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General Certificate of Education

Mathematics 6360

MD01 Decision 1

Mark Scheme

2009 examination - June series

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.

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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.

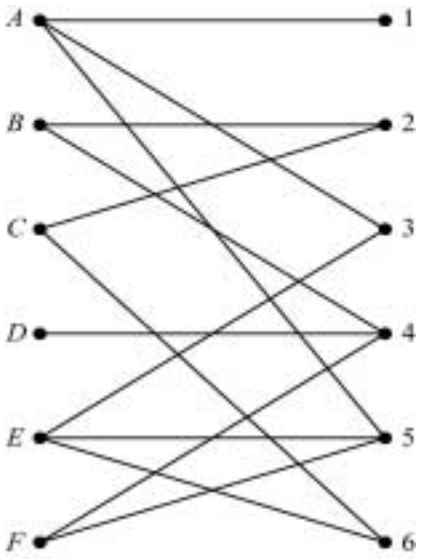
Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn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

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

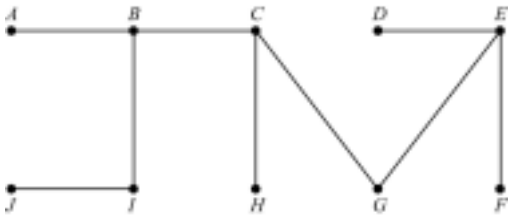
Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

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

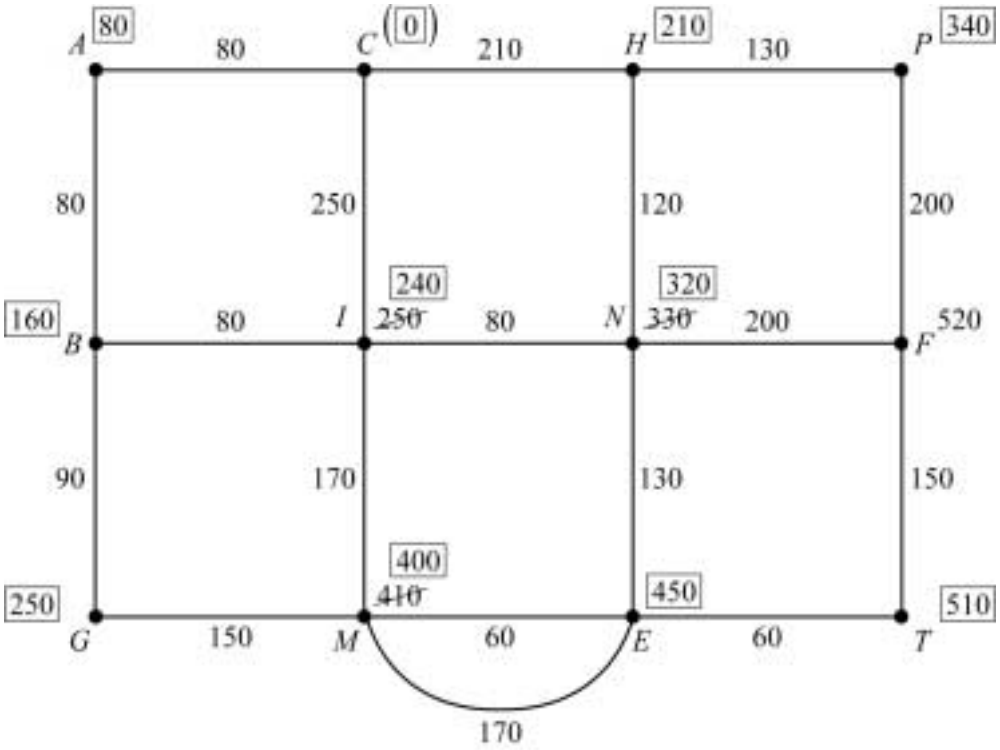
MD01

Q	Solution	Marks	Total	Comments
1(a)		M1 A1	 2	Bipartite graph, 2 sets of (some) vertices labelled, 6+ edges
(b)	$A3$, $B4$, $C2$, $E5$			
	$D-4+B$, $6-C+2$, $6-E+5$ $F-5+E$, $1-A+3$, $F-4+B$	M1 M1		1 correct 1 correct
	$D-4+B-2+C-6$ $F-5+E-3+A-1$ ignore extra paths attempted	A1 A1		Or reverse Or reverse
	OR			
	$F-4+B-2+C-6$ $D-4+F-5+E-3+A-1$ ignore extra paths attempted	(A1) (A1)		Or reverse Or reverse
	$A1$, $B2$, $C6$, $D4$, $E3$, $F5$	B1	5	Must be list, not diagram
	Watch for correct method using unusual notation One continuous path scores M1A1M0 eg $D-4+B-2+C-6+F-5+E-3+A-1$ If working on diagram(s) **only** then max M1A0 M1A0 for each M1: must have start point labelled and a **clear** path (numerically labelled or coloured) of at least left to right to left (or reverse)			
	Total		**7**	

