

AQA Maths Decision 1
Mark Scheme Pack
2006-2015



General Certificate of Education

Mathematics 6360

MD01 Decision 1

Mark Scheme

2006 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.

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																																																																	
(b)	Initial A3, B4, C2, E5 $D - 4 + B - 2 + C$ <u>No</u> $D - 5 + E - 3 + A - 1$ Yes Complete A1, B4, C2, D5, E3	B1 M1 A1 B1	4	Starting from D,1 Either Only solution																																																																
Total			6																																																																	
(2)(a)	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="border-right: 1px solid black; padding: 2px;">18</td> <td style="border-right: 1px solid black; padding: 2px;">2</td> <td style="border-right: 1px solid black; padding: 2px;">12</td> <td style="border-right: 1px solid black; padding: 2px;">7</td> <td style="border-right: 1px solid black; padding: 2px;">26</td> <td style="border-right: 1px solid black; padding: 2px;">19</td> <td style="border-right: 1px solid black; padding: 2px;">16</td> <td style="padding: 2px;">24</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 2px;"><u>2</u></td> <td style="border-right: 1px solid black; padding: 2px;"><u>18</u></td> <td style="border-right: 1px solid black; padding: 2px;"><u>12</u></td> <td style="border-right: 1px solid black; padding: 2px;">7</td> <td style="border-right: 1px solid black; padding: 2px;">26</td> <td style="border-right: 1px solid black; padding: 2px;">19</td> <td style="border-right: 1px solid black; padding: 2px;">16</td> <td style="padding: 2px;">24</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 2px;">2</td> <td style="border-right: 1px solid black; padding: 2px;">12</td> <td style="border-right: 1px solid black; padding: 2px;">18</td> <td style="border-right: 1px solid black; padding: 2px;">7</td> <td style="border-right: 1px solid black; padding: 2px;">26</td> <td style="border-right: 1px solid black; padding: 2px;">19</td> <td style="border-right: 1px solid black; padding: 2px;">16</td> <td style="padding: 2px;">24</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 2px;"><u>2</u></td> <td style="border-right: 1px solid black; padding: 2px;"><u>7</u></td> <td style="border-right: 1px solid black; padding: 2px;"><u>12</u></td> <td style="border-right: 1px solid black; padding: 2px;"><u>18</u></td> <td style="border-right: 1px solid black; padding: 2px;"><u>26</u></td> <td style="border-right: 1px solid black; padding: 2px;">19</td> <td style="border-right: 1px solid black; padding: 2px;">16</td> <td style="padding: 2px;">24</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 2px;">2</td> <td style="border-right: 1px solid black; padding: 2px;">7</td> <td style="border-right: 1px solid black; padding: 2px;">12</td> <td style="border-right: 1px solid black; padding: 2px;">18</td> <td style="border-right: 1px solid black; padding: 2px;">26</td> <td style="border-right: 1px solid black; padding: 2px;">19</td> <td style="border-right: 1px solid black; padding: 2px;">16</td> <td style="padding: 2px;">24</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 2px;"><u>2</u></td> <td style="border-right: 1px solid black; padding: 2px;"><u>7</u></td> <td style="border-right: 1px solid black; padding: 2px;"><u>12</u></td> <td style="border-right: 1px solid black; padding: 2px;"><u>18</u></td> <td style="border-right: 1px solid black; padding: 2px;"><u>19</u></td> <td style="border-right: 1px solid black; padding: 2px;"><u>26</u></td> <td style="border-right: 1px solid black; padding: 2px;">16</td> <td style="padding: 2px;">24</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 2px;">2</td> <td style="border-right: 1px solid black; padding: 2px;">7</td> <td style="border-right: 1px solid black; padding: 2px;">12</td> <td style="border-right: 1px solid black; padding: 2px;">16</td> <td style="border-right: 1px solid black; padding: 2px;">18</td> <td style="border-right: 1px solid black; padding: 2px;">19</td> <td style="border-right: 1px solid black; padding: 2px;">26</td> <td style="padding: 2px;">24</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 2px;"><u>2</u></td> <td style="border-right: 1px solid black; padding: 2px;"><u>7</u></td> <td style="border-right: 1px solid black; padding: 2px;"><u>12</u></td> <td style="border-right: 1px solid black; padding: 2px;"><u>16</u></td> <td style="border-right: 1px solid black; padding: 2px;"><u>18</u></td> <td style="border-right: 1px solid black; padding: 2px;"><u>19</u></td> <td style="border-right: 1px solid black; padding: 2px;"><u>24</u></td> <td style="padding: 2px;">26</td> </tr> </table>	18	2	12	7	26	19	16	24	<u>2</u>	<u>18</u>	<u>12</u>	7	26	19	16	24	2	12	18	7	26	19	16	24	<u>2</u>	<u>7</u>	<u>12</u>	<u>18</u>	<u>26</u>	19	16	24	2	7	12	18	26	19	16	24	<u>2</u>	<u>7</u>	<u>12</u>	<u>18</u>	<u>19</u>	<u>26</u>	16	24	2	7	12	16	18	19	26	24	<u>2</u>	<u>7</u>	<u>12</u>	<u>16</u>	<u>18</u>	<u>19</u>	<u>24</u>	26	M1 A1 A1 A1 A1	5	Shuttle SCA 1 st Pass 3 rd Pass 4 th Pass All correct
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(b)	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="border-right: 1px solid black; padding: 2px;">Pass</td> <td style="border-right: 1px solid black; padding: 2px;">C</td> <td style="padding: 2px;">S</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 2px;">1</td> <td style="border-right: 1px solid black; padding: 2px;">1</td> <td style="padding: 2px;">1</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 2px;">2</td> <td style="border-right: 1px solid black; padding: 2px;">2</td> <td style="padding: 2px;">1</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 2px;">3</td> <td style="border-right: 1px solid black; padding: 2px;">3</td> <td style="padding: 2px;">2</td> </tr> </table>	Pass	C	S	1	1	1	2	2	1	3	3	2	B1 B1 B1	3	SC All C correct B1 or all S correct B1 or 6,4 scores B1																																																				
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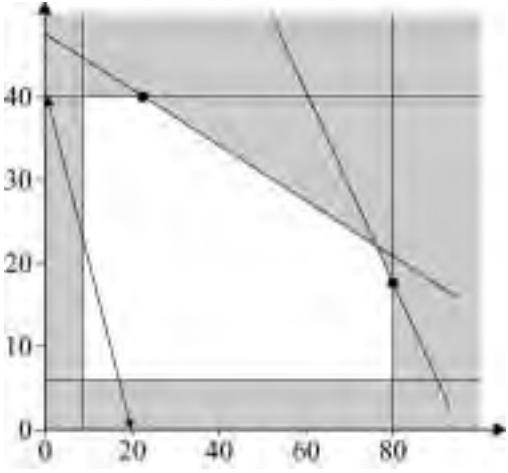
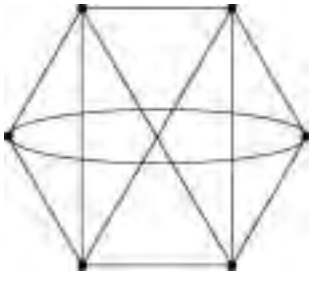
MD01 (cont)

Q	Solution	Marks	Total	Comments
3(a)(i)	<p><i>AB</i> 5 <i>BD</i> 3 <i>DC</i> 1 <i>DE</i> 4 <i>DF</i> 5 <i>FG</i> 6 <i>GI</i> 10 <i>GH</i> 11 <i>HJ</i> 13</p>	<p>M1 B1 A1 A1 B1</p>	5	<p>SCA 9 edges <i>DC</i> 3rd <i>DE</i> 4th All correct</p>
(ii)	58	B1	1	
(b)(i)		<p>M1 M1 A1 M1 A1 B1</p>	6	<p>SCA 3 values at <i>D</i> All correct at <i>D</i> 3 values at <i>G</i> All correct 42 at <i>J</i> – or in script</p>
(ii)	<p>$28 + x < 42$ O.E. $x < 14$ ISW</p>	<p>M1 A1</p>	2	<p>Allow \leq SC $x \leq 13$ B1</p>
Total			14	
4(a)	<p>A, C, D, F odd nodes $AC + DF = 18 + 22 = 40$ $AD + CF = 32 + 30 = 62$ $AF + CD = 12 + 30 = 42$ Repeat AC + DF Total $164 + 40 = 204$</p>	<p>B1 M1 A2,1,0 B1 B1</p>	6	<p>May be implied May be implied</p>
(b)	<p>Start/finish A/C \therefore Repeat DF Total $164 + 22 = 186$</p>	<p>B1 B1</p>	2	<p>Or subtract AC</p>
(c)(i)	<p>Shortest pair AF Distance = $164 + 12 = 176$</p>	<p>B1 B1</p>	2	
(ii)	Start/Finish at C/D	B1	1	May be listed in a route
Total			11	

MD01 (cont)

Q	Solution	Marks	Total	Comments
5(a)(i)	7	B1	1	
(ii)	7	B1	1	
(b)(i)	Missing values (PF 3) any 2 values correct $\left(\text{OT } 3\frac{1}{4}\right)$ other 2 values correct	B1 B1	2	
(ii)	FTPOMF $= 8\frac{1}{4}$ ISW	B1	1	
(iii)	FTMPOF $= 7$	M1 M1 A1 B1	4	Tour Visits all vertices Correct order
(iv)	Delete F Add $1\frac{1}{4} + 2$ $= 6\frac{3}{4}$	M1 A1 A1 m1 A1	5	MST – letters or numbers 3 edges Correct Adding 2 edges from F SC $6\frac{3}{4}$ with no working $\frac{2}{5}$
	Total		14	

MD01 (cont)

Q	Solution	Marks	Total	Comments
6(a)	$10 \leq x \leq 80$ $5 \leq y \leq 40$ $x + y \leq 100$ $20x + 60y \leq 3000$ OE (maximise)(P =) $2x + y$	B1 B1 B1 B1 B1	5	Strict inequalities –1 (or using p, c) May be seen in (b) or (c)
(b)		B1 M1A1 M1A1 B1 B1	7	For “x lines” and “y lines” } For each other line M1– ve gradient (0,50) } M1– ve gradient (100,0) Feasible region correct to within 1 square Objective line
(c)	Max at (80,20) P = £180	M1 A1	2	Considering an extreme point in their region
(d)	$P = x + 4y$ Max at (30, 40) P = £190	M1 A1	2	Using (30,40) (\pm square)
Total			16	
7(a)(i)	$m - 1$	B1	1	
(ii)	$n \geq m - 1$	B2	2	
(b)	$m (= n)$	B1	1	
(c)		M1 A1	2	
Total			6	
TOTAL			75	



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2007 examination - January series

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

MD01

Q	Solution	Marks	Total	Comments
1(a)	<i>AB</i> 5.5	B1		8 edges
	<i>BC</i> 8	M1		SCA
	<i>AI</i> 9	A1		<i>AI</i> 3rd
	<i>BD</i> 13	A1		<i>BD</i> 4th
	<i>DE</i> 9			
	<i>DG</i> 11			
	<i>DF, EF, GF</i> 12			
	<i>IH</i> 16.5	A1	5	All correct
(b)	84	B1	1	
(c)		M1		Minimum spanning tree
		B1		8 edges
		A1	3	All correct including labelling (or including <i>DF</i> or <i>GF</i> instead of <i>EF</i>)
(d)	2	B1	1	
Total			10	

MD01 (cont)

Q	Solution	Marks	Total	Comments
2(a)		M1		Bipartite graph
		A1	2	All correct
(b)	<p>Start with D (or S) $D-U+E-S$ or $D-V+A-R+B-T+C$ $-V+D-U+E-S$</p> <p>Match: AV, BR, CT, DU, ES or AR, BT, CV, DU, ES</p>	B1 M1 A1		For attempt at any path
		B1	4	Must be 5 pairs
	Total		6	
3(a)	$A \quad B \quad C \quad D \quad A$ $8 \quad 13 \quad 17 \quad 26$ $= 64$	M1 A1	2	4 numbers (either part)
(b)	$A \quad D \quad C \quad B \quad A$ $11 \quad 18 \quad 9 \quad 14$ $= 52$	A1	1	
(c)	$A \quad C \quad B \quad D \quad A$ $6 \quad 9 \quad 25 \quad 26$ $= 66$	M1 M1 A1 B1	4	Tour Visits every vertex Correct order
	<p>Alternative if matrix used: M1 3 numbers } all different rows M1 4th number } and columns A1 correct numbers B1 66</p>			
(d)	52 (their lowest of (a), (b), (c))	B1F	1	Allow "part (b)"
	Total		8	

MD01 (cont)

Q	Solution		Marks	Total	Comments	
4(a)	Comparisons	Swaps				
	6	5	B1B1			
	5	3	B1B1			
	4	2	B1			
	3	1	B1	6	Other 3 comparisons Other 3 swaps. Ignore 6 th pass	
2	0					
(b)	21		B1			
	21		B1	2		
Total				8		
5(a)(i)	(A)	(B)	C	D		
	2	3	0	0	M1	SCA: as far as $D = 3$
			2			
			4	3	A1	For 4
			6	6	A1	All correct
	-----	-----	-----	-----		
(ii)	(A)	(B)	C	D		
	6	8	0	0	M1	SCA: as far as $D = 8$
			6	8		
			12	16	A1	For 12
			18	24		
		24		A1	All correct	
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(b)	Find LCM		B1	1	Allow lowest common denominator	
(c)	600		B1	1		
Total				8		

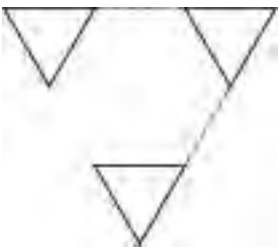
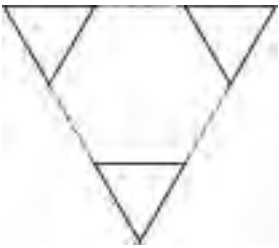
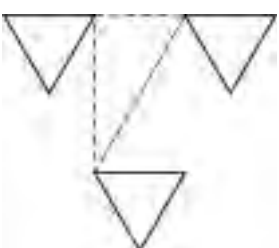
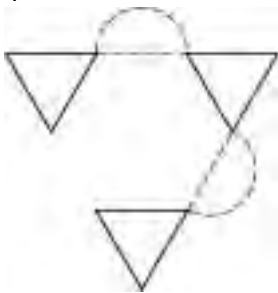
MD01 (cont)

Q	Solution	Marks	Total	Comments
6(a)	$1000x + 500y \leq 9000$ $(2x + y \leq 18)$	B1	1	
(b)	$x \geq 2, y \geq 5$ $y \geq 2x$ $y \leq 3x$	B1 B1 B1	3	} -1 for strict inequalities -1 for 'w's and 'l's
(c)		B1 B1 M1 A1 A1 B1	6	
(d)	Considering an extreme point on their f.r. $x = 4.5$ $y = 9$	M1 A1 A1	3	Extreme point - vertex
Total			13	

MD01 (cont)

Q	Solution	Marks	Total	Comments
7(a)(i)		M1 M1 M1 M1 A1 B1	6	SCA 4 values at <i>I</i> 2 values at <i>M</i> 2 values at <i>O</i> All correct 465 at <i>O</i>
(ii)	CASINO	B1	1	Or ONISAC
(b)(i)	$A \rightarrow M = 255$	B1	1	
(ii)	Odds (<i>C, A, S, M</i>) $CA + SM = 270$ $CS + AM = 390$ $CM + AS = 390$ Min $2280 + 270$ $= 2550$	M1 A3 M1 A1	6	PI (-1 EE) 2280 + their best pairing SC 2/6 for answer 2550 with no working
Total			14	

MD01 (cont)

Q	Solution	Marks	Total	Comments
8(a)(i)	2 	B1 B1	2	OE
(ii)	3 	B1 B1	2	OE
(iii)	3 	B1 B1	2	OE SC 4
				 OE
(b)(i)	n is odd	B1	1	B1(must have number and diagram)
(ii)	3 (only)	B1	1	
	Total		8	
	TOTAL		75	



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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
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SCA	substantially correct approach	dp	decimal place(s)

No Method Shown

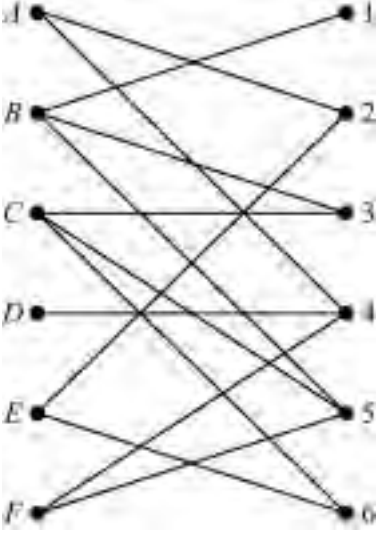
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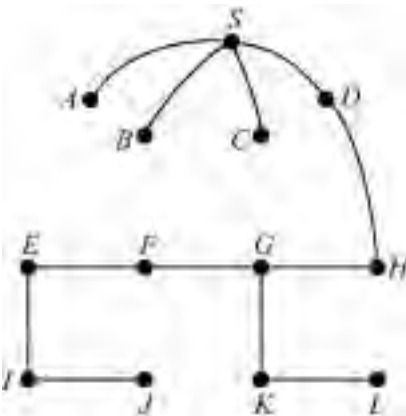
Otherwise we require evidence of a correct method for any marks to be awarded.

