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General Certificate of Education (A-level)
January 2011

Mathematics MD01

(Specification 6360)

Decision 1

Mark Scheme

Mark schemes are prepared by the Principal Examiner 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 examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

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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.

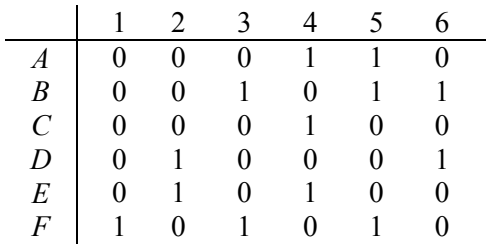
Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn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

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

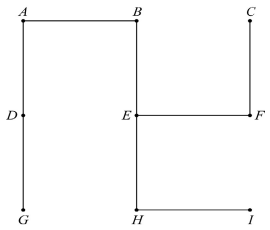
Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

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

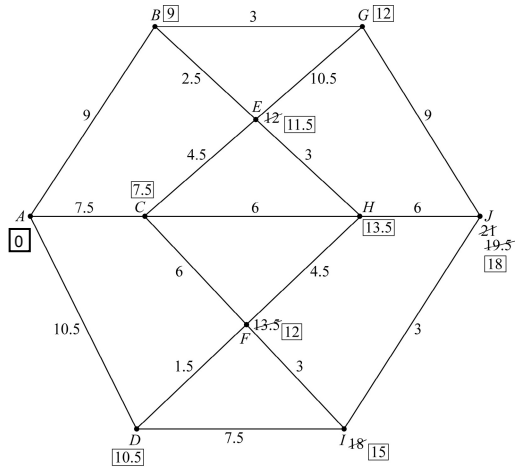
MD01

Q	Solution	Marks	Total	Comments
1(a)		M1		(6×6) matrix labelled with some $\surd$'s or $\times$'s or 0's or 1's or $-$'s
		A1	2	CAO
(b)	$A-4+E$ $A-5+B$	M1		1 correct
	$C-4+E$ $6-D+2$ $6-B+5$ $1-F+3$	M1		1 correct, from a different start point
	$A-5+B-3+F-1$ $C-4+E-2+D-6$	A1 A1		Either order
	or first $A-4+E-2+D-6$ then $C-4+A-5+B-3+F-1$	(A1) (A1)		Must be in this order
	or first $A-5+B-6$ then $C-4+E-2+D-6+B-3+F-1$	(A1) (A1)		Must be in this order
	Match $A5$, $B3$, $C4$, $D6$, $E2$, $F1$	B1	5	Must be stated (not solely on diagram)
	Total		**7**	

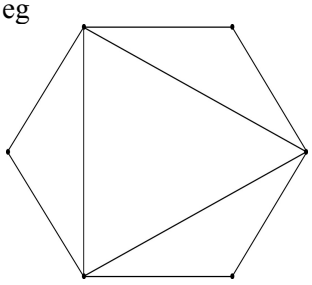
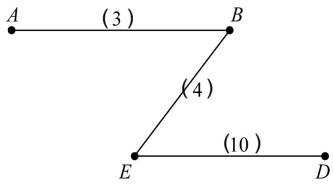
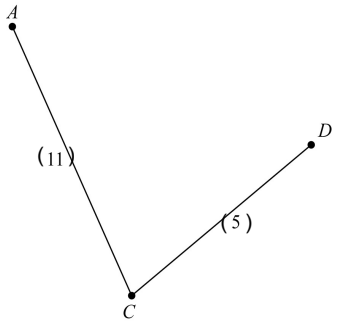
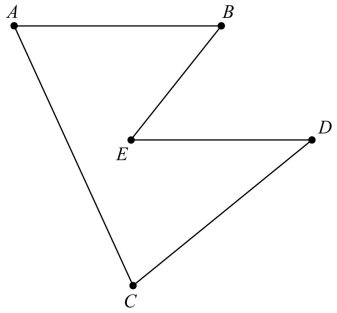
MD01 (cont)

Q	Solution	Marks	Total	Comments
2(a)	7 22	B1 B1	 2	A correct pivot (7 or 22) 2nd correct pivot and no others
(b)	<table><tr><th></th><th>*C*</th></tr><tr><td>1st</td><td>7</td></tr><tr><td>2nd</td><td>5</td></tr><tr><td>3rd</td><td>3</td></tr></table>	 B1 B1 B1	 3	 Condone 7, 5, 3 or 7 + 5 + 3 (= 15) unlabelled but must be in this order
(c)	No – 16, 19 haven't been compared (OE)	E1	1	BOTH "No" (or equiv) AND "16, 19" (only) mentioned or highlighted in script
	Total		**6**	
3(a)(i)	$\begin{pmatrix} EB & 5 \\ EH & 7 \\ AB & 8 \\ HI & 9 \\ AD & 10 \\ DG & 4 \\ EF & 12 \\ FC & 6 \end{pmatrix}$	M1 B1 A1 A1	 4	Prim's, MST, 6+ edges (no cycles), edges not lengths or vertices, with first 2 edges correct 8 edges *AB* 3rd All correct
(ii)	61	B1	1	
(iii)		 M1 A1	 2	 6+ edges, connected, no cycles Correct, including labelling
(b)	Delete *BA*, *BE* and reconnect with 1 edge or a spanning tree with 7 edges not including *B* (either as a list or diagram) (61 – 13 + 11) = 59	M1 A1	 2	PI from their diagram in (iii) Note: 59 scores 2/2
	Total		**9**	