MD01 (cont)

Q	Solution	Marks	Total	Comments
2	<table><tr><th></th><th>C</th><th>S</th></tr><tr><td>1st</td><td>1</td><td>0</td></tr><tr><td>2nd</td><td>2</td><td>2</td></tr><tr><td>3rd</td><td>1</td><td>0</td></tr><tr><td>4th</td><td>4</td><td>3</td></tr><tr><td>5th</td><td>1</td><td>0</td></tr><tr><td>6th</td><td>6</td><td>6</td></tr></table>	B6 (B5) (B4) (B3) (B2) (B1)	6	All 12 correct 10 correct 8 correct 7 correct 6 correct 5 correct Tallies can only score max B2 for three 1s and three 0s (not blanks)
	Total		**6**	
3(a)(i)	9	B1	1	
(ii)	$n - 1$	B1	1	
(b)(i)	*EF* 8 *BC* 8.5 *CG* 10 *JI* 11.5 *BI* 12 *AB* 14 *GE* 16 *CH* 16.5 *DE* 21	M1 A1 A1 B1 A1	5	SCA minimum spanning tree, 7+ **edges** (not cycles), must be in ascending order and edges required (not lengths alone) *BC* 2nd *JI* 4th 9 **edges** (not lengths alone) – may be earned in (b)(iii) All correct
(ii)	117.5	B1	1	
(iii)		M1 A1	2	7+ edges, minimum spanning tree Correct, including labelling
	Total		**10**	

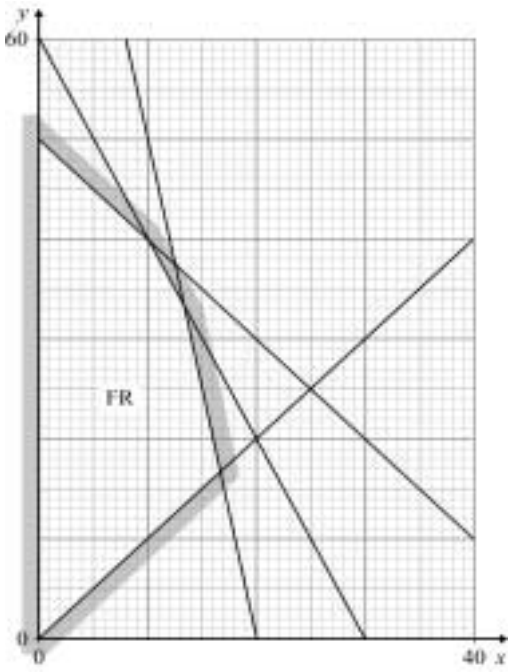
MD01 (cont)

Q	Solution	Marks	Total	Comments
4(a)	Odds B, C, H, F	E1		PI (must be these 4 vertices - CAO)
	$BC + HF = 160 + 320$ or 480 $BH + CF = 280 + 520$ or 800 $BF + CH = 360 + 210$ or 570	M1 A2,1,0		3 sets of pairs A2 for all 3 correct, A1 for 2 correct
	(Total =)(2410 + 480) = 2890	A1F B1	 6	2410 + their shortest pairing (PI) **SC** 2890 with no working or 2890 with one route listed scores 2/6 Route listed not 2890 scores 0/6
(b)				
		M1		SCA; cancelling required at I or N
		m1		2 values at I
		m1		2 values at M
		m1		2 values at N
		A1		All correct – no extra values Condone 520 boxed at F and condone final values at each vertex unboxed
		B1		510 at T (diagram takes precedence over answer book)
	Route $C\ A\ B\ I\ N\ E\ T$	B1	7	Or reverse
	Total		**13**	