MD01											
Q	Solution								Marks	Total	Comments
1(a)									M1 A1	2	
(b)	D can only do 4								E1	1	Cannot be matched to task
(c)	$A - 2 + E - 6 + C - 5$ $D - 4 + F - 5 + C - 3 + B - 1$ Match $A2, B1, C3, D4, E6, F5$								M1A1 M1A1 A1 B1	6	Starting with $A, D, 5, 1$ First pass Second pass All Correct Alt:1 $A - 4 + F - 5$ $D - 4 + A - 2 + E - 6 + C - 3 + B - 1$ Alt: 2 $D - 4 + F - 5$ $A - 2 + E - 6 + C - 3 + B - 1$
Total										9	
2(a)	$\begin{array}{cccccccc} \underline{28} & \underline{22} & \underline{20} & \underline{17} & \underline{14} & \underline{11} & \underline{6} & \underline{5} \\ 14 & & & & 28 & & & \\ & 11 & & & & 22 & & \\ & & 6 & & & & 20 & \\ & & & 5 & & & & 17 \\ \underline{14} & 11 & \underline{6} & 5 & \underline{28} & 22 & \underline{20} & 17 \\ \underline{6} & & 14 & & 20 & & 28 & \\ & 5 & & 11 & & 17 & & 22 \\ 6 & 5 & 14 & 11 & 20 & 17 & 28 & 22 \\ 5 & 6 & 11 & 14 & 17 & 20 & 22 & 28 \end{array}$								M1 M1 A1 M1 A1	5	SCA 4 sublists correct 1 st pass 2 sublists All correct
(b)(i)	4								B1		
(ii)	4								B1	2	
(c)	28								B1	1	
Total										8	

MD01 (cont)

Q	Solution	Marks	Total	Comments
<p>3(a)(i)</p>	 <p>(a)(i) Working back from L 35 at G } 47 at C } 44 at F } B1 × 7 49 at I } 56 at B } 64 at E } 71 at A }</p>	<p>M1 A1 M1 M1 M1 A1 B1</p>	<p>71 7</p>	<p>SCA Correct at F 2 values at G 2 values at J 2 values at H All correct</p>
(ii)	$A B F G K L$	B1	1	
(b)	<p>ADL gives 62 AIL gives 69 $\therefore A$ to D</p>	<p>M1 A1 A1</p>	<p>3</p>	<p>OE OE Either, considering routes ADL or AIL CSO</p>
Total			11	

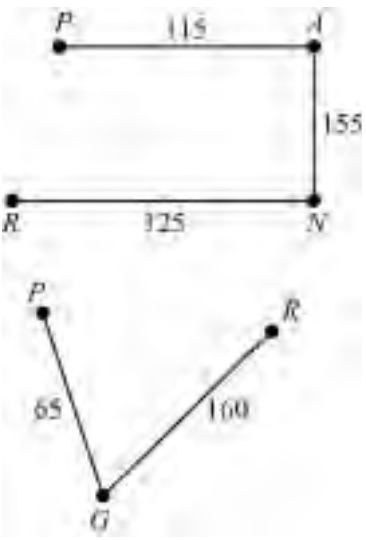
MD01 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	<i>SD</i> 12	M1	5	Prim's (first 4 edges, allow 1 slip)
	<i>SC</i> 13	B1		12 edges
	<i>SA</i> 14			
	<i>SB</i> 16	A1		<i>HG</i> 6 th
	<i>DH</i> 75			
	<i>HG</i> 23			
	<i>GF</i> 22	A1		<i>EI</i> 9 th
	<i>FE</i> 24			
	<i>EI</i> 81	B1		All correct
	<i>IJ</i> 12			
	<i>GK</i> 83	B1	1	
	<i>KL</i> 16			
(ii)	391	B1		
(iii)		M1		MST (10 + edges)
		A1		12 edges
		A1	3	All correct
(iv)	<i>GF</i> 7 th (22)	B1	2	
	<i>HG</i> 8 th (23)	B1		
(b)	Odd vertices (<i>E, H, J, K</i>)	E1		PI
	$EH + JK = 69 + 131 = (200)$	M1		2 correct sets of pairings
	$EJ + HK = 93 + 106 = (199)$	A3,2,		
	$EK + JH = 129 + 142 = (271)$	1,0		
	Repeat $EJ + HK$			
	Total 1135 + 199 = 1334	B1	6	
Total			17	

MD01 (cont)

Q	Solution	Marks	Total	Comments
5(a)	$5x + 10y \leq 1500$ (balloons) $\Rightarrow x + 2y \leq 300$ $32x + 8y \leq 4000$ (sweets) $\Rightarrow 4x + y \leq 500$ $x \geq 50, y \geq 50$, at least 50 of each $x + y \geq 140$, at least 140 in total	E1 E1 E1 E1	4	
(b)(i)		B1 B1 M1 A1 A1 B1 M1 A1	8	$x = 50, y = 50$ $x + y = 140$ Negative gradient (either) $4x + y = 500$ $x + 2y = 300$ Feasible region Objective line drawn
(ii)	Maximum (100, 100) = £200	M1 A1	2	Considering extreme point on their region
(iii)	Minimum (90, 50) = £132	M1 A1	2	Considering extreme minimum point on their region
	Total		16	

MD01 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	$G \rightarrow P \rightarrow A \rightarrow N \rightarrow R \rightarrow G$ 65 115 155 125 160 Total = 620	M1 M1 A1 B1	4	Tour Visits all places Correct order
(ii)	 <p> $LB = 395 + 225 = 620$ </p>	M1 m1 A1 m1 A1	5	SCA (MST + extra edge(s)) MST 2 edges from G
(iii)	$T = 620$	E1F		Their (a)(ii) $\leq T \leq$ their (a)(i) where (a)(i) \geq (a)(ii)
(b)(i)	92	B1	1	
(ii)	87	B1	1	
(iii)	6	B1	1	
(iv)	$n!$	B1	1	
	Total		14	
	TOTAL		75	



General Certificate of Education

Mathematics 6360

MD01 Decision 1

Mark Scheme

2008 examination - January series

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Set and published by the Assessment and Qualifications Alliance.

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
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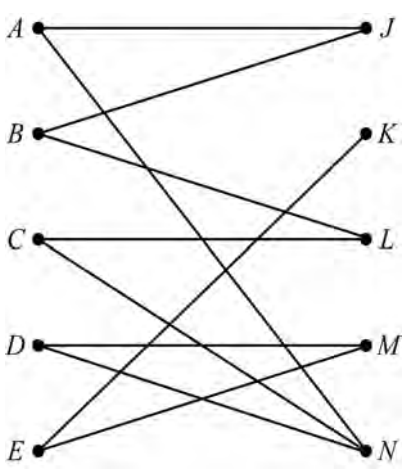
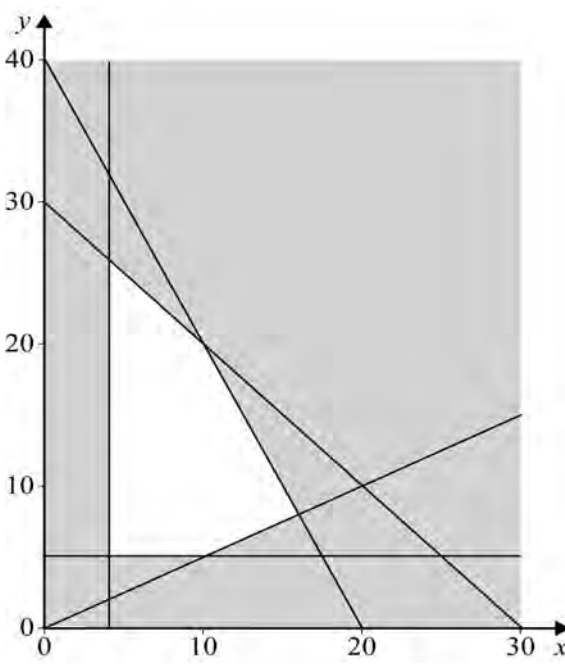
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MD01

Q	Solution	Marks	Total	Comments
<p>1(a)</p> 		<p>M1 A1</p>	<p>2</p>	<p>Bipartite graph All correct</p>
	<p>(b) $D - M (+) E - K$</p> <p>Match: AN, BJ, CL, DM, EK</p>	<p>M1 A1 B1</p>	<p>3</p>	<p>Attempt at path $D - M +$ SC: $K - E + M - D$ B1</p>
Total			5	
<p>2(a)</p> 	<p>(b)(i) Max at $(16, 8) = 56$</p> <p>(ii) Max at $(4, 26) = 82$</p>	<p>B1 B1 B1 B1 B1</p> <p>M1 A1</p> <p>M1 A1</p>	<p>5</p> <p>2</p> <p>2</p>	<p>$y = 5, x = 4$ $x + y = 30$ $2x + y = 40$ $y = \frac{1}{2}x$ feasible region CAO</p> <p>Extreme point within $\frac{1}{2}$ square of their region</p> <p>Extreme point within $\frac{1}{2}$ square of their region</p>
Total			9	

MD01 (cont)

Q	Solution	Marks	Total	Comments
3(a)	<p>DF 1.2</p> <p>IH 1.8</p> <p>BC 2.1</p> <p>AJ or 2.2</p> <p>EF 2.4</p> <p>HG 2.6</p> <p>GF 2.7</p> <p>AB 2.8</p> <p>JI 2.9</p>	B1 M1 A1 A1 A1	5	9 edges SCA AJ 4 th HG 6 th All correct
(b)	20.7	B1	1	
(c)		M1 A1	2	MST – connected (7+ edges)
(d)	EF (or 2.4)	M1 A1	2	for BC, DF, EF
Total			10	
4(a)(i)		M1 m1 m1 m1 A1 B1	6	<p>Reverse</p> <p>SCA SCA</p> <p>3 values at F 2 or 3 values at F</p> <p>2 values at I 1 or 2 values at C</p> <p>3 values at J 2 values at A</p> <p>All correct</p> <p>46 at K</p>
(ii)	Route ABEIK	B1	1	Allow KIEBA
(b)	<p>Consider A, D, K, H</p> <p>$AD + KH = 27 + 30 = 57$</p> <p>$AH + DK = 20 + 20 = 40$</p> <p>$AK + DH = 46 + 40 = 86$</p> <p>Total: $308 + 40 = 348$</p>	B1 M1 A2,1,0 B1	5	PI
Total			12	

MD01 (cont)

Q	Solution	Marks	Total	Comments																										
5(a)(i)	40	B1	1																											
(ii)	40	B1	1																											
(b)	$45 \leq T \leq 55$	B1	1																											
(c)(i)	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th style="width: 15%;"></th> <th style="width: 15%;"><i>A</i></th> <th style="width: 15%;"><i>B</i></th> <th style="width: 15%;"><i>C</i></th> <th style="width: 15%;"><i>D</i></th> </tr> </thead> <tbody> <tr> <th style="text-align: left;"><i>A</i></th> <td>-</td> <td>20</td> <td>38</td> <td>35</td> </tr> <tr> <th style="text-align: left;"><i>B</i></th> <td>20</td> <td>-</td> <td>18</td> <td>15</td> </tr> <tr> <th style="text-align: left;"><i>C</i></th> <td>38</td> <td>18</td> <td>-</td> <td>33</td> </tr> <tr> <th style="text-align: left;"><i>D</i></th> <td>35</td> <td>15</td> <td>33</td> <td>-</td> </tr> </tbody> </table>		<i>A</i>		<i>B</i>	<i>C</i>	<i>D</i>	<i>A</i>	-	20	38	35	<i>B</i>	20	-	18	15	<i>C</i>	38	18	-	33	<i>D</i>	35	15	33	-	B1	2	3 indep correct All correct
	<i>A</i>	<i>B</i>	<i>C</i>		<i>D</i>																									
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<i>B</i>	20	-	18	15																										
<i>C</i>	38	18	-	33																										
<i>D</i>	35	15	33	-																										
(ii)	$A \quad B \quad D \quad C \quad A$ $20 \quad 15 \quad 33 \quad 38$ $\quad \quad \quad = 106$	M1 A1 B1	3	Tour or visits all Correct order or their 33																										
(iii)	$A \quad B \quad D \quad B \quad C \quad B \quad A$	M1 A1	2	Any expansion on (c)(ii) Correct																										
Total			10																											

MD01 (cont)

Q	Solution								Marks	Total	Comments
6(a)(i)	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>K</i>	<i>N</i>	<i>X</i>	<i>Y</i>	M1	4	SCA Must use at least 3 variables
	1	-6	11	-6	1	0	1	0	A1		1 st pass
					2	1	2	0	A1		2 nd pass
					3	2	3	0	A1		
					3	3	3	0	A1		All correct
					1	0	1	(0)	M1		1 st pass Must use at least 3 variables
					2	1	2	6	A1		2 nd pass
					3	3	3	4	A1		3 rd pass
					4	4	4	0			
					5	2	5	0			
(b)	Line 90				3				A1	4	All correct
	Never ending or $N \neq 3$								B1 B1	2	
Total										10	

MD01 (cont)

Q	Solution	Marks	Total	Comments
7(a)	1 – Shuttle	B1	3	For one correct
	2 – Shell	B1		For a second one correct
	3 – Quick	B1		For all correct
	4 – Bubble			
(b)	Solution Comparisons Swaps			
	1 1 1	B1, B1	8	Tallies: max 6/8
	2 2 1	B1, B1		
	3 3 3	B1, B1		
	4 3 3	B1, B1		
Total		11		
8	$\left. \begin{array}{l} 2x+4y+3z \leq 360 \\ 3x+2y+4z \leq 270 \\ x+3y+5z \leq 450 \end{array} \right\}$	M1	8	Any correct LHS in inequality
		A2,1,0		OE
		M1		Allow further correct simplification
	A1			
	$6x+9y+12z \geq 720$ $\Rightarrow 2x+3y+4z \geq 240$	M1		Must have 3 parts correct
$2x+4y+3z \geq \frac{2}{5}(6x+9y+12z)$	A1			
$2y \geq 2x+9z \quad \text{OE}$	A1	Allow further correct simplification		
	Total		8	
	TOTAL		75	



General Certificate of Education

Mathematics 6360

MD01 Decision 1

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2008 examination - June series

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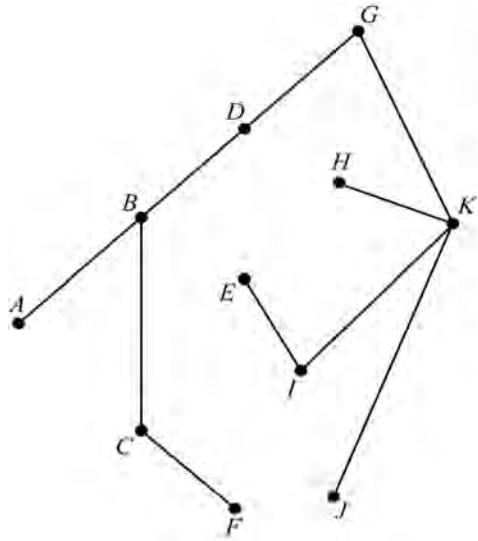
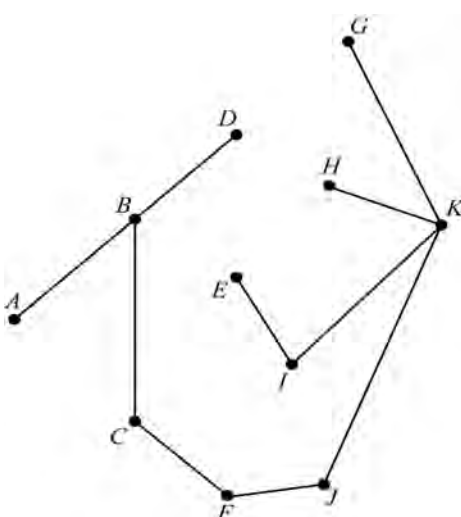
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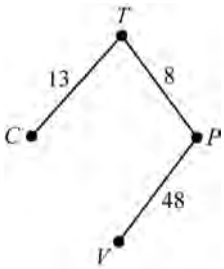
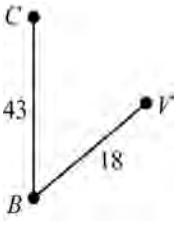
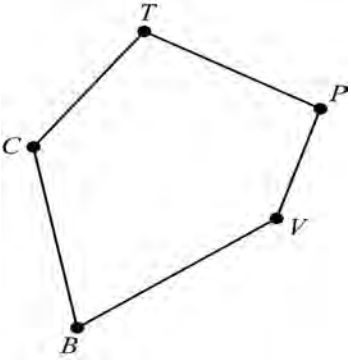
Otherwise we require evidence of a correct method for any marks to be awarded.

MD01					
Q	Solution	Marks	Total	Comments	
1(a)		M1		Bipartite graph: 2 sets of vertices with at least one edge	
		A1	2	All correct	
(b)	<p>A3, B4, C2, E5</p> <p>Start from D, F or 1, 6</p> <p>Accept paths in reverse order $D - 4 (+) B - 2 (+) C - 6$ $F - 5 (+) E - 1$ or $F - 4 (+) B - 2 (+) C - 6$ $D - 4 (+) F - 5 (+) E - 1$</p> <p>Match: A3, B2, C6, D4, E1, F5</p>	M1 M1		Initial match 1st path } must go beyond 2nd 2nd path } letter/number eg $D - 4 (+) B / F$ If working is only on diagram, the path(s) must be clear , and only 1 path per diagram can be credited. If 2 paths shown on one diagram, max mark M1A1	
		A1 A1		1st correct path 2nd correct path or $F - 5 (+) E - 3 (+) A - 6$ $D - 4 (+) B - 2 (+) C - 6 (+) A - 3 (+) E - 1$	
		B1	5	Must be clearly stated or indicated	
Total			7		
2(a)	<p><u>P</u> B M N J K R D</p> <p><u>B</u> M N J K D <u>P</u> <u>R</u></p> <p><u>B</u> <u>M</u> N J K D <u>P</u> <u>R</u></p> <p><u>B</u> <u>J</u> K D <u>M</u> N <u>P</u> <u>R</u></p> <p><u>B</u> <u>D</u> <u>J</u> <u>K</u> <u>M</u> <u>N</u> <u>P</u> <u>R</u></p>	M1 A1 A1 A1		Using quick sort First pass (based on their pivot) A correct third pass All passes correct	
		B1	5	Consistent pivots clearly labelled (at least three passes)	
(b)(i)	28	B1	1		
(ii)	In reverse order	B1	1	Allow descending	
Total			7		

MD01 (cont)

Q	Solution	Marks	Total	Comments
3(a)(i)	10	B1	1	
(ii)	$n - 1$	B1	1	
(b)	Condone candidates attempting all of part (b) together / in different order			
(i)	<p><i>AB</i></p> <p><i>BC</i></p> <p><i>BD</i></p> <p><i>CF</i></p> <p><i>DG</i> or <i>FJ</i></p> <p><i>GK</i> <i>JK</i></p> <p><i>KJ</i> <i>GK</i></p> <p><i>KH</i> or <i>KI</i></p> <p><i>KI</i> <i>IE</i></p> <p><i>EI</i> <i>KH</i></p>	<p>M1</p> <p>A1</p> <p>A1</p> <p>A1</p> <p>B1</p>	<p>5</p>	<p>Using Prim's</p> <p><i>BD</i> 3rd</p> <p><i>CF</i> 4th</p> <p>All correct</p> <p>10 edges</p>
(ii)	(Length =) 155	B1	1	
(iii)		<p>M1</p> <p>A1</p>	<p>2</p>	<p>Spanning tree with at least 8 edges</p> <p>Any cycle scores M0</p> <p>Correct and labelled</p> <p>Alternative: <i>FJ</i> instead of <i>DG</i>:</p> 
Total			10	

MD01 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	130	B1	1	$\begin{pmatrix} T & P & V & B & C & T \\ 8 & 48 & 18 & 43 & 13 \end{pmatrix}$
(ii)	$\begin{matrix} T & P & C & B & V & T \\ 8 & 18 & 43 & 18 & 51 & \end{matrix}$ $= 138$	M1 M1 A1 B1	4	Tour (vertices or edges) starting from T (Letters not numbers) Visits all vertices starting from T Correct order
(iii)	A possible solution, eg tour May be improved on	E1 E1	2	OE Allow 'can' in this case as (i) < (ii) OE
(b)(i)	<p>PT, CT, PV</p>  <p>+ 2 shortest from B</p>  <p>(Lower bound =) 130</p>	M1 A1 m1 A1 A1	5	Spanning tree with 3 edges Correct 2 edges from B Correct CSO
(ii)	May not exist Cannot be lowered	E1 E1	2	OE OE
(c)	 <p>Tour or optimum or same as (a)(i)</p>	B1 E1	2	Lower bound = Upper bound
Total			16	

MD01 (cont)