MD01 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)		M1 A1 m1 m1 B1 A1	6	(2 values at E or F) Correct values at E and F 2 values at I 3 values at J 18 at J All correct, condone 0 missing at A, with rejected values crossed and final values boxed and no extra values at other vertices
(ii)	$A\ D\ F\ I\ J$	B1	1	or reverse
(b)	$7.5 + x < 12$ OE $16.5 + x \geqslant 18$ OE	M1 A1		Either correct condone $7 \cdot 5 + x \leqslant 12$ or $16 \cdot 5 + x > 18$ Both correct
	$1.5 \leqslant x < 4.5$	A1	3	$1.5 \leqslant x < 4.5$ seen (with or without working) scores 3/3 Condone $1.5 \leqslant x$ **and** $x < 4.5$ or **exact** equiv in words but must see "and" $1.5 < x$ or $1.5 \leqslant x$ or $x < 4.5$ or $x \leqslant 4.5$ with no working M1A0
	Total		**10**	
5(a)	A vertex / vertices of odd order (A, B, G, H) OE	E1	1	Condone statement of non-Eulerian graph
(b)	$AB + GH = (180 + 165) = 345$ $AG + BH = (90 + 210) = 300$ $AH + BG = (150 + 210) = 360$	M1 A2,1		These 3 correct sets of pairs 3 correct totals, 2 correct totals
	Dist 1215 + 300 PI = 1515	M1 A1	5	1215 + their smallest CSO
(c)(i)	3	B1	1	
(ii)	2	B1	1	
	Total		**8**	

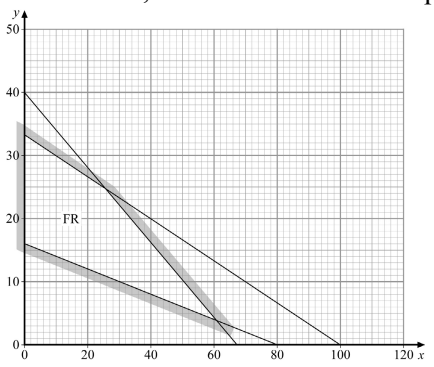
MD01 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	10	B1	1	
(ii)	4	B1	1	
(iii)	5	B1	1	
(b)	eg 	M1		**Simple** graph, 6 vertices
		A1	2	Eulerian graph with 9 edges
	Total		**5**	
7(a)	33	B1	1	
(b)	*B A E D C B*	M1		Tour that visits all vertices
		A1		Correct tour
	= 41	B1	3	
(c)		M1		Spanning tree without *C* (either drawn or edges listed) and 2 different edges from *C* (either drawn or edges listed)
		A1		Correct MST
		A1		Correct 2 edges from *C*
	= 33	B1	4	
(d)		M1		Correct network Possibly earned in (c)
	Optimal OE	A1	2	
	Total		**10**	

MD01 (cont)

Q	Solution	Marks	Total	Comments
8(a)				
	X | A | B			
	0 | 20 | 8			Condone omission of $X = 0$, $A = 20$, $B = 8$
	| 10 | 16	M1		SCA Trace as far as their '10' at A and their '16' at B, ignore values in X column
	| 5 | 32	A1		All correct up to and including 32 at B
	32 | 2 | 64	A1		All correct up to and including 64 at B
	| 1 | 128			
	160 ("160") | |	A1	4	All correct and no further working
(b)	Multiplication OE	B1	1	
(c)	Continuous loop OE	E1		
	as never reach Line 90 OE	E1	2	
	Total		**7**	

MD01 (cont)

Q	Solution	Marks	Total	Comments
9(a)	$6x + 9y + 9z \leq 600$	M1		Any of the three inequalities correct (un)simplified, condone strict inequalities
	$2x + 3y + 3z \leq 200$	A1		CAO
	$9x + 6y + 9z \leq 600$ $3x + 2y + 3z \leq 200$	A1		CAO
	$6x + 12y + 18z \geq 480$ $x + 2y + 3z \geq 80$	A1	4	CAO
(b)(i)	$(z = y)$ $2x + 3y + 3y \leq 200$ or $2x + 6y \leq 200$	M1		Correctly substitute into **this** inequality - either simplified or unsimplified form
	$x + 3y \leq 100$ AG			
	$3x + 2y + 3z \leq 200$			Correctly substitute into **this** inequality - either simplified or unsimplified form
	$(\Rightarrow)\ 3x + 5y \leq 200$ AG			
	$x + 2y + 3z \geq 80$			Correctly substitute into **this** inequality - either simplified or unsimplified form
	$(\Rightarrow)\ x + 5y \geq 80$ AG	A1	2	All correct – must link their original inequality to the stated answers
(ii)	Each line must be straight to have the B mark available. For all lines, must be correct to ½ square horizontal and vertical at the indicated vertices.			
		B1		Line through (10, 30) and (40, 20)
		B1		Line through (50, 10) and (0, 40)
		B1		Line through (80, 0) and (0, 16)
		B1	4	FR, must have all lines correct and labelled region (condone no shading)
(iii)	Max $x + 2y$ PI	M1		If no statement (PI), then check OL on diagram, which must be correct for M1
	Max (= 25 + 50) = 75	A1	2	Note: 75 with no working 2/2
(iv)	25 basic, 25 standard, 25 luxury	B1F	1	Condone "25 of each type" ONLY if (b)(iii) fully correct Note $x = 25 = y = z$ B0
	Total		**13**	
	TOTAL		**75**	