Version



General Certificate of Education (A-level) January 2013

Mathematics

MD02

(Specification 6360)

Decision 2

Final



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Key to mark scheme abbreviations

М	mark is for method
m or dM	mark is dependent on one or more M marks and is for method
А	mark is dependent on M or m marks and is for accuracy
В	mark is independent of M or m marks and is for method and accuracy
E	mark is for explanation
\sqrt{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 <i>x</i> marks for each error
NMS	no method shown
PI	possibly implied
SCA	substantially correct approach
С	candidate
sf	significant figure(s)
dp	decimal place(s)

No Method Shown

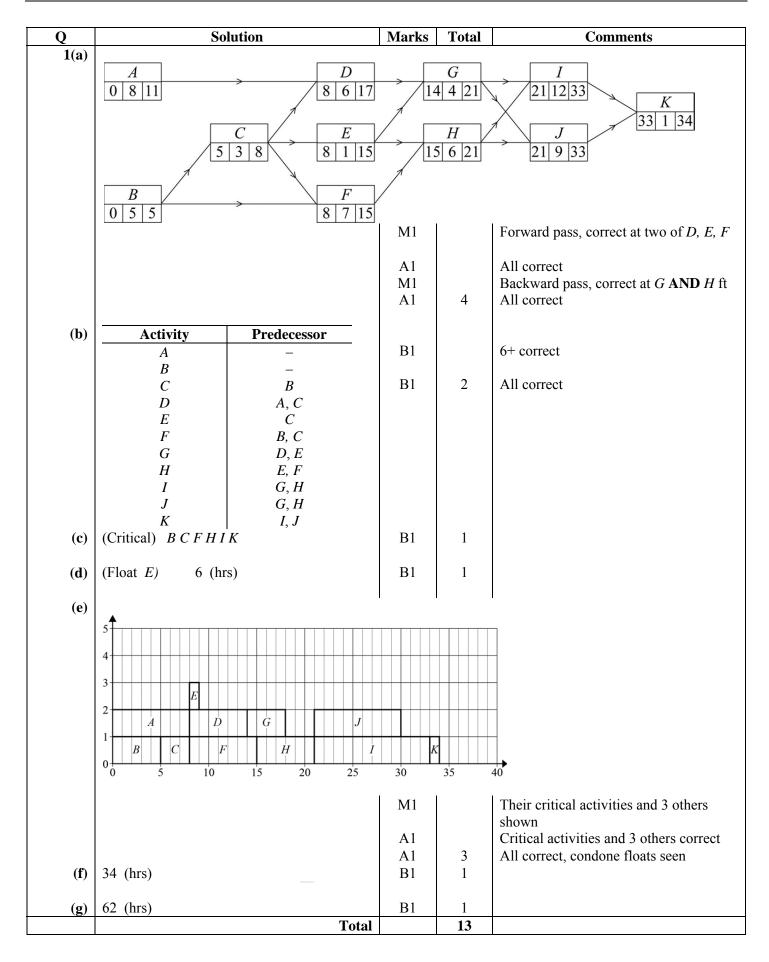
Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded.

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.



MD02				
Q	Solution	Marks	Total	Comments
2(a)	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$			
	Maximin (row) = 3	M1		Either correct, including correct values
	Minimax (col) = 3	A1 CSO		Both correct, written as equations PI by next line
	As Maximin (row) = Minimax (col) There is a stable solution	E1		Must have equation and statement and scored first 2 marks
	$ \begin{array}{l} \left(\begin{array}{cc} \text{Play safe} \right) (\text{H}) & B \\ \left(\begin{array}{cc} \text{Play safe} \end{array} \right) (\text{W}) & F \end{array} \end{array} $	B1	4	Both correct
(b)	Saddle point (B,F)	B1	1	
	Total		5	