Q	Solution	Marks	Total	Comments
5(a)	Odds A, B, C, D	M1		PI (but A, B, C, D must be mentioned)
		m1		Considering 3 sets of pairings of odd vertices, eg AB with CD etc
	$\left. \begin{aligned} AB + CD &= 270 + 270 = 540 \\ AC + BD &= 290 + 290 = 580 \\ AD + BC &= 260 + 270 = 530 \end{aligned} \right\}$	A2,1,0		A1 for 2 correct, A2 for all correct
	Repeat AD, BC	A1F		Follow through their shortest pairing PI by adding 530 to 1920 Or $AEHD$ or $DHEA$ and $BFGC$ or $CGFB$ listed in any route
	(Length = $1920 + 530 =$) 2450 (metres)	B1	6	
(b)	Repeats BC	E1		PI by $BFGC$ or $CGFB$ listed in a complete route or adding 270 / subtracting 260
	(Length = $1920 + 270 =$) 2190 (metres)	B1	2	$2450 - 260 = 2190$ (2190 with no evidence scores E0B1)
(c)(i)	Min. repeat AD	E1		PI by $AEHD$ or $DHEA$ listed in a complete route or adding 260 / subtracting 270
	(Length = $1920 + 260 =$) 2180 (metres)	B1	2	$2450 - 270 = 2180$ (2180 with no evidence scores E0B1)
(ii)	B, C	B1	1	Condone start at B , finish at C (or reverse)
	Total		11	

MD01 (cont)

Q	Solution	Marks	Total	Comments
6(a)	<p>All inequalities must be as below</p> <p>$x \leq 100, y \leq 80$</p> <p>$x + y \geq 60$</p> <p>$x < y$</p> <p>$2x + 8y \geq 320$</p> <p>(minimise $C =$) $1.5x + 3y$</p>	<p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p>	<p>5</p>	<p>Both</p> <p>OE</p>
(b)		<p>B1</p> <p>$B1 \times 3$</p> <p>B1</p> <p>B1</p>	<p>6</p>	<p>$x = 100, y = 80$ } within $\frac{1}{2}$ square</p> <p>Other lines } from (0,0) to (80,80)</p> <p>Feasible Region CAO (must have scored B4 for drawing lines) (condone $x = y$ as solid line)</p> <p>An Objective Line with gradient -0.5</p>
(c)	<p>Considering an extreme point in their region</p> <p>Min at intersect of $x + y = 60$ $x + 4y = 160$</p> <p>Considering a pair of integer values where $26 \leq x \leq 28, 32 \leq y \leq 34$</p> <p>($C =$) £141 at (26, 34) or £141 at (28, 33)</p>	<p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p>	<p>4</p>	<p>PI by indication on diagram or</p> <p>$x = 26\frac{2}{3} \quad y = 33\frac{1}{3}$</p>
Total			15	

MD01 (cont)

Q	Solution	Marks	Total	Comments
7(a)		<p>M1 A1 M1 M1 A1 B1 M1 A1 A1</p>	<p>6 3</p>	<p>SCA; cancelling at 2 (or more) vertices Correct at D 2 values at E 2 values at G All correct (condone 0 missing at A and missing expressions in x and y at H) Accept 43 at H Obtaining a pair of equations in this form or $(22) + 2x + y = (43)$ and $(22) + 3x - 2y = (43)$ $2x + y = 21$ and $3x - 2y = 21$ CAO CAO NMS: both correct M1A2 one/none correct M0A0</p>
	Total		9	
	TOTAL		75	

(Min =) 43

(b) $2x + y = p$
 $3x - 2y = q$

$x = 9$
 $y = 3$



General Certificate of Education

Mathematics 6360

MD01 Decision 1

Mark Scheme

2009 examination - January 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.

Further copies of this Mark Scheme are available to download from the AQA Website: www.aqa.org.uk

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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**.

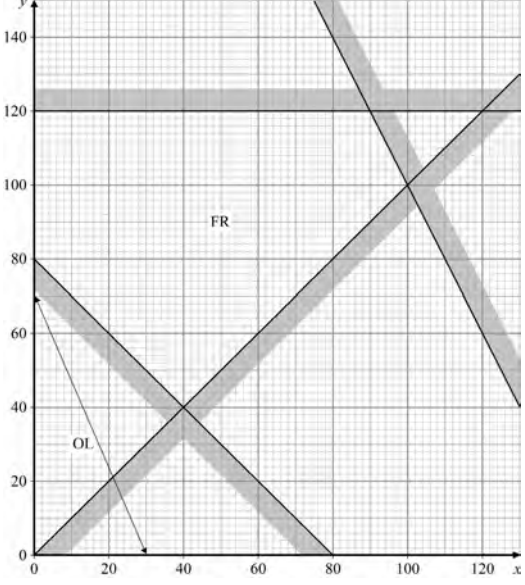
Otherwise we require evidence of a correct method for any marks to be awarded.

MD01																																																																																																							
Q	Solution	Marks	Total	Comments																																																																																																			
1(a)	<p> <i>GH</i> (5) <i>GE</i> (7) <i>HJ</i> (8) <i>BE</i> (10) <i>BD</i> (11) <i>IH</i> (14) <i>DC</i> (15) <i>AC</i> (6) <i>FJ</i> (19) <i>HK</i> (22) </p>	M1 B1 A1 A1 A1 A1	6	<p>SCA allow Prim's from any vertex but not Kruskal or path – min of 8 edges</p> <p>10 edges <i>HJ</i> 3rd <i>BE</i> 4th</p> <p><i>AC</i> 8th</p> <p>All correct</p>																																																																																																			
(b)	117	B1	1																																																																																																				
(c)	<p>(Possibly shown in part (a))</p>	M1 A1 A1	3	<p>MST (8+ edges)</p> <p>10 edges</p> <p>All correct (+ vertices labelled)</p>																																																																																																			
Total			10																																																																																																				
2(a)	<p>Labelled 6 × 6 matrix with '1's</p> <table border="1" style="display: inline-table; vertical-align: middle;"> <tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr> <tr><td>A</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>B</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>C</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>D</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td></tr> <tr><td>E</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td></tr> <tr><td>F</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td></tr> </table>		1	2	3	4	5	6	A	0	1	0	0	0	0	B	1	1	1	0	0	0	C	1	1	0	0	0	0	D	0	0	0	1	0	1	E	0	0	0	1	1	0	F	0	0	0	0	1	0	M1		<p>Must have '1's not '✓'s</p> <p>Or</p> <table border="1" style="display: inline-table; vertical-align: middle;"> <tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>2</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>3</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>4</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td></tr> <tr><td>5</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr> <tr><td>6</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td></tr> </table> <p>OE</p> <p>Must have '0's not '-'s or blank</p>			A	B	C	D	E	F	1	0	1	1	0	0	0	2	1	1	1	0	0	0	3	0	1	0	0	0	0	4	0	0	0	1	1	0	5	0	0	0	0	1	1	6	0	0	0	1	0	0
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(b)	<p>$A - 2 + C - 1 + B - 3$</p> <p>$F - 5 + E - 4 + D - 6$</p> <p>Match: A2, C1, B3, F5, E4, D6</p>	M1 A1 M1 A1 B1	5	<p>$A - 2 + C$ or $3 - B + 1$</p> <p>$F - 5 + E$ or $6 - D + 4$</p> <p>If working on diagram: Only one path on each half M1A1M1A1 as above – start point must be shown, otherwise M0</p>																																																																																																			
Total			7																																																																																																				

MD01 (cont)

Q	Solution	Marks	Total	Comments
<p>3(a)(i)</p>	<p>Alternative if working from <i>H</i>: $H \overline{0}, A \overline{10}, B \overline{23} \overline{21}, F \overline{25} \overline{24}, C \overline{29},$ $D \overline{36} \overline{35} \overline{34}, G \overline{20}, E \overline{30} \overline{29} \overline{27}$</p>	<p>M1 A1 m1 A1 m1 A1</p> <p>6</p> <p>(M1) (A1) (m1) (A1) (m1) (A1)</p> <p>B1</p> <p>B1</p> <p>E1 M1 A2,1,0</p> <p>A1F B1</p>	<p>6</p> <p>1</p> <p>1</p> <p>6</p>	<p>Cancelling at at least 2 vertices Correct at <i>F</i> 2 different values at <i>B</i> Correct at <i>G</i> – depends only on M1 4 different values at <i>H</i> All correct – no extra values</p> <p>SCA Correct at <i>B</i> 2 values at <i>F</i> Correct at <i>E</i> 2 or 3 values at <i>D</i> All correct</p> <p>Or reverse</p> <p>PI 3 sets of pairs</p> <p>167 + their shortest pairing</p>
	Total		14	

MD01 (cont)

Q	Solution	Marks	Total	Comments
4(a)	$x + y + z \geq 110$ $y \geq x$ $y + z \leq 150$ $16x + 8y + 24z \leq 3120$ ISW $(2x + y + 3z \leq 390)$ $(P =) 70x + 30y + 50z$	B1 B1 B1 B1	5	-1 for strict inequalities (max) -1 for using g, p, s instead of x, y, z (max)
(b)(i)	$z = 30$ $x + y \geq 80$ (or $x + y + 30 \geq 110$) $(y \geq x)$ $y \leq 120$ (or $y + 30 \leq 150$) $2x + y \leq 300$ (or $2x + y + 90 \leq 390$ OE) $(P = 70x + 30y + 1500)$	M1 A1	2	Justify by correctly substituting into at least one of their inequalities Correctly substituting into all 3 inequalities AG
(ii)		B1 B1 B1 M1 A1 B1 M1 A1	8	$y = 120$ $x + y = 80$ $y = x$, correct at (40, 40) and (100, 100) $2x + y = 300$, -ve gradient with one correct point in the interval $80 \leq x \leq 120$ Correct at (100, 100) and (90, 120) Correct region labelled OL: gradient of $-\frac{7}{3}$ or $-\frac{3}{7}$ Gradient = $-\frac{7}{3}$
(iii)	Considering (90, 120) and/or (100, 100) (£) 11500 100 goats, 100 pigs, 30 sheep	M1 A1 A1	3	Ignore other points being considered CAO
Total			18	

MD01 (cont)

Q	Solution	Marks	Total	Comments																																																																																																																																																																						
5	<table style="border: none; width: 100%; text-align: center;"> <tr> <td style="border: none;">A</td><td style="border: none;">B</td><td style="border: none;">C</td><td style="border: none;">D</td><td style="border: none;">E</td><td style="border: none;">F</td><td style="border: none;">G</td><td style="border: none;">H</td><td style="border: none;"></td><td style="border: none;"></td><td style="border: none;"></td> </tr> <tr> <td style="border: none;">1</td><td style="border: none;">3</td><td style="border: none;">0</td><td style="border: none;"></td><td style="border: none;">1</td><td style="border: none;">2</td><td style="border: none;">0</td><td style="border: none;"></td><td style="border: none;"></td><td style="border: none;"></td><td style="border: none;"></td> </tr> <tr> <td style="border: none;"></td><td style="border: none;"></td><td style="border: none;"></td><td style="border: none;"></td><td style="border: none;"></td><td style="border: none;"></td><td style="border: 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style="border: none;">2.007</td><td style="border: none;">A1</td><td style="border: none;"></td> </tr> <tr> <td style="border: none;"></td><td colspan="10" style="border: none;">$\left(\sqrt{2} \text{ is approximately } \frac{17}{12}\right)$</td> </tr> </table>	A	B	C	D	E	F	G	H				1	3	0		1	2	0											1.5							7					2.25				3												7					5								2				1.4							5					1.96					17							A1		7									M1			17					12								5											12					1.416											2.007	A1			$\left(\sqrt{2} \text{ is approximately } \frac{17}{12}\right)$										M1 A1 M1 A1 M1 A1		6	<p>Condone equivalent fractions</p> <p>SCA – finding a value for <i>G</i> 1st pass <i>G, H</i> correct 2nd pass – finding a new value for <i>C</i></p> <p>All correct on pass 3rd pass <i>C = 17</i> or their (<i>2B+A</i>)</p> <p>AWRT 1.417 All correct (allow 2.005 to 2.008) and no further passes</p>
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	$\left(\sqrt{2} \text{ is approximately } \frac{17}{12}\right)$																																																																																																																																																																									
Total				6																																																																																																																																																																						
6(a)	<p>Min MST = 8 + 10 + 10 + 11 = 39</p>	M1 A1		2	4 edges																																																																																																																																																																					
(b)	<p>Max MST = 8 + 17 + 17 + 18 = 60</p>	M1 A1		2	8 + 18 + 2 others																																																																																																																																																																					
(c)		M1 A1 A1		3	<p>Connected graph with 5 vertices (all edges numbered, from <i>G</i>)</p> <p>MST = 53 8, 11, 17, 17 or 8, 10, 17, 18</p> <p>other edges OE</p> <p>(other possibilities not shown) (all edges numbered, from <i>G</i>)</p>																																																																																																																																																																					
Total				7																																																																																																																																																																						

MD01 (cont)

Q	Solution	Marks	Total	Comments
7(a)(i)	$2x - 4 < x + 6$ $\therefore x < 10$	M1 A1 CSO	2	$2x - 4 <$ AG
(ii)	$2x - 4 < 3x - 7$ OE $2x - 4 < 4x - 14$ OE $\left(\begin{array}{l} = x > 3 \\ x > 5 \end{array} \right)$	B1 B1	2	Allow any expression in matrix > 0 Allow any expression in matrix > 0
(b)(i)	$2x - 1 <$ $2x - 1 < 3x - 7$ $2x - 1 < x + 8$	M1 A1 A1	3	Condone \leq for method mark only
(ii)	$\Rightarrow (x > 6)$ $x < 9$ $2x - 2 < 3x - 9$ $x > 7$ $x = 8$	B1 M1 A1 B1	4	Possibly earned in (b)(i) Condone \leq for method mark only
(iii)	A C D E B A 12 15 14 17 14 $= 72$	M1 A1	2	$8x + 8$ with their integer x CAO (unsupported 72 scores M0A0)
	Total		13	
	TOTAL		75	



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.

Further copies of this Mark Scheme are available to download from the AQA Website: www.aqa.org.uk

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Set and published by the Assessment and Qualifications Alliance.

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
A _{2,1}	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)	<p>$A3, B4, C2, E5$</p> <p>$D-4+B, 6-C+2, 6-E+5$ $F-5+E, 1-A+3, F-4+B$</p> <p>$D-4+B-2+C-6$ $F-5+E-3+A-1$ ignore extra paths attempted</p> <p>OR</p> <p>$F-4+B-2+C-6$ $D-4+F-5+E-3+A-1$ ignore extra paths attempted</p> <p>$A1, B2, C6, D4, E3, F5$</p>	M1 M1 A1 A1 (A1) (A1)	5	1 correct 1 correct Or reverse Or reverse Or reverse Or reverse Must be list, not diagram
<p>Watch for correct method using unusual notation</p> <p>One continuous path scores M1A1M0 eg $D-4+B-2+C-6+F-5+E-3+A-1$</p> <p>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)</p>				
Total			7	

MD01 (cont)

Q	Solution	Marks	Total	Comments
2				
		C	S	
	1 st	1	0	
	2 nd	2	2	
	3 rd	1	0	
	4 th	4	3	
	5 th	1	0	
	6 th	6	6	
	Total		6	
3(a)(i)	9	B1	1	
(ii)	$n - 1$	B1	1	
(b)(i)	$\begin{array}{l} EF \\ BC \\ CG \\ JI \\ BI \\ AB \\ GE \\ CH \\ DE \end{array} \left(\begin{array}{l} 8 \\ 8.5 \\ 10 \\ 11.5 \\ 12 \\ 14 \\ 16 \\ 16.5 \\ 21 \end{array} \right)$	M1		SCA minimum spanning tree, 7+ edges (not cycles), must be in ascending order and edges required (not lengths alone) BC 2 nd JI 4 th
		A1		
		A1		
		B1		
		A1	5	
		A1	5	
		A1	5	
(ii)	117.5	B1	1	
(iii)		M1		7+ edges , minimum spanning tree Correct, including labelling
		A1	2	
	Total		10	

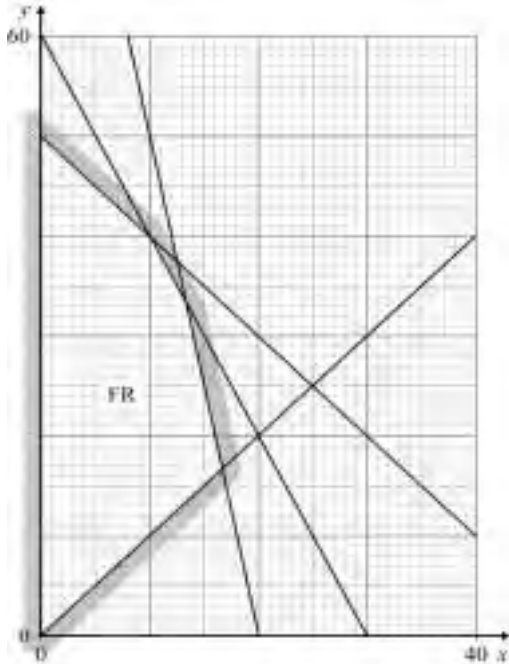
MD01 (cont)

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

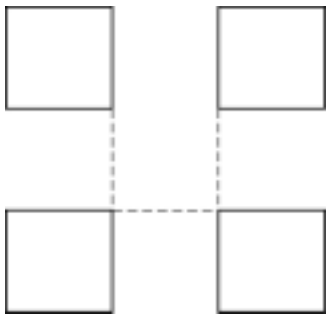
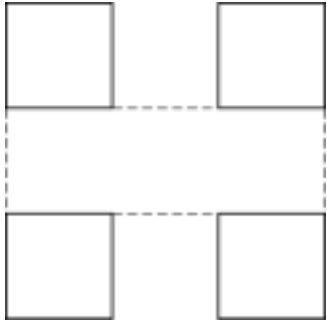
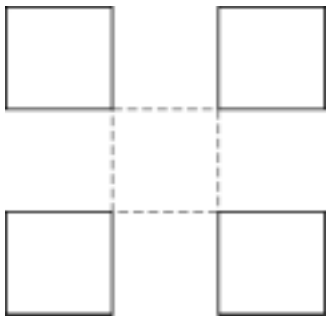
MD01 (cont)

Q	Solution	Marks	Total	Comments
5(a)	eg $A B C D E F A$	M1 A1	2	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) 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 <u>May</u> be improved on	E1 E1	2	“It’s an answer”, “a cycle”, “it works”, “it’s possible ...” “Can’t be worse”, “not necessarily best”, “could be improved” Not “can be improved”
(c)	$F E C A B D F$ (30) (7) (5) (25) (11) (10) = 88	M1 A1 B1	3	Tour $FE(ABCD$ in any order with B before $D)F$ Correct order 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)	$6x + 4y + 2z \leq 240$ $3x + 2y + z \leq 120$ $6x + 3y + 9z \leq 300$ $2x + y + 3z \leq 100$ $12x + 18y + 6z \leq 900$ $2x + 3y + z \leq 150$	M1 A1 M1 A1		CAO CAO
	$12x + 18y + 6z \geq 2(6x + 3y + 9z)$ $y \geq z$	M1 A1	8	OE CSO; OE in simplified form eg $y - z \geq 0$
(b)(i)	$(z = x)$ $4x + 2y \leq 120$ OE or $3x + 3y \leq 150$ OE $4x + 2y \leq 120$ OE $\Rightarrow 2x + y \leq 60$ AG $3x + 3y \leq 150$ OE $\Rightarrow x + y \leq 50$ AG $5x + y \leq 100$, $y \geq x$ AG	M1 A1 A1	3	Correct unsimplified subst $x = z$ into either of these 2 correct inequ. (seen) Both correct and simplified Correct subst $x = z$ into 4 correct inequ.
(ii)		B1 B1 B1 B1		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)
		B1	5	Each line correct to $\frac{1}{2}$ square, horizontally or vertically FR, must have all lines correct and labelled region (condone no shading)
(iii)	$N = x + y + z = 2x + y$ Max = 60	M1 A1	2	Stated or PI CSO; SC unsupported 60 scores 2/2
(iv)	10, 40, 10 11, 38, 11 12, 36, 12 13, 34, 13	B1 B1 B1 B1	3	Any correct; may be earned in part (iii) 3 correct 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	





General Certificate of Education

Mathematics 6360

MD01 Decision 1

Mark Scheme

2010 examination - January series

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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.

