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General Certificate of Education (A-level)
June 2013

Mathematics MD01

(Specification 6360)

Decision 1

Final

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 students' 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 students' 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.

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.

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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

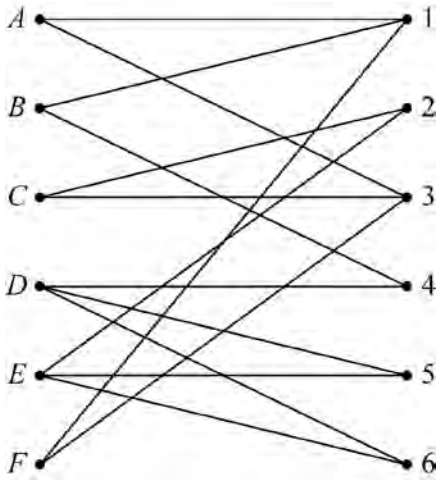
Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded.

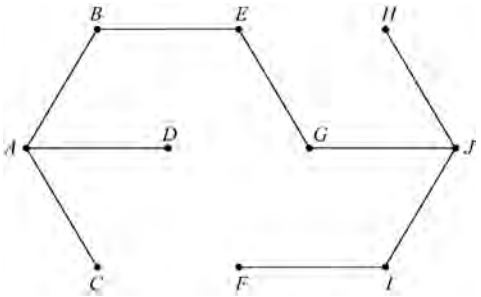
Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn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

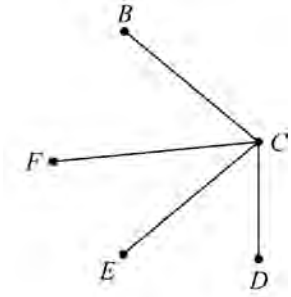
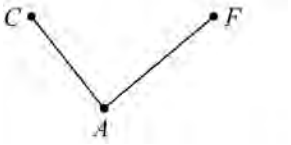
Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

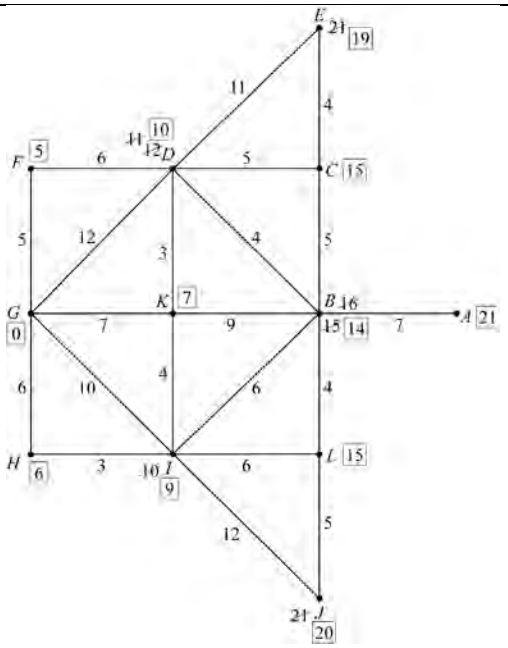
Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

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

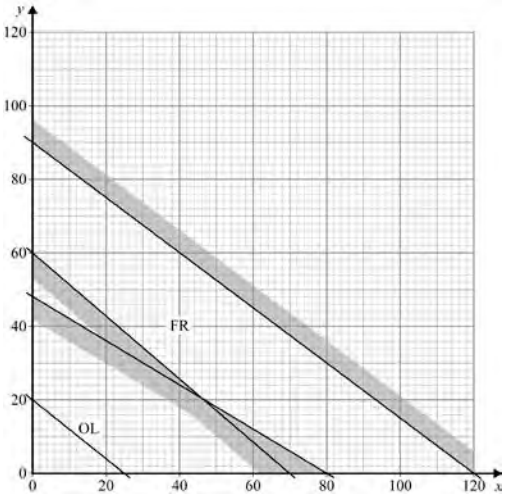
Q	Solution	Marks	Total	Comments
1		M1 A1	 2	Bipartite graph, 2 sets of 6 vertices, at least 12 edges All correct including labelling
(b)	(Missing *A*, *F* / 4, 6) $A-1+B$ or $A-3+C$ $F-1+B$ or $F-3+C$ Correct 1st path Correct 2nd path Match *A*1, *B*4, *C*2, *D*5, *E*6, *F*3	 M1 M1 A1 A1 B1	 5	or $4-B+1$ or $4-D+5$ $6-E+2$ or $6-D+5$ Eg $A-1+B-4$ $F-3+C-2+E-6$ **or** *A*1, *B*4, *C*2, *D*6, *E*5, *F*3 **or** *A*3, *B*4, *C*2, *D*5, *E*6, *F*1 **or** *A*3, *B*4, *C*2, *D*6, *E*5, *F*1
	Total		7	
2(a)	**2** 12 17 18 5 13 2 **12** 17 18 5 13 2 **5** 12 **17** 18 13 2 5 12 **13** 17 **18** (2 5 12 13 17 18)	M1 A1F B1 A1	 4	SCA, using pivots to create sublists Correct 2nd pass Consistent pivots All correct
(b)	(C =)5	B1	1	
	Total		**5**	