MD02								
Q			Soluti			Marks	Total	Comments
3 (a)	(8	5	0	9	6			
	5	6	5	9	7	B1	1	
		10	12	12	11			
	(9	5	8	12	9)			
(b)	Add an ex	xtra rov	$w \ge 1$	2		B1		
	(8	5	0	9	6 (0)			
	5	6	5	9	7 (5)			
	11	10	12	12	11 (10)			
	9	5	8	12	9 (5)			
	(12	12	12	12	12)(12)			
	8 5			96				
	0 1			4 2		M1		3 rows correct from row reduction
	$ \begin{array}{cccc} 1 & 0 \\ 4 & 0 \end{array} $		3	2 1 7 4				
	0 0			0 0		A1		All correct
	(8	Þ	Ø	9	6)			Alternatives
	0	1	ø	4	2			(86-)
	1	0	2	2	1			$\left \begin{array}{ccc} 0 & 1 & 0 & 4 & 2 \end{array} \right $
	4	0	3	7	4			
	(0	•	0	-0)			
	(Zeros co	orrectly	covere	ed by 4 lir	nes)	B1F		
	Covered	in 4 lin	es not	ontimal		E1		*
	(reduce b			opullur		21		
	8	5	0	8	5			7 (8) 5 (6) D (0) 8 (9) 5 (6)
	ø	1	0	3	1			$\phi(0)$ 2 (2) 1 (0) 4 (4) 2 (2)
	1	0	2 3	1	0			$ \begin{array}{cccccccccccccccccccccccccccccccccccc$
	4	ľ	5 1	0	0 3 0			$\begin{array}{cccccccccccccccccccccccccccccccccccc$
				•	U U	B1		
	5 lines needed, optimal					(E1)		*or earned here
	Match V	VC V	Δ VE	7R (-D)	B1		
	Value $=$		п, <i>I</i> Е	, <i>LD</i> , (-D)	B1 B1	8	
					Total		9	

MD02				
Q	Solution	Marks	Total	Comments
(4)(a)(i)	Max Flow = 50 (Min cut = 50)	E1		Either statement
(ii)	$35 \le \max \text{ flow } \le 50$ (or min cut)	E1, E1		E1 for strict inequalities
(iii)	Error or contradiction	E1	4	oe
(b)	At F,			
	$ \begin{array}{c} \text{flow in} \geq 8 \\ \text{flow out} \leq 7 \end{array} \right\} $	M1 A1	2	Stating F and one of the 'flows'
	Total		6	

MD02								
Q	Solution	Marks	Total	Comments				
5(a)	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	B2,1,0	2	All correct, 3 rows correct				
(b)(i)	<i>z</i> -col: $\frac{16}{1}, \frac{17}{2}, \frac{19}{2}$ Min, R_3 as pivot	M1 A1	2					
(ii)	$1 \frac{1}{2} -1 0 0 1\frac{1}{2} 0 \frac{51}{2}$	M1		Row operations				
	$0 \frac{1}{2} 2 0 1 -\frac{1}{2} 0 \frac{15}{2}$	A1		One row (other than R_3) correct				
	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	A1	3	All correct				
	Alternative							
	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	(M1) (A1) (A1)						
(c)(i)	$y \text{ col } \frac{15}{4}, \left(-\frac{17}{2}\right), \frac{2}{1}$ R_4 as pivot	B1		Fully correct description				
	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	M1		Row operations				
	0 1 1 0 0 -1 1 2	A1	3	All correct				
	Alternative 2 3 0 0 1 2 55							
	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	(M1) (A1)						
	0 1 1 0 0 -1 1 2							
(c)(ii)	Optimal							
	$P = \frac{55}{2}$ x = 0, y = 2, z = $\frac{21}{2}$ s = t = 0, r = $\frac{7}{2}$	B1		Both statement and value needed. OE				
	$x=0, y=2, z=\frac{21}{2}$	B1						
		B1	3					
	Total		13					