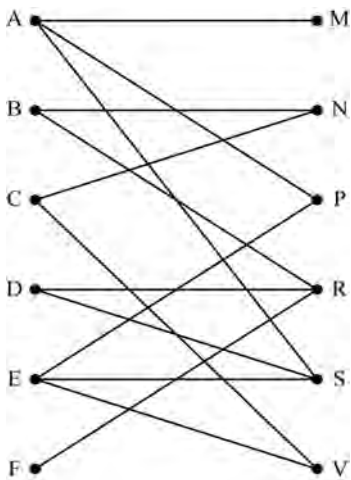
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Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, 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
<p>1(a)</p>  <p>(b) AP, BR, CN, ES</p> <p>$D - R \neq B$ $V - C \neq N$ $M - A \neq P$ $F - R \neq B$ $D - S \neq E$ $V - E \neq S$</p> <p>$D - R \neq B - N \neq C - V$ $F - R \neq D - S \neq E - P \neq A - M$</p> <p>OR $D - S \neq E - V$ $F - R \neq B - N \neq C - V \neq E - P \neq A - M$</p> <p>OR $F - R \neq B - N \neq C - V$ $D - S \neq E - P \neq A - M$</p> <p>AM, BN, CV, DS, EP, FR</p>	<p>M1</p> <p>A1</p> <p>M1</p> <p>M1</p> <p>A1</p> <p>A1</p> <p>(A1)</p> <p>(A1)</p> <p>(A1)</p> <p>(A1)</p> <p>B1</p>	<p>2</p>	<p>Bipartite graph, 2 sets of (some) vertices, labelled, 6+ edges</p> <p>1 correct</p> <p>2nd path started correctly, must be different start point from 1st path (allow $F - R \neq D$ for 2nd M1 if $D - R \neq B$ first)</p> <p>or reverse</p> <p>or reverse, but two paths must be in this order</p> <p>or reverse</p> <p>or reverse, but two paths must be in this order</p> <p>or reverse</p> <p>or reverse, the two paths can be in either order</p> <p>Must be written as a list</p>	
	Total		7	

MD01 (cont)

Q	Solution	Marks	Total	Comments												
2(a)	13 16 10 11 4 12 6 7 13 10 11 4 12 6 7 16 10 11 4 12 6 7 13 16 10 4 11 6 7 12 13 16 4 10 6 7 11 12 13 16 4 6 7 10 11 12 13 16 4 6 7 10 11 12 13 16	M1 A1 A1 A1 A1	5	All correct, must have only 2 identical lines at end. Ignore any intermediate lines and labelling on lines.												
	(b)	<table border="1" style="display: inline-table; vertical-align: middle;"> <thead> <tr> <th></th> <th>C</th> <th>S</th> </tr> </thead> <tbody> <tr> <td>1st</td> <td>7</td> <td>6</td> </tr> <tr> <td>2nd</td> <td>6</td> <td>6</td> </tr> <tr> <td>3rd</td> <td>5</td> <td>3</td> </tr> </tbody> </table>				C	S	1st	7	6	2nd	6	6	3rd	5	3
	C	S														
1st	7	6														
2nd	6	6														
3rd	5	3														
Total			8													
3(a)																
(b)(i)	Max (4, 8) = 44	M1	6	line $y = mx$, must be correct to 1 square horizontally or vertically at origin through (0, 0) and (4, 8) line through (15, 8) and (17, 0) line through (4, 8) and (12, 6) FR must have scored previous 5 marks and labelled region (condone no shading)												
		A1														
		A1														
(ii)	Max (16, 4) = 84	B1	2	Coordinates must be stated explicitly												
		B1														
Total			10													

MD01 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	AC	13	5	Use of Prim's (not Kruskal's and not path); 6+ edges (no cycles); edges, not lengths or vertices, with first 2 edges correct
	AE	14		
	EI	15		
	CD	16		
	CH	20		
	EF	21		
	FB	19		
	BG	19		
(ii)	137	B1	1	
(iii)		M1	2	6+ edges, no cycles
		A1		Correct, including labelling
(b)	(Odds) <i>B, C, D, E</i>	E1	6	PI CAO
	$BC + DE = 22 + 18$ (or 40)	M1		3 correct sets of pairs (lettered)
	$BD + CE = 38 + 27$ (or 65)	A2;1		3 correct sets of numbers; 2 correct sets of numbers
	$BE + CD = 22 + 16$ (or 38)			
	min = 307 + 38 = 345	A1F B1		PI 307 plus their shortest SC: 345 with no M mark scored scores 2/last 5 Route without 345 scores 0/last 5
Total			14	

MD01 (cont)

Q	Solution	Marks	Total	Comments																																										
5(a)	(B E C D A B) 12(.0)	B1	1																																											
(b)	B D A C E B = 13.5	M1 m1 A1 B1	4	Tour starts/finishes at B Visits B twice and all other vertices once Correct order If solution only on a matrix, then order of selection of vertices must be clearly shown																																										
(c)	12(.0)	B1F	1	Their min, condone writing 'part (a)' ft																																										
(d)	B A D E C B = 12.1	M1 m1 A1 B1	4	Tour starts/finishes at B Visits B twice and all other vertices once Correct order If solution only on a matrix, then order of selection of vertices must be clearly shown																																										
Total			10																																											
6(a)	<table border="1" style="display: inline-table; vertical-align: top;"> <thead> <tr> <th>(A)</th> <th>(B)</th> <th>(N)</th> <th>T</th> <th>D</th> <th>H</th> <th>E</th> </tr> </thead> <tbody> <tr> <td>(1)</td> <td>(5)</td> <td>(2)</td> <td>0</td> <td>1</td> <td>2</td> <td>1</td> </tr> <tr> <td></td> <td></td> <td></td> <td>126</td> <td>3</td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td>180</td> <td>5</td> <td></td> <td></td> </tr> </tbody> </table> ("Area =") 180	(A)	(B)	(N)	T	D	H	E	(1)	(5)	(2)	0	1	2	1				126	3						180	5			M1 A1 m1 A1	4	SCA trace as far as a second value for T with at least 1 value for all other variables T = 126 T = (180) trace as far as a third value for T and 2 values for D All correct values including final value of 180 and no extra values, but including A, B, N and their values 1, 5, 2														
(A)	(B)	(N)	T	D	H	E																																								
(1)	(5)	(2)	0	1	2	1																																								
			126	3																																										
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(A)	(B)	(N)	T	D	H	E																																								
(1)	(5)	(4)	0	1	1	0.5																																								
			126	2																																										
			142	3																																										
			196	4																																										
			324	5																																										
Total			8																																											

MD01 (cont)

Q	Solution	Marks	Total	Comments
7(a)		<p>M1 A1 m1 A1 m1 A1 B1</p>	7	<p>SCA cancelling at C (PI) Correct values at C 3 values at G Correct values at G 2 values at both E and I All correct, with no extra values, and including $18 + x + y$ boxed at K 50 at M (diagram takes precedence over answer book)</p>
(b)	<p>$3x + y (=22)$ OE $x + y (=12)$ OE $\therefore x=5, y=7$</p>	<p>M1 A1+1</p>	3	<p>setting up simultaneous equations CSO SC $x = 5, y = 7$ with no working 3/3</p>
Total			10	
8	<p>$\left. \begin{aligned} 2x+3y+4z &\leq 360 \\ 3x+y+5z &\leq 300 \\ 4x+3y+2z &\leq 400 \end{aligned} \right\}$ $2x+3y+4z (>) 3x+y+5z$ $2y > x+z$ $5x+4y+9z (\geq) 4x+3y+2z$ $x+y+7z \geq 0$ $4x+3y+2z (\geq) \frac{40}{100} (9x+7y+11z)$ $2x+y \geq 12z$</p>	<p>B2,1,0 M1 A1 M1 A1 M1 A1</p>	8	<p>Their A (>) their B OE Their A + B (\geq) their C OE Their C (\geq) 40% of their total OE OE</p>
Total			8	
TOTAL			75	

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.

Further copies of this Mark Scheme are available to download from the AQA Website: www.aqa.org.uk

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Set and published by the Assessment and Qualifications Alliance.

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.

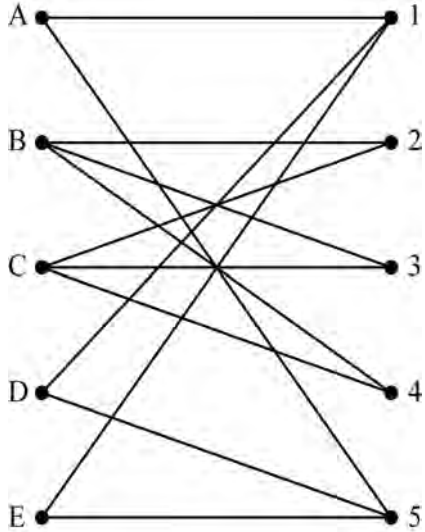
Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **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
<p>1(a)</p>  <p>(b) 3 letters matched to 2 numbers impossible or 2 letters matched to 3 numbers impossible</p> <p>A, D, E matched to 1, 5 impossible or B, C matched to 2, 3, 4 impossible</p>		<p>M1</p> <p>A1</p> <p>E1</p> <p>E1</p>	<p>2</p> <p>2</p>	<p>Bipartite graph, 2 sets of (some) vertices, labelled, 6+ edges.</p> <p>All correct</p> <p>OE; PI by subsequent E1</p> <p>OE</p>
Total			4	

MD01 (cont)

Q	Solution	Marks	Total	Comments
2(a)(i)	(6 2 3 5 4) 2 3 5 4 6	M1	3	Bubble, condone 1 slip but must have 6 at end of first pass 1st pass correct
	2 3 4 5 6 2 3 4 5 6	A1		
	2 3 4 5 6 2 3 4 5 6	A1		
	Or reverse: (6 2 3 5 4) 2 6 3 4 5	M1		
	2 3 6 4 5 2 3 4 6 5 2 3 4 5 6	A1		
	2 3 6 4 5 2 3 4 6 5 2 3 4 5 6	A1		
	2 3 6 4 5 2 3 4 6 5 2 3 4 5 6	A1		
	2 3 6 4 5 2 3 4 6 5 2 3 4 5 6	A1		
	2 3 6 4 5 2 3 4 6 5 2 3 4 5 6	A1		
	2 3 6 4 5 2 3 4 6 5 2 3 4 5 6	A1		
				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) <u>2 6 3 5 4</u>	M1	4	Shuttle – swap 2 and 6 only on 1st pass 2nd pass 3rd pass All correct
	<u>2 3 6 5 4</u>	A1		
	<u>2 3 5 6 4</u>	A1		
	<u>2 3 4 6 4</u>	A1		
	2 3 4 5 6	A1		
(ii)	1	B1	1	
Total			9	

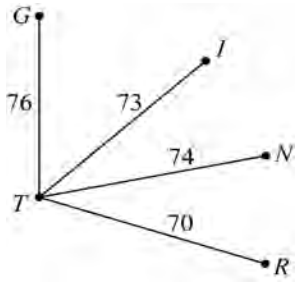
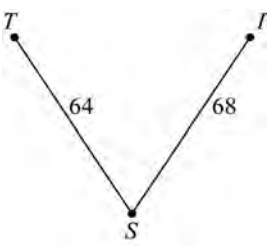
MD01 (cont)

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

MD01 (cont)

Q	Solution	Marks	Total	Comments
<p>4(a)</p>	<p>(b)(i) Odd vertices A, B, C, M</p> <p> $AB + CM = 25 + 48$ or 73 $AC + BM = 24 + 49$ or 73 $AM + BC = 47 + 23$ or 70 </p> <p> $\text{Min} = 384 + 70$ $= 454$ </p>	<p>M1 A1 m1 m1 m1 A1 B1 E1 M1 A2,1 A1F B1 B1</p>	<p>7 6 1</p>	<p>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 PI, CAO 3 correct sets of lettered pairs of candidate's vertices 3 correct, 2 correct PI, 384 plus their shortest SC 454 with no working, or 454 with route Route without 454</p> <p>2/6 0/6</p>
(ii)	4	B1	1	
Total			14	

MD01 (cont)

Q	Solution	Marks	Total	Comments
5(a)	$ \begin{array}{cccccc} S & T & R & I & N & G & S \\ 64 & 70 & 82 & 80 & 82 & 72 & \\ \end{array} $ = 450	M1 m1 A1 B1	4	Tour starting from any vertex Visits all other vertices only once Correct order 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 A1 A1F		Spanning tree with 4 edges (may include S) Correct MST 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	Strict inequalities: penalise first two instances only	
	$x + y + z \geq 300$	oe	B1		
$2.5x + 2y + 2z \leq 1000$ ($5x + 4y + 4z \leq 2000$)	oe	B1			
$x \geq \frac{60}{100}(x + y + z)$ ($2x \geq 3y + 3z$)	oe	B1			
(b)(i)	$y = z$ $x \geq 190, y \geq 50$			$x + y + y \geq 300$ or $5x + 4y + 4y \leq 2000$ or $2x \geq 3y + 3y$ ie at least one clear line of working showing substitution of $y = z$	
	$x + 2y \geq 300$	oe	M1		
	$5x + 8y \leq 2000$ $2x \geq 6y$ ($y \leq \frac{1}{3}x$)	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 $x = 190, y = 50$ through (0,150) and (300,0) through (0,250) and (400,0) $y = mx$ through (0,0) through (300,100) Region must have all lines correct and labelled region (condone lack of shading) A correct objective line
					B1 B1 B1 M1 A1 B1 B1
				7	

MD01 (cont)

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

MD01 (cont)

Q	Solution					Marks	Total	Comments
7	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>			
	(1	4	0	4	0)			
	3	-4	$-\frac{4}{3}$	$\frac{8}{3}$	0.22404	M1		1st pass to candidate's $\frac{8}{3}$
			(awrt -1.33)	(awrt 2.67)	444	A1		1st pass all correct to $E = 0.22$
					(awrt 0.22)			
	5	4	$\frac{4}{5}$	$\frac{52}{15}$	0.10671	M1		2nd pass to candidate's $\frac{52}{15}$
				(awrt 3.5)	111	A1		2nd pass correct to $E = 0.11$
			(awrt 0.11)					
7	-4	$-\frac{4}{7}$	$\frac{304}{105}$	0.0599	M1		3rd pass to candidate's $\frac{304}{105}$	
		(awrt -0.571)	(awrt 2.9)	(awrt 0.06)				
9	4	$\frac{4}{9}$	$\frac{1052}{315}$	0.03987				
		(awrt 0.444)	(awrt 3.34)	(awrt 0.04)	A1	6	All correct and no extra line Final answer $\frac{1052}{315}$ or awrt 3.34	
π is approximately 3.34								
Total						6		

MD01 (cont)

Q	Solution	Marks	Total	Comments
8(a)	Max 5 Min 1	B1 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) $\left(x \leq \frac{17}{4} \right)$ Or $2x - 4 \leq 5$ (or <6) $x \leq \frac{9}{2}$ $x = 4$	M1 A1	2	Any one of these inequalities OR Exhaustive check of all values from 1 to 5 inclusive, condone one omission. 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 $x - 2 > 0 \Rightarrow x > 2$ $x \leq 5$ Hence $x = 4$	M1 A1		
	Total		4	
	TOTAL		75	

Version1.0



**General Certificate of Education (A-level)
January 2011**

Mathematics

MD01

(Specification 6360)

Decision 1

Mark Scheme

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CSO	correct solution only
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AWRT	anything which rounds to
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AG	answer given
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OE	or equivalent
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PI	possibly implied
SCA	substantially correct approach
c	candidate
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dp	decimal place(s)

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

MD01

Q	Solution	Marks	Total	Comments																																																	
1(a)	<table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td></td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> </tr> <tr> <td>A</td> <td>0</td> <td>0</td> <td>0</td> <td>1</td> <td>1</td> <td>0</td> </tr> <tr> <td>B</td> <td>0</td> <td>0</td> <td>1</td> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>C</td> <td>0</td> <td>0</td> <td>0</td> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>D</td> <td>0</td> <td>1</td> <td>0</td> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>E</td> <td>0</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>F</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> </tr> </table>		1	2	3	4	5	6	A	0	0	0	1	1	0	B	0	0	1	0	1	1	C	0	0	0	1	0	0	D	0	1	0	0	0	1	E	0	1	0	1	0	0	F	1	0	1	0	1	0	M1		(6×6) matrix labelled with some√'s or ×'s or 0's or 1's or –'s
		1	2	3	4	5	6																																														
A	0	0	0	1	1	0																																															
B	0	0	1	0	1	1																																															
C	0	0	0	1	0	0																																															
D	0	1	0	0	0	1																																															
E	0	1	0	1	0	0																																															
F	1	0	1	0	1	0																																															
		A1	2	CAO																																																	
(b)	$\left. \begin{array}{l} A-4+E \\ A-5+B \\ C-4+E \\ 6-D+2 \\ 6-B+5 \\ 1-F+3 \end{array} \right\}$	M1		1 correct																																																	
		M1		1 correct, from a different start point																																																	
	$\left. \begin{array}{l} A-5+B-3+F-1 \\ C-4+E-2+D-6 \end{array} \right\}$	A1		Either order																																																	
		A1																																																			
	or first $\left. \begin{array}{l} A-4+E-2+D-6 \\ \text{then} \\ C-4+A-5+B-3+F-1 \end{array} \right\}$	(A1)		Must be in this order																																																	
		(A1)																																																			
	or first $\left. \begin{array}{l} A-5+B-6 \\ \text{then} \\ C-4+E-2+D-6+B-3+F-1 \end{array} \right\}$	(A1)		Must be in this order																																																	
	(A1)																																																				
	Match A5, B3, C4, D6, E2, F1	B1	5	Must be stated (not solely on diagram)																																																	
	Total		7																																																		

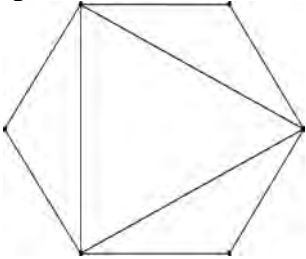
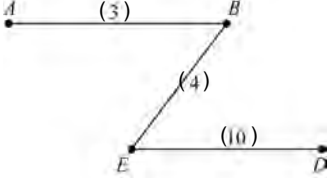
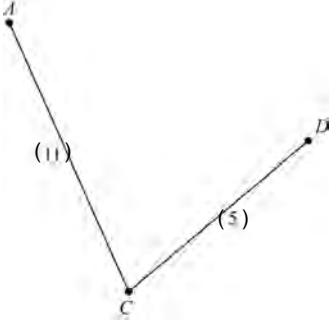
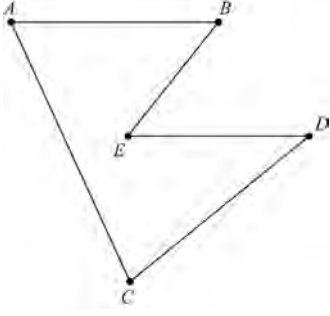
MD01 (cont)