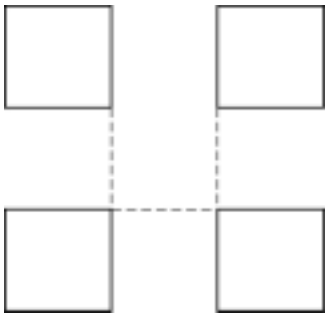
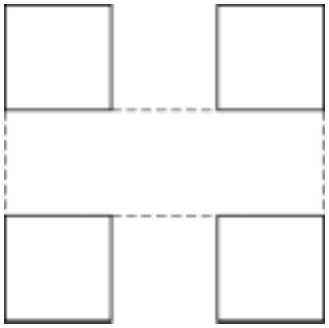
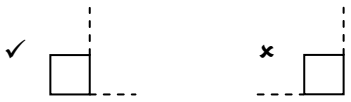
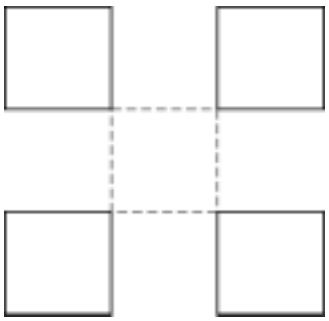
MD01 (cont)

Q	Solution	Marks	Total	Comments
5(a)	eg *A B C D E F A*	M1		Any tour *ABA* or better, any start vertex but not revisiting a vertex May be shown in a labelled diagram of a cycle (eg triangle *ABC*)
		A1	2	With all vertices visited May be shown in a labelled diagram of a cycle
(b)(i)	*F D C A B E F* (20) (15) (5) (25) (15) (15) (= 95) **AG**	M1 m1 A1	3	Any tour, start/finish at *F* Visits all vertices Correct order If solution shown solely on matrix, then order of selection of vertices must be shown
(ii)	Tour	E1		"It's an answer", "a cycle", "it works", "it's possible …"
	<u>May</u> be improved on	E1	2	"Can't be worse", "not necessarily best", "could be improved" Not "can be improved"
(c)	*F E C A B D F*	M1		Tour *FE*(*ABCD* in any order with *B* before *D*)*F*
	(30) (7) (5) (25) (11) (10)	A1		Correct order
	= 88	B1	3	If solution shown solely on matrix, order of selection of vertices must be shown
	Total		**10**	

MD01 (cont)

Q	Solution	Marks	Total	Comments
6				Working must be in x, y and z Equalities can only score M marks Strict inequalities: –1 first error only
(a)	$6x + 4y + 2z \le 240$	M1		
	$3x + 2y + z \le 120$	A1		CAO
	$6x + 3y + 9z \le 300$	M1		
	$2x + y + 3z \le 100$	A1		CAO
	$12x + 18y + 6z \le 900$	M1		
	$2x + 3y + z \le 150$	A1		CAO
	$12x + 18y + 6z \ge 2(6x + 3y + 9z)$	M1		OE
	$y \ge z$	A1	8	**CSO**; OE in simplified form eg $y - z \ge 0$
(b)(i)	$(z = x)$			
	$4x + 2y \le 120$ OE or $3x + 3y \le 150$ OE	M1		Correct unsimplified subst $x = z$ into either of these 2 correct inequs. (seen)
	$4x + 2y \le 120$ OE $\Rightarrow 2x + y \le 60$ **AG** $3x + 3y \le 150$ OE $\Rightarrow x + y \le 50$ **AG**	A1		Both correct and simplified
	$5x + y \le 100$, $y \ge x$ **AG**	A1	3	Correct subst $x = z$ into 4 correct inequs.
(ii)		B1 B1 B1 B1 B1	5	Line 1 correct at (0, 50) (25, 25) Line 2 correct at (10, 50) (20, 0) Line 3 correct at (0, 60) (30, 0) Line 4 correct at (0, 0) (25, 25) Each line correct to $\frac{1}{2}$ square, horizontally or vertically FR, must have all lines correct **and** labelled region (condone no shading)
(iii)	$N = x + y + z = 2x + y$	M1		Stated or PI
	Max = 60	A1	2	CSO; **SC** unsupported 60 scores 2/2
(iv)	10, 40, 10 11, 38, 11	B1		Any correct; may be earned in part (iii)
	12, 36, 12	B1		3 correct
	13, 34, 13	B1	3	4 correct **and** no extras
	Total		**21**	

MD01 (cont)

Q	Solution	Marks	Total	Comments
7(a)(i)		B1	1	OE
(ii)		M1 A1	 2	4 edges OE **Note**: new edges must meet each square at vertices on the opposite ends of a side of the square eg 
(iii)		M1 A1	 2	4 edges Eulerian (all vertices are of even order)
(b)(i)	n odd	B1	1	$(n \pm 1)$ even
(ii)	(Triangle) $n = 3$	B2	2	Triangle, stated or drawn, scores B1
	Total		**8**	
	TOTAL		**75**	