MD02				
Q	Solution	Marks	Total	Comments
6(a)	$R_C > R_B$	E1	1	oe
(b)	$ \begin{array}{cccc} A & -2 & 0 & 3 \\ C & 4 & 1 & -1 \end{array} $			
	K plays A prob p			
	C prob $1-p$			
	<i>P</i> plays			
	D, K wins $-2p + 4(1-p) (= 4-6p)$	M1		Allow 2 expressions in unsimplified
	E, K wins 1-p	A1		form All 3 correct
	F, K wins $3p-1(1-p)$ $(=-1+4p)$			
	4			
		M1		Must have 3 lines
	-2	A1		With values shown
	Max at $1-p = -1+4p$	M1		Identifying correct maximum from their graph
	$p = \frac{2}{5}$			
	$(K \text{ plays}) A \text{ prob } \frac{2}{5}, C \text{ prob } \frac{3}{5}$	A1		Both stated, coming from equating correct two equations and M2 scored
	Value of game = $\frac{3}{5}$	B1	7	

MD02				
Q	Solution	Marks	Total	Comments
6(c)	P plays D prob p E " q F " 1-p-q K plays A P losse	M1		Either (mained if ad) arrangeion agreet
	K plays A, P loses -2p + 3(1-p-q) = 3 - 5p - 3q K plays C, P loses 4p+q-1(1-p-q) = -1+5p+2q $3-5p-3q = \frac{3}{2}$	M1		Either (unsimplified) expression correct
	$3-5p-3q = \frac{3}{5}$ $\frac{-1+5p+2q = \frac{3}{5}}{2}$ $\frac{-q = \frac{6}{5}}{2}$	m1		Equating BOTH of their expressions to value of their game
	$q = \frac{4}{5}$	A1 CSO		Or for finding <i>p</i>
	$5p + \frac{8}{5} - 1 = \frac{3}{5}$ $p = 0$ $P \text{ plays } D \text{ prob } 0$ $E, \text{ prob } \frac{4}{5}$			
	F , prob $\frac{1}{5}$	E1	4	All three needed, must have scored previous A mark
	Alternative method			
	Probability of <i>D</i> is 0	(E1)		OE, might be earned in final line
	$3(1-p) = \frac{3}{5}$ or $p-1(1-p) = \frac{3}{5}$	(M1)		Or equating the expressions
	$p = \frac{4}{5}$	(m1)		
	$E \operatorname{prob} \frac{4}{5}$ $F \operatorname{prob} \frac{1}{5}$	(A1) CSO		
	Total		12	

Q			Solutio	n	Marks	Total	Comments
7(a)	Stage	State	From	Value			
	1	G	Ι	15			
		Н	Ι	12			
	2	Ε	G	$15+15=30 \leftarrow$			
			Н	12 + 16 = 28			
					B1		Stage 2 values correct
		F	G	15+13=28			
			Н	12+17=29←			
	3	В	Ε	30+16 = 46			
					M1		Coloritations Associates at stars 2
		С	E	30+14 = 44 ←	M1 m1		Calculating 4 values at stage 3 Using max values at <i>E</i> and <i>F</i>
			F	29+12 = 41	1111		Using max values at E and F
		D	F	29 + 15 = 44	A1		All 4 values correct
					111		
	4	A	В	46+12 = 58			
			С	44+20=64 ←			
					m1		Using max at C
			D	44 + 18 = 62	A1		All correct
					B1	7	Identifying 64 as maximum value
(b)	Route A	A C E G	Ι		B1	1	
				Total		8	

MD02				
Q	Solution	Marks	Total	Comments
(8)(a)	A B E H 8 A C F H 5 A D G H 11	B1	1	
(b)(i)	ACEH 2 ACGH 4 Either ADFH 1 and ABFH 2 Or ADFH 3	M1 A1 A1		One correct route and flow At least one other correct All correct
	$A = \begin{bmatrix} B & \frac{8}{42} & E \\ & & & & & \\ & & & & & \\ & & & & &$	M1		Forward and back flows on diagram
(**)	$D \xrightarrow{0} G$	A1	5	All correct
(ii)	Max flow 33 [9](8) 10 2 (0) 10 10 2 4 (1) C 5 F 8 H (1) $(2)(3)$ (14) D (1) G (15) $(1$	B1 B1	2	OE
(c)	Cut through BE, CE, FH, CG, DG	B1	1	
	Total		9	
	TOTAL		75	