Q	Solution	Marks	Total	Comments																
2(a)	7 22	B1 B1	2	A correct pivot (7 or 22) 2 nd correct pivot and no others																
(b)	<table style="border-collapse: collapse; margin-left: 40px;"> <tr> <td style="border-right: 1px solid black; padding: 2px 10px;"></td> <td style="border-bottom: 1px solid black; padding: 2px 10px;"><i>C</i></td> </tr> <tr> <td style="border-right: 1px solid black; padding: 2px 10px;">1st</td> <td style="padding: 2px 10px;">7</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 2px 10px;">2nd</td> <td style="padding: 2px 10px;">5</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 2px 10px;">3rd</td> <td style="padding: 2px 10px;">3</td> </tr> </table>		<i>C</i>	1st	7	2nd	5	3rd	3	B1 B1 B1	3	Condone 7, 5, 3 or 7 + 5 + 3 (= 15) unlabelled but must be in this order								
	<i>C</i>																			
1st	7																			
2nd	5																			
3rd	3																			
(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)	<table style="border-collapse: collapse; margin-left: 40px;"> <tr> <td style="padding-right: 5px;"><i>EB</i></td> <td style="border-left: 1px solid black; border-right: 1px solid black; padding: 2px 10px;">5</td> </tr> <tr> <td><i>EH</i></td> <td style="border-left: 1px solid black; border-right: 1px solid black; padding: 2px 10px;">7</td> </tr> <tr> <td><i>AB</i></td> <td style="border-left: 1px solid black; border-right: 1px solid black; padding: 2px 10px;">8</td> </tr> <tr> <td><i>HI</i></td> <td style="border-left: 1px solid black; border-right: 1px solid black; padding: 2px 10px;">9</td> </tr> <tr> <td><i>AD</i></td> <td style="border-left: 1px solid black; border-right: 1px solid black; padding: 2px 10px;">10</td> </tr> <tr> <td><i>DG</i></td> <td style="border-left: 1px solid black; border-right: 1px solid black; padding: 2px 10px;">4</td> </tr> <tr> <td><i>EF</i></td> <td style="border-left: 1px solid black; border-right: 1px solid black; padding: 2px 10px;">12</td> </tr> <tr> <td><i>FC</i></td> <td style="border-left: 1px solid black; border-right: 1px solid black; padding: 2px 10px;">6</td> </tr> </table>	<i>EB</i>	5	<i>EH</i>	7	<i>AB</i>	8	<i>HI</i>	9	<i>AD</i>	10	<i>DG</i>	4	<i>EF</i>	12	<i>FC</i>	6	M1 B1 A1 A1	4	Prim's, MST, 6+ edges (no cycles), edges not lengths or vertices, with first 2 edges correct 8 edges <i>AB</i> 3rd All correct
<i>EB</i>	5																			
<i>EH</i>	7																			
<i>AB</i>	8																			
<i>HI</i>	9																			
<i>AD</i>	10																			
<i>DG</i>	4																			
<i>EF</i>	12																			
<i>FC</i>	6																			
(ii)	61	B1	1																	
(iii)		M1 A1	2	6+ edges, connected, no cycles Correct, including labelling																
(b)	Delete <i>BA</i> , <i>BE</i> and reconnect with 1 edge or a spanning tree with 7 edges not including <i>B</i> (either as a list or diagram)	M1		PI from their diagram in (iii)																
	$(61 - 13 + 11) = 59$	A1	2	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)	<i>ADFIJ</i>	B1	1	or reverse	
(b)	$7.5 + x < 12$ $16.5 + x \geq 18$ $1.5 \leq x < 4.5$	OE OE	M1 A1 A1	Either correct condone $7.5 + x \leq 12$ or $16.5 + x > 18$ Both correct $1.5 \leq x < 4.5$ seen (with or without working) scores 3/3 Condone $1.5 \leq x$ and $x < 4.5$ or exact equiv in words but must see “and” $1.5 < x$ or $1.5 \leq x$ or $x < 4.5$ or $x \leq 4.5$ 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	3	These 3 correct sets of pairs 3 correct totals, 2 correct totals
	Dist $1215 + 300 = 1515$	PI	M1 A1	5	1215 + their smallest CSO
(c)(i)	3		B1	1	
(ii)	2		B1	1	
Total			8		

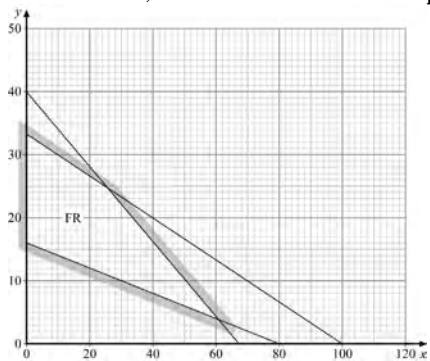
MD01 (cont)

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

MD01 (cont)

Q	Solution			Marks	Total	Comments
8(a)	X	A	B			
	0					Condone omission of $X = 0, A = 20, B = 8$
		20	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 as never reach Line 90		OE	E1		
			OE	E1	2	
			Total		7	

MD01 (cont)

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

Version 1.0



**General Certificate of Education (A-level)
June 2011**

Mathematics

MD01

(Specification 6360)

Decision 1

Final

Mark Scheme

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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 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 A1	2	Bipartite graph, 2 sets of 6 vertices with 10+ edges Correct including labelling
(b)	$\left. \begin{array}{l} E-5+D \\ E-3+A \\ F-5+D \\ F-5+E \\ 1-A+3 \\ 1-B+2 \\ 6-B+1 \\ 6-B+2 \end{array} \right\}$ $\left. \begin{array}{l} E-3+A-1 \\ F-5+D-2+B-6 \end{array} \right\}$ <p>Match A1, B6, C4, D2, E3, F5</p> <p>or first $E-5+D-2+B-1$ then $F-5+E-3+A-1+B-6$</p> <p>or first $E-5+D-2+B-6$ then $F-5+E-3+A-1$</p> <p>or first $F-5+D-2+B-1$ then $E-3+A-1+B-6$</p>	M1 M1 A1 A1 B1 (A1) (A1) (A1) (A1) (A1)	5	1 correct 1 correct, from a different starting point Either order Must be listed, not simply shown on diagram Must be in this order Must be in this order
	Total		7	

MD01 (cont)

Q	Solution	Marks	Total	Comments
2(a)(i)	$x < 6$	B1	1	Condone $x \leq 5$
(ii)	$x < 4$	B1	1	$x \leq 3$
(b)(i)	$x < 11$	B1	1	$x \leq 10$
(ii)	$x > 2$	B1	1	$x \geq 3$ Condone $2 < x < 11$
(c)	$x = 3$	M1 A1	2	Their max (b)(ii) $< x <$ their min (a) CSO
Total			6	
3(a)(i)	<p><i>AC</i> <i>CH</i> <i>FH</i> <i>CE</i> <i>CD</i> (or <i>ED</i>) <i>GH</i> <i>DB</i></p>	M1 B1 A1 A1	4	Prim's, ST, 5+ edges (no cycles), edges not lengths or vertices, with first 4 edges correct 7 edges <i>CD</i> (or <i>ED</i>) 5th All correct
(ii)		M1 A1	2	<i>CD, ED</i> either of these lines ST with 5+ edges, connected, no cycles Correct, including labelling
(iii)	75(p)	B1	1	
(b)	Delete <i>CH, HG, HF</i> and add <i>FA</i> and one of <i>GC, GA, GD, GF</i> or a ST with 6 edges not including <i>H</i> (either as a list or a diagram)	M1		Deleting their edges connected to <i>H</i> , and adding edges to make a ST with 6 edges
	70(p)	A1	2	Note: 70 scores 2/2
Total			9	

MD01 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)		M1		2+ values at <i>S</i> or <i>R</i> or <i>T</i>
		A1		Correct values at <i>S</i>
		m1		2 values at <i>E</i> and 2 values at <i>B</i>
		m1		3 values at <i>D</i>
		A1		All correct, condone 0 missing at <i>A</i> , with rejected values crossed and final values boxed and no extra values at other vertices
		B1	6	22 is final value at <i>D</i> (value on diagram overrides value in script)
(ii)	Route <i>O F S T E D</i>	B1	1	Or reverse
(b)(i)	16	B1	1	
(ii)	<i>O F S R B</i>	B1	1	Or reverse
Total			9	
5(a)	$AC + FD (= 14 + 18) = 32$ $AF + CD (= 10 + 26) = 36$ $AD + CF (= 26 + 24) = 50$ $\min = 150 + 32$ $= 182$	M1		These 3 correct sets of pairs, letters not numbers
		A2,1		3 correct totals, 2 correct totals
		m1		Condone 26 + 24 not evaluated if statement of "too big" OE
		A1cso	5	150 + their smallest, PI
(b)	Repeat <i>FD</i> $(= 150 + 18) = 168$	M1		PI 182 - AC
		A1	2	168 unsupported scores 2/2
(c)(i)	Repeat <i>AF</i> $(= 150 + 10) = 160$	M1		PI
		A1	2	160 unsupported scores 2/2
(ii)	(Start/finish) <i>C</i> and <i>D</i>	B1	1	Must have both and only these
Total			10	

MD01 (cont)

Q	Solution					Marks	Total	Comments
6(a)	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>			
	6	7	300	6.5	25.375			
	6.5			6.75	-7.547	M1		Trace as far as 2 values for <i>D</i> and <i>E</i> Condone omission of 6, 7, 300
		6.75		6.625	9.22	A1		6.5 at <i>A</i> , 6.75 at <i>D</i>
	6.625			6.6875	0.92	m1		At least 4 values for <i>D</i> and <i>E</i>
					A1	4	All correct including sight of 6, 7, 300, with AWRT correct to 3sf or better	
(b)	1 st reason: No output					E1		OE
	2 nd reason: Need to know an interval within which the cube root lies at the outset					E2,1	3	OE For E2, must be a general statement For E1, a statement only referring to 6, 7 or 300
	Total						7	

MD01 (cont)

Q	Solution	Marks	Total	Comments
7(a)	$x+5y \geq 25$ OE $2x+15y \geq 60$ OE $x+25y \geq 40$ OE (C =) $2.5x+15y$	B1 B1 B1 B1	4	ISW ISW ISW ISW; condone $250x + 1500y$, but not any other multiples
(b)(i)		B1 B1 B1 B1 M1		Note: all points need to be correct to within half a square horizontally and vertically Line through (0, 5) and (25, 0) Line through (0, 4) and (30, 0) Line through (15, 1) and (30, 0.4) FR, must have all lines correct and labelled region (condone no shading) Objective line drawn, gradient of $-\frac{1}{6}$ or -6
(ii)	15 DIY, 2 trade	B1	1	Gradient = $-\frac{1}{6}$
(iii)	(Cost) £67.50	B1	1	Condone 6750p, £67.5
	Total		12	

MD01 (cont)

Q	Solution	Marks	Total	Comments																																																	
8(a)(i)	$P U S R (= 40)$	E1																																																			
	Less than any other route	E1	2	Or any one of $PQR = 50$, $PUQR = 45$, $PUR = 44$, $PUTSR = 54$ etc stated																																																	
(ii)	<table border="1"> <thead> <tr> <th></th> <th>P</th> <th>Q</th> <th>R</th> <th>S</th> <th>T</th> <th>U</th> </tr> </thead> <tbody> <tr> <td>P</td> <td>-</td> <td>25</td> <td>40</td> <td>24</td> <td>26</td> <td>14</td> </tr> <tr> <td>Q</td> <td>25</td> <td>-</td> <td>20</td> <td>21</td> <td>23</td> <td>11</td> </tr> <tr> <td>R</td> <td>40</td> <td>20</td> <td>-</td> <td>16</td> <td>28</td> <td>26</td> </tr> <tr> <td>S</td> <td>24</td> <td>21</td> <td>16</td> <td>-</td> <td>12</td> <td>10</td> </tr> <tr> <td>T</td> <td>26</td> <td>23</td> <td>28</td> <td>12</td> <td>-</td> <td>12</td> </tr> <tr> <td>U</td> <td>14</td> <td>11</td> <td>26</td> <td>10</td> <td>12</td> <td>-</td> </tr> </tbody> </table>		P	Q	R	S	T	U	P	-	25	40	24	26	14	Q	25	-	20	21	23	11	R	40	20	-	16	28	26	S	24	21	16	-	12	10	T	26	23	28	12	-	12	U	14	11	26	10	12	-	B1		6+ correct either above or below diagonal
			P	Q	R	S	T	U																																													
		P	-	25	40	24	26	14																																													
		Q	25	-	20	21	23	11																																													
		R	40	20	-	16	28	26																																													
		S	24	21	16	-	12	10																																													
T	26	23	28	12	-	12																																															
U	14	11	26	10	12	-																																															
B1	2	All correct																																																			
(b)(i)	$Q U S T P R Q$	M1		Tour visiting vertices once only (except start/finish vertex)																																																	
		m1		Visits all vertices																																																	
		A1		Correct order																																																	
		B1	4																																																		
	= 119 (min)																																																				
(ii)	$Q U S T U P U S R Q$	M1		Any "expansion" of TP or PR from their (b)(i), PI																																																	
		A1	2																																																		
(c)		M1		ST without Q (either drawn (vertices labelled) or edges listed) and																																																	
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		A1		either UT or TS in correct MST																																																	
		B1		4 edges in a labelled ST (must not include Q)																																																	
		A1		Correct 2 edges from Q																																																	
		B1	5																																																		
	= 83																																																				
	Total		15																																																		
	TOTAL		75																																																		

Version 1.0



**General Certificate of Education (A-level)
January 2012**

Mathematics

MD01

(Specification 6360)

Decision 1

Final

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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)

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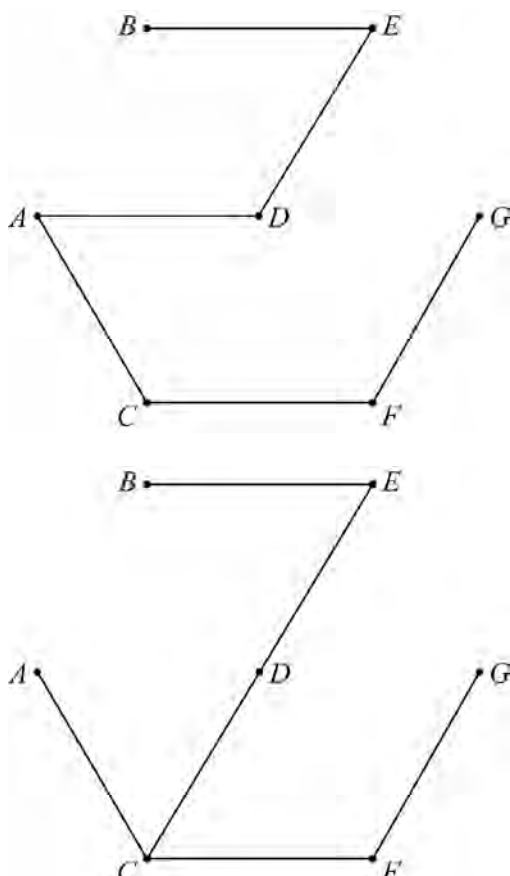
Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

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

MD01

Q	Solution	Marks	Total	Comments
1	<p>37 25 16 12 36 24 13 11 - ~ × • - ~ × •</p> <p>36 37 24 25 13 16 11 12</p> <p>36 24 13 11 37 25 16 12 - × - × - × - ×</p> <p>13 16 36 37 11 12 24 25</p> <p>13 11 16 12 36 24 37 25</p> <p>11 12 13 16 24 25 36 37</p>	M1 A1 m1 A1 A1	5	Using 4 sets of 2 Must see this line Using 2 sets of 4 Must see this line All correct
Total			5	
2(a)		M1 A1	2	Bipartite graph, 2 sets of 6 vertices, at least 10 edges Correct, including labels
(b)	<p>F must be with 6 } $\therefore E$ must be with 5 } $\therefore B$ must be with 2 $\therefore A$ & C both with 1</p> <p>Impossible as two people cannot be allocated to the same task</p>	E1 E1 E1	3	Include conclusion Or E1 3 must be with D (generous) E1 4 “ “ “ D (generous) E1 Impossible as D cannot do both 3 and 4 (strict)
Total			5	

MD01 (cont)

Q	Solution	Marks	Total	Comments
3(a)	$\left. \begin{array}{l} ED = 6 \\ AC = 8 \\ AD = 10 \\ \text{or} \\ DC = 10 \\ FG = 11 \\ BE = 12 \\ CF = 16 \end{array} \right\}$	M1 A1 A1 B1 A1	5	Kruskal, must have first 2 edges correct & no cycles (edges not lengths must be seen) AD or CD third edge BE 5th edge 6 edges All correct
(b)	63	B1	1	
(c)		M1 A1 A1	3	Spanning tree with 5+ edges Correct including labelling Correct including labelling on a separate diagram
Total			9	
4(a)	$\left. \begin{array}{l} CE + KH = (35 + 24) = 59 \\ CK + EH = (25 + 40) = 65 \\ CH + EK = (25 + 30) = 55 \end{array} \right\}$ <p>Total = 224 + 55 PI by their '279' = 279</p>	M1 A2,1 M1 A1	5	These 3 correct sets of pairs 3 correct totals, 2 correct totals 224 + their smallest of three pair totals CSO including totals seen
(b)	3	B1	1	
Total			6	

MD01 (cont)

Q	Solution	Marks	Total	Comments
5(a)		<p>B1 B1 B1</p> <p>M1</p> <p>A1</p> <p>B1</p>	6	<p>Each line must be straight to have the B mark available. For all lines, must be correct to $\frac{1}{2}$ square horizontal and vertical at the indicated vertices.</p> <p>$y = 20$ line through (4,40) and (16,10) line through (0,25) and (10,15)</p> <p>any line through origin (or if extended, through the origin) with positive gradient (generous ± 1 square at the origin)</p> <p>lines through (10,20) and (10,40) as well as origin (normal accuracy rules)</p> <p>FR, all lines correct and region labelled (condone no shading, ignore 'poor' shading)</p>
(b)(i)	<p>(Min at) $x = 5, y = 20$ (P =) 45</p>	<p>B1 B1</p>		<p>Accept (5, 20)</p>
(ii)	<p>(Min at) $x = 10, y = 20$ (P =) 10</p>	<p>B1 B1</p>	4	<p>Accept (10, 20)</p>
	Total		10	

MD01 (cont)

