Version 1.0

General Certificate of Education
June 2010

Mathematics MD01

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 meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting 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 the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' 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.

Set and published by the Assessment and Qualifications Alliance.

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales (company number 3644723) and a registered charity (registered charity number 1073334).
Registered address: AQA, Devas Street, Manchester M15 6EX

Key to mark scheme and abbreviations used in marking

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	MC	mis-copy
CAO	correct answer only	MR	mis-read
CSO	correct solution only	RA	required accuracy
AWFW	anything which falls within	FW	further work
AWRT	anything which rounds to	ISW	ignore subsequent work
ACF	any correct form	FIW	from incorrect work
AG	answer given	BOD	given benefit of doubt
SC	special case	WR	work replaced by candidate
OE	or equivalent	FB	formulae book
A2,1	2 or 1 (or 0) accuracy marks	NOS	not on scheme
–*x* EE	deduct *x* marks for each error	G	graph
NMS	no method shown	c	candidate
PI	possibly implied	sf	significant figure(s)
SCA	substantially correct approach	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. However, there are situations in some units where part marks would be appropriate, particularly when similar techniques are involved. Your Principal Examiner will alert you to these and details will be provided on the mark scheme.

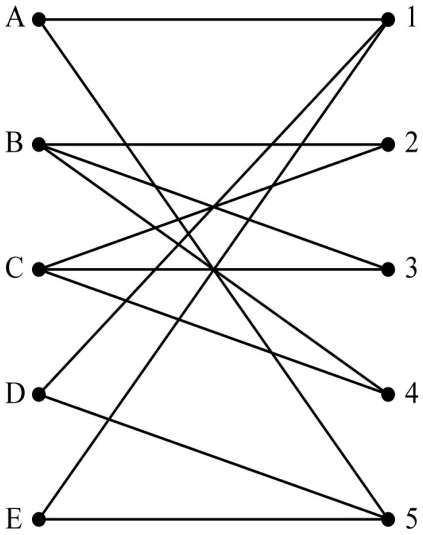
Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn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

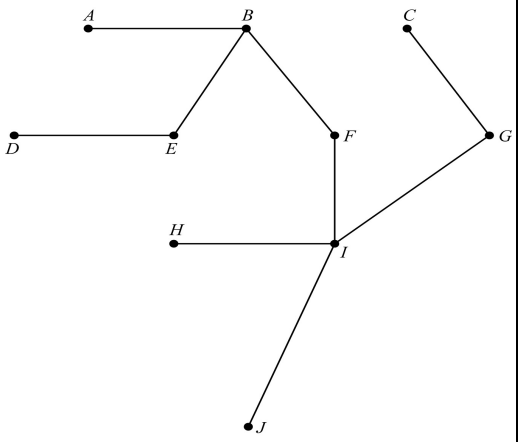
MD01

Q	Solution	Marks	Total	Comments
1(a)		M1		Bipartite graph, 2 sets of (some) vertices, labelled, 6+ edges.
		A1	2	All correct
(b)	3 letters matched to 2 numbers impossible or 2 letters matched to 3 numbers impossible	E1		OE; PI by subsequent E1
	A, D, E matched to 1, 5 impossible or B, C matched to 2, 3, 4 impossible	E1	2	OE
	Total		**4**	