Q	Solution	Marks	Total	Comments
3(a)(i)	*EG* 2.3 *AB* 2.5 *IJ* 2.9	M1		SCA, Kruskal's, 1st 3 edges correct, must be edges not lengths, and no cycle in solution
	AC 3.1	B1		9 edges
	AD 3.2 *HJ* 3.4 *GJ* 3.6 *BE* 3.9	A1		*AD* 5th
	FI 5.4	A1		All correct
(ii)	30.3	B1		
(iii)		M1		Spanning tree with 10 vertices and 9 edges.
		A1	7	All correct including labelling
(b)(i)	*FI*	B1		
(ii)	*DA*	B1	2	
	Total		**9**	

Q	Solution	Marks	Total	Comments
4(a)	103	B1	1	
(b)	Tour	E1		
	May be improved	E1	2	
(c)	*A C D F B E A* (11 10 15 15 24 27)	M1		Tour, from A, visiting at least 4 other vertices, once only
		m1		Visits all vertices
		A1		Correct order
	= 102	A1 CSO	4	If M0 scored then 102 scores SC2
(d)		M1		Spanning tree connecting *B, C, D, E, F* AND 2 labelled edges from *A* (for both, edges, not lengths, can be either listed or shown in diagram)
		A1		Correct ST
	+			
		A1		Correct edges from *A*
	= 77	A1 CSO	4	If M0 scored then 77 scores SC2
(e)	Min tour ≥ 77	E1	1	Allow their '77', provided '77'>75
	Total		**12**	

Q	Solution	Marks	Total	Comments
5(a)(i)		M1 A1 A1 m1 A1 B1 A1	 7	SCA, using Dijkstra with 2 or more values at D or I AND one value only at both F and H. Correct values at *D* Correct values at *I* 2 values at *E* and *J* AND 3 values at *B* Correct values at *B, E* and *J* Final value at *A* is 21 All correct, including cancelling and boxing (condone omission of 0 at G)
(ii)	*A B D K G* *E C D K G* *J L I H G*	B1 × 3	3	Do NOT allow reverse order, but if correct in reverse order for all 3 then SC1
(b)(i)	(Odds *A, C, L, G)* *AC* + *LG* = 27 *AL* + *CG* = 26 *AG* + *CL* = 30 Min 134 + 26 = 160	 M1 A1 × 3 m1 A1 CSO	 6	 These 3 sets of pairs stated One mark for each correct total 134 + their min of 3 totals. Must have scored first 5 marks. If M0 scored, then 160 scores SC2
(ii)	4	B1	1	
	Total		**17**	

Q	Solution	Marks	Total	Comments
6(a)(i)				
	A *B* *C* *D* *E* 36 16 2 32 4 16 4 4 16 0 (Print) 4	M1		*A*, *B* correct and value(s) for each of *C*, *D* and *E*
		A1		Correct 1st pass
		A1	3	All correct
(ii)	*A* *B* *C* *D* *E* 11 7 1 7 4 7 4 1 4 3 4 3 1 3 1 3 0 (Print) 1	M1		*A*, *B* correct and value(s) for each of *C*, *D* and *E*
		A1		Correct 1st pass
		A1		Correct 2nd pass
		A1		Correct 3rd pass
		A1	5	All correct
(b)	HCF (of *A* and *B*) oe	E1	1	
	Total		**9**	

Q	Solution	Marks	Total	Comments
7(a)	$6x + 4y + 3z \geq 420$	B1		
	$6x + 6y + 4z \geq 480$ oe	B1		
	$6x + 4y + 4z \leq 720$ oe	B1	3	
(b)(i)	$(y = z)$			
	$6x + 4y + 3y \geq 420 \Rightarrow 6x + 7y \geq 420$	B1		Must see this substitution
	$6x + 10y \geq 480 \Rightarrow 3x + 5y \geq 240$ oe			
	$6x + 8y \leq 720 \Rightarrow 3x + 4y \leq 360$ oe	B1	2	Both other inequalities correct, condone direct substitution into simplified versions of part (a)
(ii)				Accuracy: All lines must be ruled, correct to within ½ square BOTH horizontally and vertically
		B1		Correct at (0, 60) and (70, 0)
		B1		Correct at (0, 48) and (80, 0)
		B1		Correct at (0, 90) and (120, 0)
		B1		FR labelled, MUST have scored previous 3 marks
				Condone omission of shading on axes
		M1		OL, drawn, with gradient –0.8 or –1.25
		A1	6	Gradient –0.8
(iii)	(Max profit =) £480	B1		Including '£'
	120 gold, 0 silver, 0 bronze	B1	2	All 3 must be stated
(c)	(Max profit =) £1080	B1		Including '£'
	0 gold, 90 silver, 90 bronze	B2	3	If B0 scored then B1 for $x = 0$ and $y = 90$, PI
	Total		**16**	
	TOTAL		**75**	