Q	Solution	Marks	Total	Comments
<p>6(a)</p>		<p>M1</p> <p>A1</p> <p>m1</p> <p>m1</p> <p>m1</p> <p>A1</p> <p>B1</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>B1</p>	<p></p> <p></p> <p></p> <p></p> <p></p> <p>7</p> <p>1</p> <p></p> <p></p> <p>3</p>	<p>SCA, 2 values at <i>C</i> or <i>D</i></p> <p>Correct values at <i>D</i></p> <p>4 values at <i>F</i></p> <p>2 values at <i>G</i> or <i>H</i></p> <p>2 values at <i>I</i></p> <p>Each m1 depends only on the M1</p> <p>All correct, condone 0 missing at <i>A</i>, with rejected values crossed and final values boxed and no extra values at other vertices.</p> <p>145 at <i>J</i></p> <p>Or reverse</p> <p>or replace their <i>BG</i> in terms of letters or numbers eg $55 + 8 + 10 = 73$, then 'their 73' - 10 = ...</p> <p>or $BG = AG - 10 - 28$ eg $BG = \text{'their 101'} - 10 - 28$</p> <p>Note: 63 with no working seen scores 2/2</p> <p>Or reverse</p>
	<p>(b) Route: <i>A B E F G H I J</i></p>			
	<p>(c) 'their 135' - (28 + <i>GJ</i>) <i>GJ</i> may be in terms of letters or numbers</p> <p>= 63</p> <p>Route: <i>A B G H I J</i></p>			
Total			11	

MD01 (cont)

Q	Solution	Marks	Total	Comments																																																																
7(a)	<table style="border-collapse: collapse; margin-left: 40px;"> <tr> <td></td> <td style="border-right: 1px solid black; border-bottom: 1px solid black;">A</td> <td style="border-right: 1px solid black; border-bottom: 1px solid black;">B</td> <td style="border-right: 1px solid black; border-bottom: 1px solid black;">C</td> <td style="border-right: 1px solid black; border-bottom: 1px solid black;">D</td> <td style="border-right: 1px solid black; border-bottom: 1px solid black;">E</td> <td style="border-bottom: 1px solid black;">F</td> <td style="border-bottom: 1px solid black;">G</td> </tr> <tr> <td>A</td> <td></td> <td></td> <td></td> <td></td> <td style="border-right: 1px solid black;">8</td> <td></td> <td></td> </tr> <tr> <td>B</td> <td></td> <td></td> <td></td> <td></td> <td style="border-right: 1px solid black;">7</td> <td></td> <td></td> </tr> <tr> <td>C</td> <td></td> <td></td> <td></td> <td></td> <td style="border-right: 1px solid black;">13</td> <td></td> <td></td> </tr> <tr> <td>D</td> <td></td> <td></td> <td></td> <td></td> <td style="border-right: 1px solid black;">4</td> <td></td> <td></td> </tr> <tr> <td>E</td> <td style="border-right: 1px solid black;">8</td> <td style="border-right: 1px solid black;">7</td> <td style="border-right: 1px solid black;">13</td> <td style="border-right: 1px solid black;">4</td> <td style="border-right: 1px solid black;">-</td> <td>10</td> <td>19</td> </tr> <tr> <td>F</td> <td></td> <td></td> <td></td> <td></td> <td style="border-right: 1px solid black;">10</td> <td></td> <td></td> </tr> <tr> <td>G</td> <td></td> <td></td> <td></td> <td></td> <td style="border-right: 1px solid black;">19</td> <td></td> <td></td> </tr> </table>		A	B	C	D	E	F	G	A					8			B					7			C					13			D					4			E	8	7	13	4	-	10	19	F					10			G					19			B1 B1	2	5 correct values in an <i>E</i> 'line' All correct
	A	B	C	D	E	F	G																																																													
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(b)(i)	BADEFGCB	M1 A1 A1		Tour visiting at least 6 vertices Visits all 7 vertices Correct order from <i>B</i>																																																																
	80	B1	4																																																																	
(ii)	B A D E F G <u>E</u> C <u>A</u> B	M1 A1	2	Expansion of <i>GC</i> or <i>CB</i> Both correct																																																																
(iii)	76	B1F	1	Minimum of 76 and their (b)(i)																																																																
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	1	2	4	3	5	6																																																														
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(ii)	43 43 + (4 + 7) = 54	B1 M1 A1	3	For 43 seen, or for 2 + 6 + 3 + 12 + 20 Their 43 + 2 different edges from <i>E</i> SC 54 with no working 2/3																																																																
(iii)	64	B1	1																																																																	
(d)	$64 \leq T \leq 76$	B1B1	2	Must be written in symbols																																																																
	Total		19																																																																	

MD01 (cont)

Q	Solution	Marks	Total	Comments
8(a)	$\left. \begin{array}{l} 2x+3 > 0 \\ 3x-5 > 0 \\ x+1 > 0 \\ 4x-13 > 0 \end{array} \right\}$ $\left. \begin{array}{l} x > \frac{13}{4} \text{ or } \geq \frac{14}{4} \\ \text{(Integer) so } x \geq 4 \end{array} \right]$	M1		Any of these seen
		A1	2	Candidates may use ≥ 1 instead of > 0 Must see both lines. Ignore further work on other inequalities. Accept 4.6 or 4.7 AWRT
(b)(i)	$\begin{array}{l} 2x+3 > 3x-5 \\ > x+1 \\ > 4x-13 \end{array}$	M1		Any correct ISW, condone use of \geq
		A1		2nd correct ISW
		A1	3	All correct ISW
(ii)	$\begin{array}{l} 3x-5 > x+1 \\ > 4x-13 \end{array}$	M1		Either correct ISW, condone use of \geq
		A1	2	Both correct ISW
(iii)	$x+1 > 4x-13$	B1	1	ISW
(c)	$\frac{13}{4} < x < \frac{14}{3}$ $x = 4$	M1		Or $4 \leq x < \frac{14}{3}$, condone $3 < x < \frac{14}{3}$
		A1	2	(Ignore all other inequalities) Must have scored 9/9 earlier SC $x < \frac{14}{3} \therefore x = 4 \quad 1/2$
	Total		10	
	TOTAL		75	

Version



**General Certificate of Education (A-level)
June 2012**

Mathematics

MD01

(Specification 6360)

Decision 1

Mark Scheme

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Set and published by the Assessment and Qualifications Alliance.

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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**.

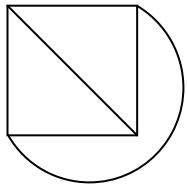
Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

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.

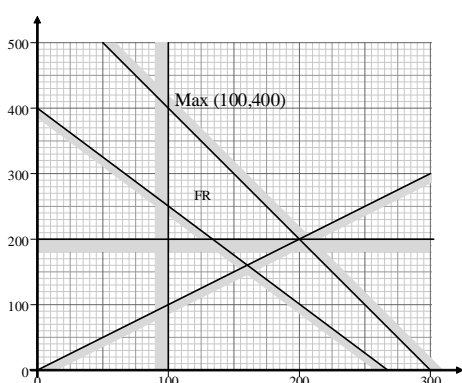
Q	Solution	Marks	Total	Comments
1(a)	1 2 3 4 5 6			
	A 0 0 1 0 0 0	M1		6 × 6 matrix labelled with some 0, 1, ✓, ✗'s (at least 9 entries)
	B 1 0 0 1 0 0			
	C 0 0 1 0 0 1			All correct
	D 1 1 0 0 0 0	A1	2	
	E 0 0 0 1 1 0			
	F 0 0 0 0 1 1			
(b) A – 3 + C	M1			
or 2 – D + 1				
A – 3 + C – 6 + F – 5 + E – 4 + B – 1 + D – 2	A1			
or 2 – D + 1 – B + 4 – E + 5 – F + 6 – C + 3 – A				
Match A3, B1, C6, D2, E4, F5	B1	3		
	Total		5	
2(a)	1st 1 } 2nd 2 } 3rd 1 }	B2		All correct
		(B1)	2	2 correct
	(b) 1st 1 } 2nd 2 } 3rd 0 }	B2		All correct
	(B1)	2	2 correct	
(c) No, has to check 23 (and 26)	E1	1		No, (at least) one more pass needed etc
	Total		5	

Q	Solution	Marks	Total	Comments
3(a)(i)	$AD \begin{pmatrix} 4 \\ 6 \\ 16 \\ 19 \\ 10 \\ 12 \\ 13 \\ 17 \end{pmatrix}$ AB AC DE EG GI IH IF	M1 B1 A1 A1	4	Using Prim's, first 3 edges correct, 6+ edges, no cycles, must have edges not lengths 8 edges <i>GI</i> 6 th All correct
(ii)	97	B1	1	
(iii)		M1 A1	2	ST with 6+ edges All correct including labels
(b)(i)	IF	B1	1	
(ii)	AC	B1	1	
Total			9	
4(a)(i)		M1 A1 m1 A1	5	Dijkstra, 2+ values at <i>C</i> and 1 value at <i>B</i> and <i>D</i> Sight of 10, 9, 8 (only) at <i>C</i> 3 values at <i>E</i> and 2 values at <i>G</i> or <i>I</i> All correct, including crossing out, boxing (condone omission of 0 at <i>A</i>) 39 at <i>J</i> (final value)
(ii)	Route A D C E F H I J	B1	1	or reverse
(b)	(Time = 39 min) (Dist ⇒) $\frac{\text{their } 39}{60} \times 90$ OE = 58.5 km CAO	M1 A1	2	Must see km, or 58500 m SC 58.5 with no working scores M1A0, but 58.5 km with no working scores 2/2
Total			8	

Q	Solution	Marks	Total	Comments	
5(a)	$BD+FH = \left[\begin{matrix} 210+210 \\ 200+180 \\ 260+340 \end{matrix} \right] = 420$	M1	5	These 3 sets of pairs 3 correct totals, 2 correct totals 2430 + their smallest of three pair totals CSO	
	$BF+DH = 380$	A2,1			
	$BH+DF = 600$	m1			
	$(\text{MIN}) = 2430 + 380$	A1			
	$= 2810$				
(b)	$2430 + 340 (DF) = 2770$	B1F	1	2430 + their DF	
(c)(i)	$2430 + 180 (DH) = 2610$	B1F	1	2430 + their min (must have scored M1)	
(ii)	B, F only	B1	1		
Total			8		
6(a)		E1	1		
	(b)(i)	28	B1		
	(ii)	Odd number of edges at (all) vertices	E1	2	Must see the word odd, not just 7
	(c)(i)	$\frac{n(n-1)}{2}$ OE	B1		
	(ii)	$n-1$	B1		
	(iii)	n must be odd	E1		Must have n in their answer
(iv)	$n = 3$	B1	4	Must have n in their answer	
Total			7		

Q	Solution	Marks	Total	Comments
7(a)	$\begin{pmatrix} A & C & F & D & E & B & A \\ 10 & 31 & 32 & 11 & 18 & 16 & \end{pmatrix}$ $= 118$	B1	1	
(b)	$\begin{matrix} A & C & D & E & B & F & A \\ [10 & 14 & 11 & 18 & 50 & 40] \end{matrix}$ $= 143$	M1 m1 A1 B1	4	Tour from A visiting at least 4 vertices Visits all vertices Correct order from A
(c)	<p> $+ \begin{matrix} B & & C \\ [16] & & [10] \\ & A & \end{matrix}$ </p> $= 100$	M1 A1 A1 B1	4	Spanning tree + 2 different edges from A (ST must be edges using B, C, D, E, F not lengths, but condone two lengths from A, or 26) Diagram is not necessary in part (c) Correct minimum spanning tree Correct edges (not lengths) from A
(d)	<p> Lower bound does not make a cycle OE } AND tour > 100 </p>	B1 E1	2	Correctly labelled diagram Both, must be strict inequality
	Total		11	

Q	Solution	Marks	Total	Comments																																													
8(a)	<table style="border-collapse: collapse; margin-left: 20px;"> <tr> <td style="border-bottom: 1px solid black; padding: 2px 10px;"><i>A</i></td> <td style="border-bottom: 1px solid black; padding: 2px 10px;"><i>B</i></td> <td style="border-bottom: 1px solid black; padding: 2px 10px;"><i>C</i></td> <td style="border-bottom: 1px solid black; padding: 2px 10px;"><i>D</i></td> <td></td> </tr> <tr> <td style="padding: 2px 10px;">1</td> <td style="padding: 2px 10px;">1</td> <td style="padding: 2px 10px;">1</td> <td style="padding: 2px 10px;">1</td> <td></td> </tr> <tr> <td></td> <td></td> <td style="padding: 2px 10px;">1</td> <td style="padding: 2px 10px;">2</td> <td></td> </tr> <tr> <td></td> <td style="padding: 2px 10px;">2</td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td style="padding: 2px 10px;">2</td> <td style="padding: 2px 10px;">2.5</td> <td></td> </tr> <tr> <td></td> <td style="padding: 2px 10px;">3</td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td style="padding: 2px 10px;">6</td> <td style="padding: 2px 10px;">2.67</td> <td style="padding: 2px 10px;">AWRT</td> </tr> <tr> <td></td> <td style="padding: 2px 10px;">4</td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td style="padding: 2px 10px;">24</td> <td style="padding: 2px 10px;">2.71</td> <td style="padding: 2px 10px;">AWRT</td> </tr> </table>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>		1	1	1	1				1	2			2						2	2.5			3						6	2.67	AWRT		4						24	2.71	AWRT	M1 A1		At least 3 evaluated values for <i>D</i> 3 rd value of <i>D</i> as 2.5
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>																																													
1	1	1	1																																														
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	An estimate of <i>e</i> is 2.71 AWRT	A1 CSO	6	Values of (1), 1, 2, 6, 24 (only) seen for <i>C</i> Exactly 5 evaluated values for <i>D</i> Correct 5 values for <i>D</i>																																													
(b)	Never-ending (loop) (<i>A</i> ,) <i>B</i> (, <i>C</i>) always reset to 1 OE	B2,1	2	All correct values seen (1 for <i>A</i> , 4 for <i>B</i> , 5 for <i>C</i> and <i>D</i>) <u>and</u> correct final statement																																													
	Total		8																																														

Q	Solution	Marks	Total	Comments
9(a)	$\left. \begin{array}{l} x \geq 100, y \geq 200 \\ x + y + z \geq 400 \end{array} \right\} \text{OE}$ $4x + 3y + 4z \leq 1800 \text{ OE}$ $y \geq \frac{40}{100} (x + y + z) \text{ OE}$	B1 B1 B1	3	
(b)(i)	$(x = 2z)$ $\left. \begin{array}{l} x + y + \frac{1}{2}x \geq 400 \\ \Rightarrow 3x + 2y \geq 800 \end{array} \right\}$ $\left. \begin{array}{l} 4x + 3y + 2x \leq 1800 \\ 6x + 3y \leq 1800 \\ 2x + y \leq 600 \end{array} \right\}$ $\left. \begin{array}{l} 5y \geq 2x + 2y + x \\ 3y \geq 3x \\ y \geq x \end{array} \right\}$	M1 A1 A1	3	<p>Correct substitution and fully simplifying 1 inequality (must see evidence: either replacing z or multiplying inequality)</p> <p>As above 'in 2nd inequality'</p> <p>As above 'in 3rd inequality'</p>
(ii)		B1 B1 B1 B1 B1	5	<p>Each line must be straight to have the B mark available. For all lines, must be correct to half square horizontal and vertical at the indicated vertices.</p> <p>$x = 100, y = 200$</p> <p>$y = x$ line through (100, 100) and (200, 200)</p> <p>$2x + y = 600$ line through (100, 400) and (200, 200)</p> <p>$3x + 2y = 800$ line through (100, 250) and (200, 100)</p> <p>Feasible Region, all lines correct and region labelled (condone no shading, ignore 'poor' shading)</p>
(iii)	$\text{(Max)} y + \frac{3}{2}x$ $= 400 + 150 = 550$	M1 A1	2	PI by objective line with gradient -1.5
(iv)	<p>Buys 100 soft 400 medium 50 firm</p>	B1	1	
	Total		14	
	TOTAL		75	

Version



**General Certificate of Education (A-level)
January 2013**

Mathematics

MD01

(Specification 6360)

Decision 1

Final

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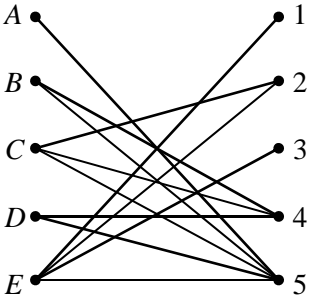
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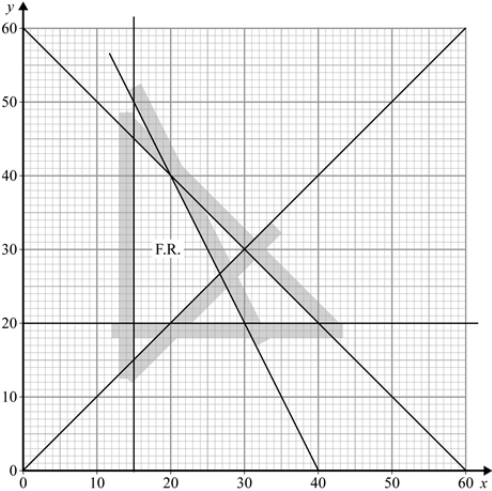
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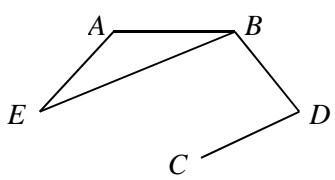
Q	Solution	Marks	Total	Comments
(1)(a)		M1		Bipartite graph, 2 sets of 5 vertices, at least 9 edges
	<p data-bbox="245 394 758 465">(b) Only <i>E</i> can do task 1 and task 3. One person cannot do 2 tasks so impossible.</p> <p data-bbox="245 506 284 537">Or</p> <p data-bbox="245 577 758 649"><i>A</i> does 5, then <i>B</i> must do task 4 and <i>D</i> must do task 4.</p> <p data-bbox="245 689 758 761">One task cannot be done by 2 people so impossible.</p> <p data-bbox="245 801 284 833">Or</p> <p data-bbox="245 873 758 945">4 people <i>A, B, C, D</i> can only do 3 tasks 2, 4, 5</p> <p data-bbox="245 985 758 1057">Not enough tasks for the number of people so impossible.</p>	A1	2	All correct, including labelling
		M1	2	
		(M1)		Must have <i>A</i> to 5 first, or 3 people <i>A, B, D</i> can only do 2 tasks 4, 5
		(A1)		Not enough tasks for the number of people so impossible.
		(M1)		
		(A1)		
	Total		4	

Q	Solution	Marks	Total	Comments
2(a)	$\begin{array}{cccccccc} 7 & 8 & 1 & 6 & 3 & 4 & 5 & 2 \\ x & - & 0 & \sim & x & - & 0 & \sim \\ 7 & & & & 3 & & & \\ & 8 & & & & 4 & & \\ & & 1 & & & & 5 & \\ & & & 6 & & & & 2 \\ 3 & 4 & 1 & 2 & 7 & 8 & 5 & 6 \\ - & x & - & x & - & x & - & x \\ 3 & & 1 & & 7 & & 5 & \\ & 4 & & 2 & & 8 & & 6 \\ 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 \\ 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 \end{array}$	M1 A1 m1 A1	 4	<p>4 sets of 2 with evidence of at least 1 pair being compared</p> <p>Must see this line</p> <p>2 sets of 4 with evidence of at least 1 set being compared</p> <p>All correct, including third pass (ignore extra 'lines' of working)</p>
(b)	4	B1	1	
Total			5	
3(a)	<p>(Odds B, D, F, H) $BD + FH = 37.2$ $BF + DH = 38.4$ $BH + DF = 40$</p> <p>Length $118 + 37.2$ $= 155.2$</p>	M1 A2,1 m1 A1	 5	<p>These 3 pairs of odds stated 3 correct totals, 2 correct totals</p> <p>118 + their 'smallest' PI by their final answer CSO, including 3 correct totals.</p>
(b)(i)	E twice	B1		
(ii)	I twice	B1	2	
Total			7	