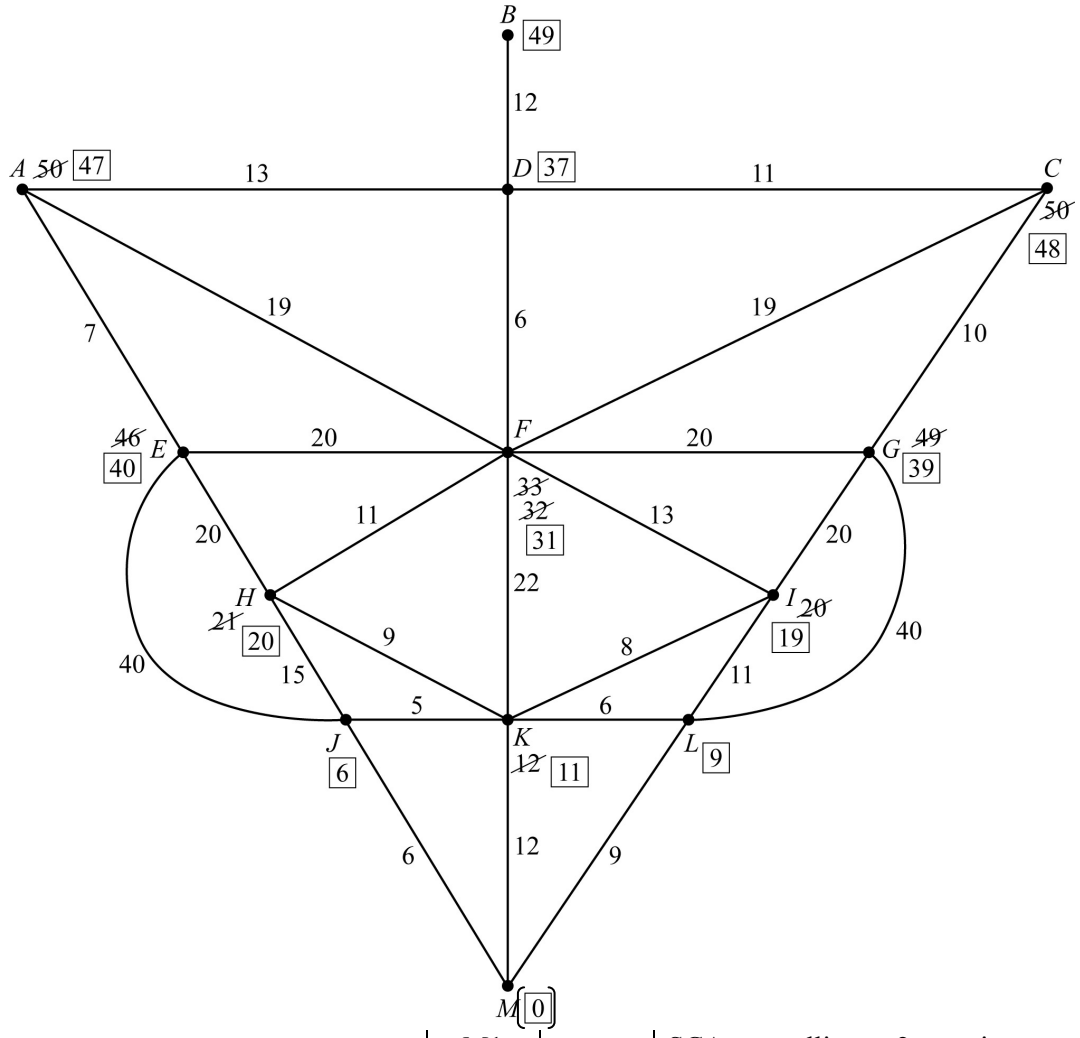
MD01 (cont)

Q	Solution	Marks	Total	Comments
2(a)(i)	(6 2 3 5 4)			
	2 3 5 4 6	M1		Bubble, condone 1 slip but must have 6 at end of first pass
		A1		1st pass correct
	2 3 4 5 6			
	2 3 4 5 6	A1	3	All correct, these 3 lines only
	Or reverse:			
	(6 2 3 5 4)			
	2 6 3 4 5	M1		Bubble, condone 1 slip but must have 2 at start of 1st pass
		A1		1st pass correct
	2 3 6 4 5			
	2 3 4 6 5			
	2 3 4 5 6	A1		All correct these 4 lines only
				NOTE (6 2 3 5 4) 2 3 5 4 6 2 3 5 4 6 2 3 5 4 6 2 3 4 5 6 scores M0
(ii)	4	B1	1	
(b)(i)	(6 2 3 5 4)			
	2 6 3 5 4	M1		Shuttle – swap 2 and 6 only on 1st pass
	2 3 6 5 4	A1		2nd pass
	2 3 5 6 4	A1		3rd pass
	2 3 4 5 6	A1	4	All correct
(ii)	1	B1	1	
	Total		**9**	

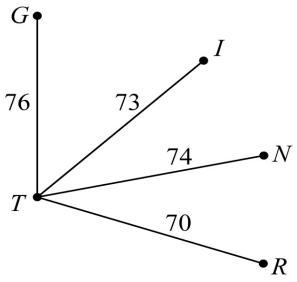
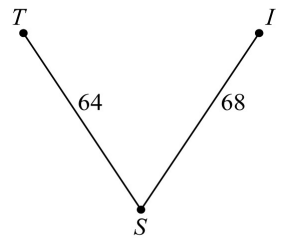
MD01 (cont)

Q	Solution	Marks	Total	Comments
3(a)	*HI* 6 *DE* 8 *IJ* 9 *IG* 11 *AB* 12 *CG* 14 *BF* 16 *BE* 17 *FI* 19	M1 B1 A1 A1 A1	 6	Kruskal's, 6 + edges stated, not just lengths, (no cycles) must be in ascending order (condone 1 slip only) 9 edges *IJ* 3rd *AB* 5th *BF* 7th All correct
(b)	112	B1	1	
(c)		M1 A1 A1	 3	tree 7+ edges 9 edges All correct , including labelling
(d)	*CG*	B1	1	
	Total		**11**	

