 scored then <b>SC1</b> for either part of <b>complete</b> inequality correct (ft) as above Or answer written as 2 correct (ft) but separate inequalities scores <b>SC1</b> Only one inequality given, scores 0/2
<b>Total</b>			<b>12</b>	

**Notes:** (a) OE, allow 'hamiltonian' or description in words visiting all vertices, returning to start. **But not 'it'**  
 (b)(i) A candidate 'working' on the table:  
**M1** for 5 values circled, one per row/column, with C numbered as 0 or 1  
**A1** for vertices correctly numbered with C labelled as 5 or 6  
 (d) condone  $40 \leq L \leq 48$  for **B2**. Do **not** condone  $L < 48$   
 If a candidate has written two separate inequalities, one of which is incorrect (ft), then this scores 0/2

Q	Solution					Mark	Total	Comment
<b>8 (a)</b>	<i>N</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<b>M1</b>		Trace as far as $N = 4$ , condone exact fractions or working to other than 4 dp.  Correct to $A = 0.2970$ , <b>values as shown in the table</b>  Correct to $N = 2$ and stopped, <b>values as shown in the table</b>  Correct $C$ ' <b>printed</b> ' ie must appear in addition to final value in $C$ -column  <b>For parts (b) and (c) condone exact fractions or working to at least 3 dp</b>  Correct trace as far as $N = 5$ and stopping  Correct $C$ ' <b>printed</b> ' (as above)  <b>2</b> eg $D =  A - C $ , $ D  < 0.001$  Correct trace to 2 <sup>nd</sup> value of $D$ with signs consistent with their 'change step'  Correct to $N = 3$ and stopped, including correct $C$ ' <b>printed</b> ' (as above)
	(6)	(1)	3	0.4286	0.5714			
	5	0.4286	2.0787	0.2970	0.1316	<b>A1</b>		
	4	0.2970	2.0262	0.2895	0.0075			
	3	0.2895	2.0243	0.2892	0.0003	<b>A1</b>		
	2					<b>B1</b>		
<b>(b)</b>	(‘C’) <u>0.2892</u>					<b>B1</b>	<b>4</b>	
	<i>N</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<b>B1</b>		
	(6)	(0)	2	0.2857	-0.2857			
	5					<b>B1</b>		
	(C) <u>0.2857</u> AWRT (or 2/7)						<b>B1</b>	<b>2</b>
	<b>(c)(i)</b>	Replace $D < 0.001?$ with $-0.001 < D < 0.001?$ OE					<b>B1</b>	
<i>N</i>		<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<b>M1</b>		
(6)	(0)	2	0.2857	(-)0.2857				
5	0.2857	2.0233	0.2890	(-)0.0033				
4	0.2890	2.0241	0.2892	(-)0.0002				
3								
(C) <u>0.2892</u>					<b>A1</b>		<b>3</b>	
<b>Total</b>							<b>9</b>	

**Notes:**

- (a) At least 2 values for  $N$ , and at least 2 values for each of  $B$ ,  $C$  and  $D$ . Condone correct answers given in standard form
- (b) Condone 0.286 as printed value
- (c) Only accept 0.2892 as printed value  
If a candidate has used exact fractions, or working to more than 4dp, their correct final value of  $D$  is 0.0001

Alternative to (c)

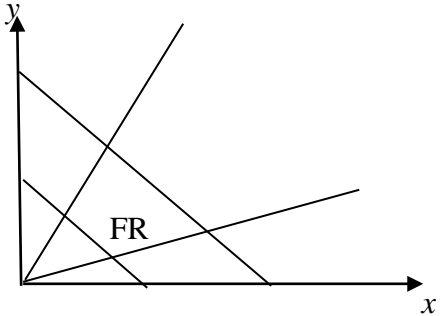
Replace ‘ $D < 0.001?$ ’ with ‘ $D = 0$  to 4dp?’ **B1**

$N$	$A$	$B$	$C$	$D$
(6)	(0)	2	0.2857	-0.2857
5	0.2857	2.0233	0.2890	-0.0033
4	0.2890	2.0241	0.2892	-0.0002
3	0.2892	2.0242	0.2892	0.0000
2				

(‘C’) 0.2892

Correct trace to 2<sup>nd</sup> value of  $D$  **M1**

Correct to  $N = 2$  and stopped, including correct  $C$  ‘printed’ (as before) **A1**

Q	Solution	Mark	Total	Comment
9	(a) $x + y + z \geq 225$ $x + y + z \leq 375$ $y \geq \frac{1}{2}x$ $y \leq 3x$	<b>B2</b>	<b>2</b>	OE OE
	(b) $z = (x + y + z) \div 5$ <b>PI</b> $\Rightarrow 4z = x + y$ <b>PI</b>	<b>M1</b> <b>A1</b>		OE eg $x + y = 0.8(x + y + z)$ OE simplified to 3 terms
	$x + y + (x + y)/4 \geq 225$ $(\leq 375)$	<b>M1</b>	Correctly substitute for their $z$ (must be in terms of $x$ and $y$ ) in at least one of their 1 <sup>st</sup> two inequalities in part (a)	
	eg $5x + 5y \geq 900$ $(\leq 1500)$		Must see a middle step	
	$x + y \geq 180$ $x + y \leq 300$ <b>AG</b>	<b>A1</b>	CSO to produce given answers	
	(c)		<b>B2</b>	All lines must be ruled, correct to within 1/2 square horizontally AND vertically
	(d)(i)	$(C) = 10x + 20y + 40z$ <b>PI</b> $= 10x + 20y + 40(x + y) \div 4$ $= 20x + 30y$	<b>M1</b> <b>A1</b>	All 4 lines correct $x + y = 180$ $x + y = 300$ , through intercepts 180 & 300 $y = \frac{1}{2}x$ , $y = 3x$ through origin & (200, 100) and (100, 300) respectively <b>B1</b> for 2 correct lines
(ii)	OL with gradient $-2/3$ (correct by eye)	<b>B1F</b>	All correct and FR labelled	
	(120, 60) stated (and identified as min) (Cost =) £4200 120 Economy, 60 Standard, 45 Deluxe	<b>B1F</b> <b>B1</b> <b>B1</b>	See below Including units	
	<b>Total</b>		<b>6</b>	
			<b>15</b>	

**Notes (a)** **B1** for any two inequalities correct

(b) For 1<sup>st</sup> method mark, allow 20/100 but not 20%. If a candidate has used inequality for  $z$ , then max mark is **M0A0M1A0**

Candidate **only** finding 80% of 225 (or 20%) scores 0

(d)(ii) For the **B1F**, using their OL on their FR (must be a quadrilateral), and stating the co-ordinates of the point that gives 'their' correct minimum. Correct by eye from graph.

If a candidate lists their extreme points, then the **B1F** is earned by correctly identifying their 'minimum' Must see 'economy', 'standard' and 'deluxe' for final **B** mark