Q	Solution	Marks	Total	Comments	
4(a)(i)	AB (6.1)	M1		Prim's, 1st 3 correct, must be edges not lengths and no cycles	
	BC 7.4				
	BE 9.7				
	DE 7.2	B1			8 edges
	EF 10.6	A1			EF 5th
	EH 12.5				
	GH (8.9)	A1			All correct
(ii)	(Length =) 69.1	B1			
(iii)		M1		Spanning tree with 9 vertices and 8 edges	
		A1	7		All correct, including labelling
(b)(i)	GH	B1			
(ii)	EF	B1	2		
(c)(i)	1st AB	B1			
	Last EH	B1	2		
Total			11		

Q	Solution	Marks	Total	Comments
<p>5(a)</p> 	<p>(b)(i) (Max at) (15,45) (P =) 195</p> <p>(ii) Sight of (26 – 27, 26 – 27) (P =) 130 - 135 (P =) $\frac{400}{3}$</p>	<p>B1 B1 B1 B1</p> <p>B1</p> <p>B1 B1 M1 A1</p>	<p>5</p> <p>2</p> <p>3</p> <p>10</p>	<p>Accuracy: All lines must be ruled, correct to within $\frac{1}{2}$ small square both horizontally and vertically</p> <p>$x = 15, y = 20$ $x + y = 60,$ correct at (10, 50) and (40, 20) $2x + y = 80,$ correct at (15, 50) and (30, 20) $y = x,$ correct at (10, 10) and (30, 30)</p> <p>F.R. (a pentagon) labelled, must have scored previous 4 marks</p> <p>oe</p>
Total			10	

Q	Solution	Marks	Total	Comments
6(a)	<p>Route A B C F I J</p>	M1		Using Dijkstra, 2 or 3 values at C and one value only at both B and D
		A1		Correct values at C
		m1		2 values at G, H, I
		m1		4 values at J
		A1		All correct, including cancelling and boxing. (condone omission of 0 at A)
		B1		Final value at J is 30.
		B1	7	Or reverse
		M1		Attempt at finding EITHER time (PI by answer)
		A1F		Both correct (oe)
		B1	3	Must see units
	Total		10	
7(a)(i)	7	B1		
(ii)	28	B1	2	
(b)(i)	$n - 1$	B1		
(ii)	$\frac{n(n-1)}{2}$	B1	2	oe,
(c)(i)	(d =) 0,1,2,3,4,5	B2		B1 for at least 0,1,5 or B1 for at least 2,3,4
(ii)	(d =) 2,3,4,5	B1		
(iii)	(d =) 2,4	B1	4	
	Total		8	

Q	Solution	Marks	Total	Comments
8(a)	58	B1	1	
(b)	$E A C D B E$	B1	1	Or reverse
(c)	$E A B D C E$ (8 10 15 10 23) = 66	M1 m1 A1 A1 CSO	4	Tour Visit all vertices Correct order If M0 scored, then 66 scores SC2
(d)	$\left. \begin{array}{l} AB \\ BD \\ DC \end{array} \right\} (35)$ $\left. \begin{array}{l} EA \\ EB \end{array} \right\} (17 = 52)$ 52	M1 A1 A1 A1 CSO	4	A spanning tree with 3 edges connecting A, B, C and D and 2 edges from E Correct m s t Correct edges from E If M0 scored, then 52 scores SC2
(e)	 Doesn't give a tour	B1 E1	2	Or other sensible conclusion Eg: tour > 52 or 'doesn't give a solution'
	Total		12	

Q	Solution	Marks	Total	Comments
9	$\left. \begin{aligned} 2x+3y+5z &\leq 400 \\ 3x+4y+3z &\leq 400 \end{aligned} \right\}$ $(6x+2y+2z \leq 400)$ $\Rightarrow 3x+y+z \leq 200$ $11x+9y+10z \geq 1000$ their $(2x+3y+5z) >$ their $(3x+4y+3z)$ $2z > x+y$ $6x+2y+2z \leq \frac{4}{10}(11x+9y+10z)$ $16x-16y-20z \leq 0 \text{ oe}$ $4x \leq 4y+5z$	 B1 B1 B1 M1 A1 CAO M1 A1 A1 CAO	 8	Both Condone \geq oe Condone $<$ Allow numerical values to $\frac{4}{10}$
	Total		8	
	TOTAL		75	

Version 1.0



**General Certificate of Education (A-level)
June 2013**

Mathematics

MD01

(Specification 6360)

Decision 1

Final

Mark Scheme

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Set and published by the Assessment and Qualifications Alliance.

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**.

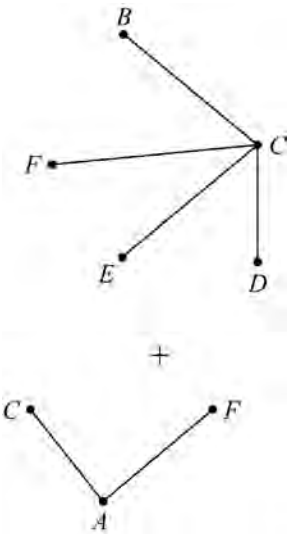

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

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	<p>(b) (Missing A, F / 4, 6) $A - 1 + B$ or $A - 3 + C$ $F - 1 + B$ or $F - 3 + C$</p> <p>Correct 1st path Correct 2nd path</p> <p>Match A1, B4, C2, D5, E6, F3</p>	M1 A1 M1 M1 A1 A1 B1	2 5	<p>Bipartite graph, 2 sets of 6 vertices, at least 12 edges</p> <p>All correct including labelling</p> <p>or $4 - B + 1$ or $4 - D + 5$ $6 - E + 2$ or $6 - D + 5$</p> <p>Eg $A - 1 + B - 4$ $F - 3 + C - 2 + E - 6$</p> <p>or A1, B4, C2, D6, E5, F3 or A3, B4, C2, D5, E6, F1 or A3, B4, C2, D6, E5, F1</p>																														
Total			7																															
2(a)	<table style="border-collapse: collapse; margin-left: 20px;"> <tr> <td style="padding: 2px 10px;">2</td> <td style="padding: 2px 10px;">12</td> <td style="padding: 2px 10px;">17</td> <td style="padding: 2px 10px;">18</td> <td style="padding: 2px 10px;">5</td> <td style="padding: 2px 10px;">13</td> </tr> <tr> <td style="padding: 2px 10px;">(2)</td> <td style="padding: 2px 10px;">12</td> <td style="padding: 2px 10px;">17</td> <td style="padding: 2px 10px;">18</td> <td style="padding: 2px 10px;">5</td> <td style="padding: 2px 10px;">13</td> </tr> <tr> <td style="padding: 2px 10px;">(2)</td> <td style="padding: 2px 10px;">5</td> <td style="padding: 2px 10px;">(12)</td> <td style="padding: 2px 10px;">17</td> <td style="padding: 2px 10px;">18</td> <td style="padding: 2px 10px;">13</td> </tr> <tr> <td style="padding: 2px 10px;">(2)</td> <td style="padding: 2px 10px;">(5)</td> <td style="padding: 2px 10px;">(12)</td> <td style="padding: 2px 10px;">13</td> <td style="padding: 2px 10px;">(17)</td> <td style="padding: 2px 10px;">18</td> </tr> <tr> <td style="padding: 2px 10px;">((2)</td> <td style="padding: 2px 10px;">(5)</td> <td style="padding: 2px 10px;">(12)</td> <td style="padding: 2px 10px;">(13)</td> <td style="padding: 2px 10px;">(17)</td> <td style="padding: 2px 10px;">(18)</td> </tr> </table>	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	<p>SCA, using pivots to create sublists</p> <p>Correct 2nd pass Consistent pivots</p> <p>All correct</p>
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)																													
(b)	(C=)5	B1	1																															
Total			5																															

Q	Solution	Marks	Total	Comments	
3(a)(i)	EG 2.3	M1		SCA, Kruskal's, 1 st 3 edges correct, must be edges not lengths, and no cycle in solution	
	AB 2.5				
	IJ 2.9				
	AC 3.1	B1	9 edges		
	AD 3.2	A1	AD 5th		
	HJ 3.4				
	GJ 3.6				
	BE 3.9				
	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 May be improved	E1 E1	2	
(c)	$\begin{matrix} A & C & D & F & B & E & A \\ (11 & 10 & 15 & 15 & 24 & 27) \end{matrix}$ <p style="text-align: center;">= 102</p>	M1 m1 A1 A1 CSO	4	Tour, from A, visiting at least 4 other vertices, once only Visits all vertices Correct order If M0 scored then 102 scores SC2
(d)	 <p style="text-align: center;">+</p>  <p>= 77</p>	M1 A1 A1 A1 CSO	4 1	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) Correct ST Correct edges from A If M0 scored then 77 scores SC2 Allow their '77', provided '77' > 75
(e)	Min tour ≥ 77	E1	1	
Total			12	

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

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

Q	Solution	Marks	Total	Comments
7(a)	$6x + 4y + 3z \geq 420$ $6x + 6y + 4z \geq 480$ oe $6x + 4y + 4z \leq 720$ oe	B1 B1 B1	3	
(b)(i)	$(y = z)$ $6x + 4y + 3y \geq 420 \Rightarrow 6x + 7y \geq 420$ $6x + 10y \geq 480 \Rightarrow 3x + 5y \geq 240$ oe $6x + 8y \leq 720 \Rightarrow 3x + 4y \leq 360$ oe	B1 B1	2	<p>Must see this substitution</p> <p>Both other inequalities correct, condone direct substitution into simplified versions of part (a)</p>
(ii)		B1 B1 B1 B1 M1 A1	6	<p>Accuracy: All lines must be ruled, correct to within $\frac{1}{2}$ square</p> <p>BOTH horizontally and vertically Correct at (0, 60) and (70, 0) Correct at (0, 48) and (80, 0) Correct at (0, 90) and (120, 0) FR labelled, MUST have scored previous 3 marks Condone omission of shading on axes OL, drawn, with gradient -0.8 or -1.25 Gradient -0.8</p>
(iii)	(Max profit =) £480 120 gold, 0 silver, 0 bronze	B1 B1	2	<p>Including '£'</p> <p>All 3 must be stated</p>
(c)	(Max profit =) £1080 0 gold, 90 silver, 90 bronze	B1 B2	3	<p>Including '£'</p> <p>If B0 scored then B1 for $x = 0$ and $y = 90$, PI</p>
	Total		16	
	TOTAL		75	



A-LEVEL MATHEMATICS

Decision 1 – MD01
Mark scheme

6360
June 2014

Version/Stage: 1.0 Final

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√ or ft or F	follow through from previous incorrect result
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PI	possibly implied
SCA	substantially correct approach
c	candidate
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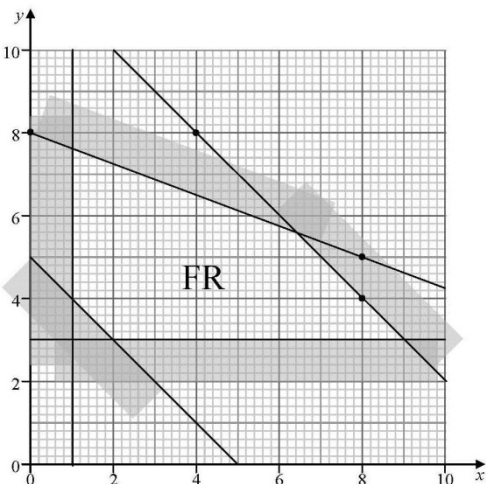
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Q	Solution	Mark	Total	Comment																																				
1(a)	<table border="1"> <tr> <td></td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> <tr> <td>A</td> <td>0</td> <td>0</td> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>B</td> <td>1</td> <td>1</td> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>C</td> <td>0</td> <td>0</td> <td>1</td> <td>1</td> <td>1</td> </tr> <tr> <td>D</td> <td>0</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>E</td> <td>0</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> </tr> </table>		1	2	3	4	5	A	0	0	1	0	0	B	1	1	1	0	0	C	0	0	1	1	1	D	0	1	0	1	0	E	0	1	0	1	0	M1	2	5x5 matrix with some 0's, 1's oe (or transpose)
		1	2	3	4	5																																		
A	0	0	1	0	0																																			
B	1	1	1	0	0																																			
C	0	0	1	1	1																																			
D	0	1	0	1	0																																			
E	0	1	0	1	0																																			
(b)(i)	<p>Ignore paths that do not lead to a complete match. For all paths, the order may start from 1 and/or 5. Initial path MUST have only 4 'terms' Correct 4 term path Correct pair of paths (order is only important if second path has 6 terms) $D - 2 + B - 1$ and $E - 4 + C - 5$ $D - 2 + B - 1$ then $E - 2 + D - 4 + C - 5$ $E - 4 + C - 5$ then $D - 4 + E - 2 + B - 1$</p> <p>Match - must be stated and not simply 'shown' on a diagram $A3, B1, C5, D2, E4$ or $A3, B1, C5, D4, E2$</p>	M1 A1	3	<p>This diagram (or transpose), including labelling.</p> <p>Or, $D - 4 + C - 5$ and $E - 2 + B - 1$ $D - 4 + C - 5$ then $E - 4 + D - 2 + B - 1$ $E - 2 + B - 1$ then $D - 2 + E - 4 + C - 5$</p> <p>If a candidate works on diagrams, then the marks can be earned, BUT only one path per diagram (2 paths on 1 diagram scores M0). The start vertex and path must be clear and correct to score M1. The start vertex and path on a second diagram must be clear and correct to score A1.</p>																																				
(ii)	<p>Match - must be stated and not simply 'shown' on a diagram Match $A3, B1, C5, D4, E2$ or $A3, B1, C5, D2, E4$</p>	B1		1																																				
	Total		6																																					

Q	Solution	Mark	Total	Comment																																																																								
2(a)(i)	<table border="1"> <tr> <td></td> <td>4</td> <td>1</td> <td>2</td> <td>3</td> <td>(7)</td> <td>5</td> <td>6</td> </tr> <tr> <td></td> <td><i>D</i></td> <td><i>E</i></td> <td><i>F</i></td> <td><i>G</i></td> <td><i>H</i></td> <td><i>I</i></td> <td><i>S</i></td> </tr> <tr> <td><i>D</i></td> <td></td> <td>120</td> <td>140</td> <td>80</td> <td>170</td> <td>140</td> <td>140</td> </tr> <tr> <td><i>E</i></td> <td>120</td> <td></td> <td>70</td> <td>80</td> <td>130</td> <td>130</td> <td>110</td> </tr> <tr> <td><i>F</i></td> <td>140</td> <td>70</td> <td></td> <td>90</td> <td>190</td> <td>85</td> <td>90</td> </tr> <tr> <td><i>G</i></td> <td>80</td> <td>80</td> <td>90</td> <td></td> <td>110</td> <td>100</td> <td>100</td> </tr> <tr> <td><i>H</i></td> <td>170</td> <td>130</td> <td>190</td> <td>110</td> <td></td> <td>140</td> <td>150</td> </tr> <tr> <td><i>I</i></td> <td>140</td> <td>130</td> <td>85</td> <td>100</td> <td>140</td> <td></td> <td>60</td> </tr> <tr> <td><i>S</i></td> <td>140</td> <td>110</td> <td>90</td> <td>100</td> <td>150</td> <td>60</td> <td></td> </tr> </table>		4	1	2	3	(7)	5	6		<i>D</i>	<i>E</i>	<i>F</i>	<i>G</i>	<i>H</i>	<i>I</i>	<i>S</i>	<i>D</i>		120	140	80	170	140	140	<i>E</i>	120		70	80	130	130	110	<i>F</i>	140	70		90	190	85	90	<i>G</i>	80	80	90		110	100	100	<i>H</i>	170	130	190	110		140	150	<i>I</i>	140	130	85	100	140		60	<i>S</i>	140	110	90	100	150	60		M1		Some (just) rows or (just) cols crossed out, with some values circled/highlighted
		4	1	2	3	(7)	5	6																																																																				
		<i>D</i>	<i>E</i>	<i>F</i>	<i>G</i>	<i>H</i>	<i>I</i>	<i>S</i>																																																																				
	<i>D</i>		120	140	80	170	140	140																																																																				
	<i>E</i>	120		70	80	130	130	110																																																																				
	<i>F</i>	140	70		90	190	85	90																																																																				
	<i>G</i>	80	80	90		110	100	100																																																																				
	<i>H</i>	170	130	190	110		140	150																																																																				
	<i>I</i>	140	130	85	100	140		60																																																																				
	<i>S</i>	140	110	90	100	150	60																																																																					
		A1		Any 6 values circled/highlighted/listed seen either in table or body of script																																																																								
		A1		First 3 correct, <i>EF</i> or <i>FE</i> , <i>EG</i> or <i>GE</i> , <i>GD</i> or <i>DG</i> , identified AND <i>E</i> , <i>F</i> , <i>G</i> numbered (1, 2, 3 or (0), 1, 2) (if no numbering on table, accept order if clearly shown by a correct list)																																																																								
		A1		All correct or fully correct transpose (numbering may be as first A mark, if no numbering on table, accept order if clearly shown by a correct list, condone omission of 7 at <i>H</i> . Condone row (or col) <i>H</i> not crossed out.)																																																																								
		B1	5	Correct edges (not lengths), either listed or values circled/highlighted seen either in table or body of script																																																																								
(ii)	485	B1	1																																																																									
(iii)		M1		ST with 7 vertices and 6 edges																																																																								
		A1	2	Correct including labelling																																																																								
(b)(i)	<i>IF</i> (<i>FI</i>), <i>IS</i> (<i>SI</i>)	B1, B1		Must be in this order If only 1 edge given then ‘last/2 nd last’ must be clearly stated																																																																								
(ii)	<i>IF</i> (<i>FI</i>), <i>GH</i> (<i>HG</i>)	B1	3	Must be in this order (SC1 if B0 scored in part (i) and (ii), and ONLY IS given for part(i) and <i>GH</i> for part (ii).)																																																																								
Total			11																																																																									

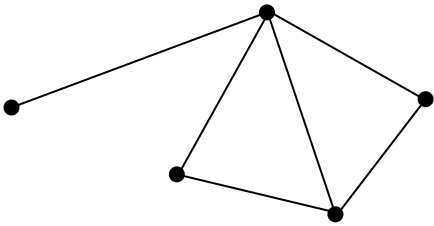
Q	Solution	Mark	Total	Comment
3 (a)(i)		M1	6	Use of Dijkstra, 2+ values at <i>F</i> Values of 44, 37, 36 only at <i>F</i> 3 values at <i>I</i> 3 values at <i>J</i> All correct, including cancelling and boxing. (condone omission of 0 at <i>A</i>) Final value at <i>K</i> is 61 (diagram takes precedence over value in body of script) (Notation: accept correct alternative notation eg 3 ‘box’ method etc) If working from <i>K</i> to <i>A</i> : M1 2 values at <i>F</i> A1 values of 34 and 26 at <i>F</i> m1 2 values at <i>A</i> m1 only one value at every other vertex A1 as above, B1 final value at <i>A</i> is 61
		A1		
		m1		
		m1		
(ii)	ABEIK	B1	1	Or reverse Condone AB, BE, EI, IK
(b)	63 (mins) oe	B1	1	
(c)	64 (mins) oe ABFJK	B1 B1	2	Or reverse
Total			10	