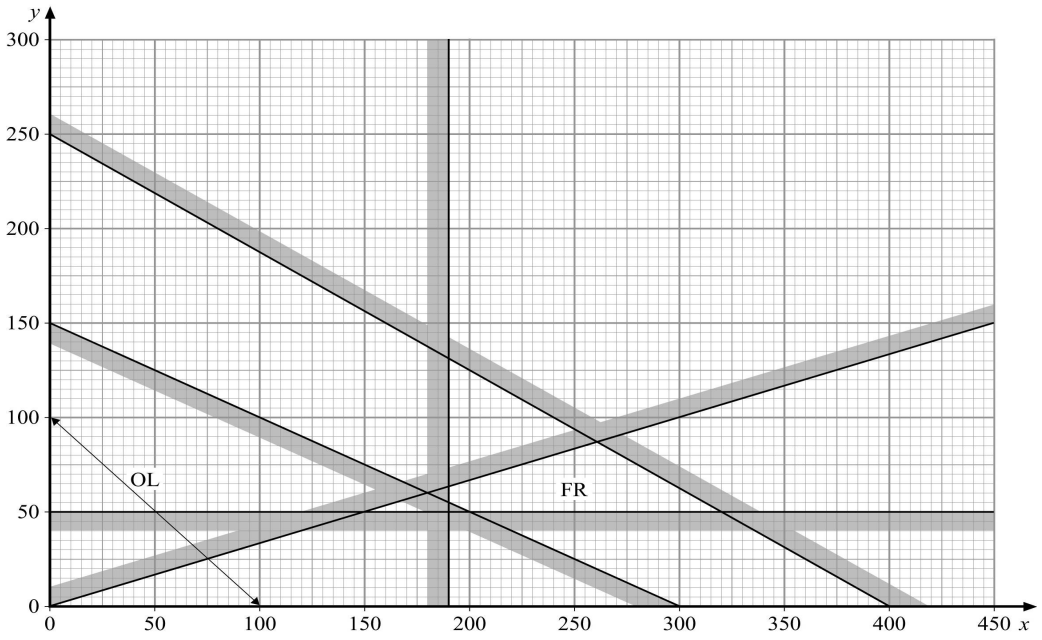
MD01 (cont)

Q	Solution	Marks	Total	Comments
4(a)		M1 A1 m1 m1 m1 A1 B1	 7	SCA, cancelling at 2+ vertices Correct values at *K,* condone no box at 11 3 values at *F* 2 values at *E* or *G* 2 values at *A* or *C* All correct including final values at vertices boxed 49 at *B*
(b)(i)	Odd vertices *A*, *B*, *C*, *M*	E1		PI, CAO
	AB + *CM* = 25 + 48 or 73 *AC* + *BM* = 24 + 49 or 73 *AM* + *BC* = 47 + 23 or 70	M1 A2,1		3 correct sets of lettered pairs of candidate's vertices 3 correct, 2 correct
	Min = 384 + 70 = 454	A1F B1	 6	PI, 384 plus their shortest **SC** 454 with no working, or 454 with route 2/6 Route without 454 0/6
(ii)	4	B1	1	
	Total		**14**	

MD01 (cont)

Q	Solution	Marks	Total	Comments
5(a)	*S T R I N G S* 64 70 82 80 82 72	M1 m1 A1		Tour starting from any vertex Visits all other vertices only once Correct order
	= 450	B1	4	Note: If solution on a matrix then order of selection of vertices must be clearly shown
(b)	*N G S T R I N* Or reverse	B1F	1	Must have scored M2 in part (a)
(c)	Delete *S*	M1		Clear method: spanning tree (edges or diagram, not just numbers) with one vertex deleted AND adding 2 edges from deleted vertex (condone double shortest edge from deleted vertex)
		B1		Spanning tree with 4 edges (may include *S*)
		A1		Correct MST
	+			
		A1F		2 shortest from candidate's deleted vertex (not shortest edge doubled)
	= 425	A1	5	SC 425 without earning first M1: 2/5
	Total		**10**	

MD01 (cont)