Q	Solution	Mark	Total	Comment
4(a)	$AC + EG = (6 + 9.5) = 15.5$ $AE + CG = 11 + 12.5 \text{ or } 23.5$ $AG + CE = (7 + 8) = 15$ $79.5 + \text{their min total} = 94.5$	M1	5	These 3 sets of pairs stated All 3 correct, 2 correct PI by their final answer (if M0 scored then 94.5 scores SC2)
		A2,1,0		
(b)(i)	2	B1		
(ii)	3	B1	2	
(c)(i)	$79.5 + \text{their min edge} = 85.5$	M1	3	PI by their final answer (must have 6 ‘values’ in part (a)) If M0 scored then 85.5 scores 2/2
		A1		
(ii)	E,G	B1	3	
Total			10	

Q	Solution	Mark	Total	Comment
<p>5</p> <p>(a) $x = 1, y = 3$ and $x + y = 5$ $x + y = 12$ $3x + 8y = 64$</p> <p>Correct feasible region</p> <p>(b)</p> <p>(i) 30, (9, 3)</p> <p>(ii) 29.6, (6.4, 5.6) oe</p> <p>(iii) -15, (9, 3)</p>		<p>B1 B1 M1 A1 B1</p> <p>B1, B1</p> <p>B1, B1</p> <p>B1, B1</p>	<p>5</p> <p>6</p>	<p>Accuracy: All lines must be ruled, correct to within ½ small square both horizontally and vertically, at ‘key’ vertices, stated below. Ignore objective lines in part (a)</p> <p>$x + y = 5$, correct at (0, 5) and (5, 0) Correct at (4, 8) and (8, 4) Line with ‘correct’ gradient (-0.5 to -0.3) passing through (0, 8). Correct at (8, 5) F.R. (a pentagon) clearly identified and labelled, must have scored previous 4 marks</p> <p>If multiple vertices are listed then final answer must be clearly identified. For the second B1, the coordinates must be stated explicitly. (allow $x=9, y=3$ etc)</p> <p>SC1 for 29 - 31, AND (6 - 7, 5 - 6)</p>
	Total		11	

Q	Solution	Mark	Total	Comment
6(a)(i)	30	B1		
(ii)	20	B1	2	
(b)(i)	Quicker going via L oe	E1	1	MLN (= 236), allow 126 + 110
(ii)	932 (mins) isw	B1	1	
(iii)	MLNLBLELM	M1		Any correct 'expansion' eg MLN, NLB or BLE
		A1	2	
(iv)	Script takes precedence over working on table. MBLNEM or MBLNLEM	M1 m1 A1 A1 cso		Any tour starting and finishing at M Visits all vertices Correct order If M0 scored, then 796 scores SC2
	796 (mins)		4	If a candidate works only on a table M1 for 4 or 5 values circled m1 for 5 values circled, one per row/col A1 for correct values circled and order shown A1 for 796
Total			10	

Q	Solution	Mark	Total	Comment
7	$4x + 10y + 10z \leq 240$	M1		One correct inequality, PI by correct simplified inequalities
	$7x + 14y + 14z \leq 210$	A1		All 3 correct,(PI by correct simplified inequalities)
	$14x + 21y + 28z \leq 420$			
	(Leading to)			
	$2x + 5y + 5z \leq 120$ ISW	m1		Correctly simplifying one inequality
	$x + 2y + 2z \leq 30$ ISW	A1		All correct
	$2x + 3y + 4z \leq 60$ ISW			
	$x > y + z$ ISW	B1		OE, must have all coefficients as ± 1
$y \geq z$ ISW	B1		OE, must have all coefficients as ± 1	
$y \geq \frac{15}{100}(x + y + z)$	M1		OE (but not 15%)	
(Leading to)				
$17y \geq 3x + 3z$ ISW	A1		Any correct rearrangement involving integer coefficients eg $17y - 3x - 3z \geq 0$	
Total			8	

Q	Solution	Mark	Total	Comment
8(a)(i)	If x is even, there would be three odds	M1	2	Or, Sum = $5x + 7$, must be even, M1 (so $5x$ must be odd), so x must be odd A1
	Hence x is odd.	A1		
(ii)	$x = 1$ (if only seen in part (i), this mark can be awarded if a correct graph is given in part (ii))	B1	3	eg 
	Graph clearly having 5 vertices and 5 or 6 edges Correct graph must clearly have 5 vertices, 6 edges and degree of vertices as 1, 2, 2, 3, 4	B1 B1		
(b)(i)	(Min =) 0 (Max =) 9	B1 B1	2	
(ii)	(the degrees of the vertices must be 0, 1, 2...9) There would be an odd number of odds Impossible	E1 E1	2	Or, If all different, then sum = 45 Impossible, as sum must be even Or, Degrees of 0 and 9 would occur, Impossible as '9' would connect to the '0'
	Total		9	



A-LEVEL

Mathematics

Decision 1 – MD01
Mark scheme

6360
June 2015

Version/Stage: Version 1.0 : Final

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

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.

Q1	Solution	Mark	Total	Comment
1	<p>I Path starting $D-2+A$ or $5-A+2$ Path starting $E-3+B$ or $6-F+4$</p> <p>$D-2+A-5$ $E-3+B-4+F-6$</p> <p>Or</p> <p>II Path starting $D-2+A$ or $6-F+4$ followed by Path starting $E-3+C$ or $5-A+1$</p> <p>$D-2+A-1+C-3+B-4+F-6$ followed by $E-3+C-1+A-5$</p> <p>Or</p> <p>III Path starting $E-3+B$ or $5-A+2$ followed by Path starting $D-2+B$ or $6-F+4$</p> <p>$E-3+B-2+A-5$ followed by $D-2+B-4+F-6$</p> <p>Matching $A5, B4, C1, D2, E3, F6$</p>	<p>M1 M1</p> <p>A1 A1</p> <p>(M1) (M1)</p> <p>(A1) (A1)</p> <p>(M1) (M1)</p> <p>(A1) (A1)</p> <p>B1</p>		<p>Paths should be listed, but allow on diagram provided one path per diagram and start/end clearly labelled. Or reverse Or reverse</p> <p>Or reverse Or reverse</p> <p>Or reverse Or reverse</p> <p>Must be listed, not on a diagram</p>
	Total		5	

Notes:

For **II and III** the paths **MUST** be in the order stated. If order is reversed then the max mark is M0A0M1A1
Watch for alternative, but correct, notation (needs to be clear).

If using a diagram, two paths indicated on one diagram will score M0.

Use of one long path, usually by attempting to combine two shorter ones, can earn a max of M1 A0 M0.

Q2	Solution	Mark	Total	Comment
2 (a) (i)	<p>AC AD CE EH HG AB DF</p>	<p>M1 B1 A1 A1</p>	4	<p>Use of Prim's, first three edges (not numbers) correct 7 different edges Correct up to and including AB 6th All correct</p>
(ii)		<p>M1 A1</p>	2	<p>Spanning tree, no cycles, 8 vertices, 7 edges Correct, including labels but ignore any lengths</p>
(iii)	£1170	B1	1	Must include units.
(b)	<p>Replace CE with DG New cost £1200 or (value of their "£1170" + £30)</p>	<p>M1 A1F</p>	2	<p>PI Must include units.</p>
	Total		9	

Notes:

For a(i), accept a diagram with the order of selection of edges clearly indicated.

For (a)(iii) and (b) penalise omission of units in the first instance only.

Q3	Solution	Mark	Total	Comment
3a	15	B1	1	
b	8	B1	1	
c	1	B1	1	
d	$\frac{n(n-1)}{2}$ with $n = 16$ Or $\frac{n(n+1)}{2}$ with $n = 15$ or $15 + 14 + \dots + 1$ 120	M1	2	
Total			5	PI (clear attempt to sum 1 st 15 integers) NMS 120 scores 2/2

Q4	Solution	Mark	Total	Comment
4 (a) (i)		M1 A1 m1 A1 B1	5	Use of Dijkstra; two values at <i>E</i> and one at each of <i>G</i> and <i>H</i> Correct values only at <i>E</i> 2 values at each of <i>D</i> , <i>F</i> and <i>I</i> . Completely correct including all crossing out and boxing 19 at <i>J</i> . If stated in text as well, diagram takes precedence.
(ii)	Route <i>ABEHFJ</i> or reverse	B1	1	Must be listed, not just marked on diagram.
(b)	$12 + 19 + 3 (= 34)$ 11.04 (a.m.)	M1 A1F	2	Their final values for <i>AD</i> and <i>AJ</i> + 3 11.04 unsupported scores 2/2
Total			8	

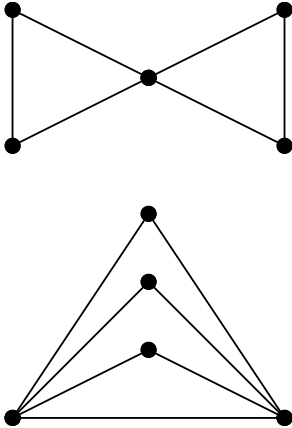
Q5	Solution	Mark	Total	Comment
5 (a)	$AB+CG = (50 + 240) = 290$	M1		These 3 pairs stated including the intention to add 3 correct totals, 2 correct totals Of three totals PI CSO Must include units
	$AC+BG = (100 + 230) = 330$	A2,1		
	$AG+BC = (210 + 70) = 280$	m1		
	Solution = 1400 + their min total = 1680 m	A1	5	
(b)(i)	3	B1		
(ii)	3	B1	2	
	Total		7	

Notes:

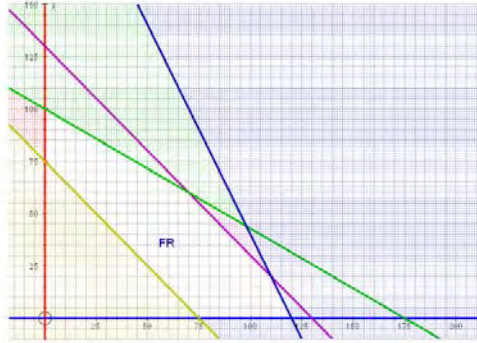
For 5(a), SC if M0 scored then 1680 m scores 2/5. Must include units.

For 5(a), SC if M0 scored then 1680 scores 1/5 (no units)

Q	Solution	Mark	Total	Comment																																																	
6 (a)	<table border="1"> <tr> <td></td> <td>A</td> <td>B</td> <td>C</td> <td>D</td> <td>E</td> <td>F</td> </tr> <tr> <td>A</td> <td>-</td> <td>7</td> <td>6</td> <td>5</td> <td>7</td> <td>10</td> </tr> <tr> <td>B</td> <td>7</td> <td>-</td> <td>5</td> <td>9</td> <td>14</td> <td>12</td> </tr> <tr> <td>C</td> <td>6</td> <td>5</td> <td>-</td> <td>4</td> <td>10</td> <td>8</td> </tr> <tr> <td>D</td> <td>5</td> <td>9</td> <td>4</td> <td>-</td> <td>6</td> <td>5</td> </tr> <tr> <td>E</td> <td>7</td> <td>14</td> <td>10</td> <td>6</td> <td>-</td> <td>10</td> </tr> <tr> <td>F</td> <td>10</td> <td>12</td> <td>8</td> <td>5</td> <td>10</td> <td>-</td> </tr> </table>		A	B	C	D	E	F	A	-	7	6	5	7	10	B	7	-	5	9	14	12	C	6	5	-	4	10	8	D	5	9	4	-	6	5	E	7	14	10	6	-	10	F	10	12	8	5	10	-	B2,1,0	2	- 1 each independent error
	A	B	C	D	E	F																																															
A	-	7	6	5	7	10																																															
B	7	-	5	9	14	12																																															
C	6	5	-	4	10	8																																															
D	5	9	4	-	6	5																																															
E	7	14	10	6	-	10																																															
F	10	12	8	5	10	-																																															
(b) (i)	$(7+10+12+5+4+5 =) 43$	B1	1	A possible solution to the problem, OE																																																	
(ii)	It is a Hamiltonian cycle	E1	1																																																		
(c)	DCBAEFD $(= 4+5+7+7+10+5 =) 38$	M1 A1 B1	3	Hamiltonian cycle from D Correct order Correct length																																																	
(d)	<table border="1"> <tr> <td></td> <td>A</td> <td>B</td> <td>C</td> <td>D</td> <td>E</td> <td>F</td> </tr> <tr> <td>A</td> <td>-</td> <td>7</td> <td>6</td> <td>5</td> <td>7</td> <td>10</td> </tr> <tr> <td>B</td> <td>7</td> <td>-</td> <td>5</td> <td>9</td> <td>14</td> <td>12</td> </tr> <tr> <td>C</td> <td>6</td> <td>5</td> <td>-</td> <td>4</td> <td>10</td> <td>8</td> </tr> <tr> <td>D</td> <td>5</td> <td>9</td> <td>4</td> <td>-</td> <td>6</td> <td>5</td> </tr> <tr> <td>E</td> <td>7</td> <td>14</td> <td>10</td> <td>6</td> <td>-</td> <td>10</td> </tr> <tr> <td>F</td> <td>10</td> <td>12</td> <td>8</td> <td>5</td> <td>10</td> <td>-</td> </tr> </table> <p>MST BC, CD, DE, DF Edges from A: AC, AD</p> $(5+4+6+5)+(6+5) = 31$		A	B	C	D	E	F	A	-	7	6	5	7	10	B	7	-	5	9	14	12	C	6	5	-	4	10	8	D	5	9	4	-	6	5	E	7	14	10	6	-	10	F	10	12	8	5	10	-	M1 A1 A1 B1	4	6 different edges, not just numbers, of which exactly 2 are from A (seen in diagram, listed or in table) Correct MST (seen in diagram, listed or in table) Correct edges from A (listed, in table or seen in diagram and clearly identified)
	A	B	C	D	E	F																																															
A	-	7	6	5	7	10																																															
B	7	-	5	9	14	12																																															
C	6	5	-	4	10	8																																															
D	5	9	4	-	6	5																																															
E	7	14	10	6	-	10																																															
F	10	12	8	5	10	-																																															
(e)	$31 < T \leq 38$	B1 B1F	1	Their "31" < T ≤ their best of 2 ub provided lb ≤ ub Condone their "31" ≤ T ≤ their "38"																																																	
	Total		12																																																		

Q7	Solution	Mark	Total	Comment
7 (a)	$(m =) 4$ or 5	B1	2	Either value, with no incorrect values, Or both correct and ONE other value. Both values correct and no others
(b)	$(n =) 3, 4, 5$ or 6	B1		
(c)		B1	2	Three correct values and no incorrect values or all four correct with at most one extra value All correct with no extra values
		B1		
Total			6	
Notes: (a) An answer of 3, 4, 5, 6 scores B0 as 2 correct and 2 incorrect answers.				

Q8	Solution	Mark	Total	Comment																																																																																																																																																																																																												
8 (a)	<table border="1"> <thead> <tr> <th>N</th> <th>A</th> <th>B</th> <th>C</th> <th>D</th> <th>Print</th> </tr> </thead> <tbody> <tr><td>5</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td>1</td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td>1</td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td>0</td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td>1</td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td>2</td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td>1</td></tr> <tr><td>4</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td>1</td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td>2</td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td>2</td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td>3</td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td>1</td></tr> <tr><td>3</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td>2</td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td>3</td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td>4</td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td>5</td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td>2</td></tr> <tr><td>2</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td>3</td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td>5</td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td>7</td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td>8</td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td>3</td></tr> <tr><td>1</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td>5</td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td>8</td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td>12</td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td>13</td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td>5</td></tr> <tr><td>0</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td>12</td></tr> </tbody> </table>	N	A	B	C	D	Print	5							1							1							0						1							2							1	4							1							2							2							3							1	3							2							3							4							5							2	2							3							5							7							8							3	1							5							8							12							13							5	0											12			<p>For all marks: for each column/variable, condone 0s at the beginning of sequences and any repeated values</p> <p>For N: sequence "5,4,3" M1</p> <p>For N: sequence "5,4,3,2,1,0" A1</p> <p>For B: sequence "1,2,3,5,8" and for D: sequence "2,3,5,8,13" A1</p> <p>All prints seen and correct B1</p> <p>Complete correct solution including all prints seen A1</p>
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(b)	N is used as a stopping condition	E1	1	OE but not simply "a counter"																																																																																																																																																																																																												
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Q9	Solution	Mark	Total	Comment	
9	(a) $400x + 400y + 600z \leq 130000$ ($2x + 2y + 3z \leq 650$) $200x + 500y + 200z \leq 70000$ ($2x + 5y + 2z \leq 700$) $400x + 100y + 200z \leq 72000$ ($4x + y + 2z \leq 720$) $z \geq 75$	B1		OE	
		B1		OE	
		B1		OE	
		B1	4	OE but z terms must be collected	
	(b) Substitute $z = x + y$ $2x + 2y + 3z \leq 650 \Rightarrow 5x + 5y \leq 650$ $\Rightarrow x + y \leq 130$ $2x + 5y + 2z \leq 700 \Rightarrow 4x + 7y \leq 700$ $4x + y + 2z \leq 720 \Rightarrow 6x + 3y \leq 720$ $\Rightarrow 2x + y \leq 240$ $z \geq 75 \Rightarrow x + y \geq 75$	M1		Clear substitution of $z = x + y$ into one of the first three inequalities	
		A1	2	All correct. AG. (with middle line in 1 st and 3 rd inequalities)	
	(c)		B1 B1 B1 B1		All points correct to within $\pm 1/2$ a small square vertically and horizontally and lines ruled Line through (130,0) and (0,130) Line through (175,0) and (0,100) Line through (120,0) and (80,80) Line through (75,0) and (0,75)
	(d)	(P=) $50x + 100y + 150z$ (P=) $200x + 250y$	M1 A1	2	PI or seen ISW
	(e) (i)	Either OL drawn with gradient -0.8	M1		Condone gradient of $-\frac{a}{b}$ or $-\frac{b}{a}$ from their final answer for part (d) $ax + by$
		$x = 70, y = 60$	A1 CSO		Dependent on gradient of -0.8
(ii)	or (0, 100) $P = \text{£}25000$ (70, 60) $P = \text{£}29000$ (110, 20) $P = \text{£}27000$ (120, 0) $P = \text{£}24000$ so max at $x = 70, y = 60$	(M1)		SCA Attempt to identify and list at least the four relevant vertices (OE from their hexagon) and attempt at finding some values of P .	
	$P = \text{£}29000$ 70 tonnes Basic, 60 (tonnes) Premium, 130 (tonnes) Supreme	(A1 CSO)	2	Must be clearly chosen from these four correct values	
		B1		Including £	
		B1	2	All three correct, including units. (Not just $x = 70, y = 60$ and $z = 130$.)	
	Total		17		