Q	Solution		Marks	Total	Comments
6(a)	$x \geq 190,\ y \geq 50,\ z \geq 50$	oe	B1		
	$x + y + z \geq 300$	oe	B1		
	$2.5x + 2y + 2z \leq 1000$ $(5x + 4y + 4z \leq 2000)$	oe	B1		Strict inequalities: penalise first two instances only
	$x \geq \frac{60}{100}(x + y + z)$ $(2x \geq 3y + 3z)$	oe	B1	4	
(b)(i)	$y = z$ $x \geq 190,\ y \geq 50$				
	$x + 2y \geq 300$	oe	M1		$x + y + y \geq 300$ or $5x + 4y + 4y \leq 2000$ or $2x \geq 3y + 3y$ ie at least one clear line of working showing substitution of $y = z$
	$5x + 8y \leq 2000$ $2x \geq 6y$				
	$\left(y \leq \frac{1}{3}x\right)$	oe	A1	2	AG All correct (3 'or' become 'and')
(ii)					For all lines must be correct to $\frac{1}{2}$ square horizontal or vertical
			B1		$x = 190,\ y = 50$
			B1		through (0,150) and (300,0)
			B1		through (0,250) and (400,0)
			M1		$y = mx$ through (0,0)
			A1		through (300,100)
			B1		Region must have all lines correct and labelled region (condone lack of shading)
			B1	7	A correct objective line

MD01 (cont)

Q	Solution	Marks	Total	Comments
6 (b)(iii)	$P = \frac{1}{2}x + \frac{1}{4}y + \frac{1}{4}z$ *or* $\frac{1}{2}x + \frac{1}{2}y$	M1		PI
	Max at $(320, 50)$	B1		
	Profit $(160 + 25) = £185$	A1		Note: (with no working) £185 3/4
	Buys 320 slow, 50 medium, 50 fast	B1	4	320 slow, 50 medium, 50 fast 2/4 320 slow, 50 medium, 50 fast and £185 4/4
	Total		**17**	

MD01 (cont)

<table>
<tr><th>Q</th><th>Solution</th><th>Marks</th><th>Total</th><th>Comments</th></tr>
<tr><td>7</td><td>
<table>
<tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th></tr>
<tr><td>(1</td><td>4</td><td>0</td><td>4</td><td>0)</td></tr>
<tr><td>3</td><td>–4</td><td>$-\frac{4}{3}$ (awrt –1.33)</td><td>$\frac{8}{3}$ (awrt 2.67)</td><td>0.22404444 (awrt 0.22)</td></tr>
<tr><td>5</td><td>4</td><td>$\frac{4}{5}$</td><td>$\frac{52}{15}$ (awrt 3.5)</td><td>0.10671111 (awrt 0.11)</td></tr>
<tr><td>7</td><td>–4</td><td>$\frac{-4}{7}$ (awrt –0.571)</td><td>$\frac{304}{105}$ (awrt 2.9)</td><td>0.0599 (awrt 0.06)</td></tr>
<tr><td>9</td><td>4</td><td>$\frac{4}{9}$ (awrt 0.444)</td><td>$\frac{1052}{315}$ (awrt 3.34)</td><td>0.03987 (awrt 0.04)</td></tr>
</table>
π is approximately 3.34</td><td>M1
A1
M1
A1
M1
A1</td><td>6</td><td>1st pass to candidate's $\frac{8}{3}$
1st pass all correct to E = 0.22
2nd pass to candidate's $\frac{52}{15}$
2nd pass correct to E = 0.11
3rd pass to candidate's $\frac{304}{105}$
All correct and no extra line
Final answer $\frac{1052}{315}$ or awrt 3.34</td></tr>
<tr><td></td><td>Total</td><td></td><td>6</td><td></td></tr>
</table>

MD01 (cont)

Q	Solution	Marks	Total	Comments
8(a)	Max 5	B1		
	Min 1	B1	2	Do not allow 1° or 5°
(b)	$4x - 12 \geq 1$ (or >0) $\left(x \geq \frac{13}{4}\right)$			
	Or			
	$4x - 12 \leq 5$ (or <6) $\left(x \leq \frac{17}{4}\right)$	M1		Any one of these inequalities
	Or			OR
	$2x - 4 \leq 5$ (or < 6) $x \leq \frac{9}{2}$			Exhaustive check of all values from 1 to 5 inclusive, condone one omission.
	$x = 4$	A1	2	First inequality and one of the other two, or completely correct exhaustive check, and $x = 4$
	<u>Alternative solution</u>			
	Sum of degrees = $11x - 24$ must be even			
	$\Rightarrow x$ is even			
	$x - 2 > 0 \Rightarrow x > 2$	M1		
	$x \leq 5$			
	Hence $x = 4$	A1		
	Total		**4**	
	TOTAL		**75**	