



# A-LEVEL MATHEMATICS

Decision 2 – MD02

Mark scheme

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6360  
June 2014

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Version/Stage Final V1.0

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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](http://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**.

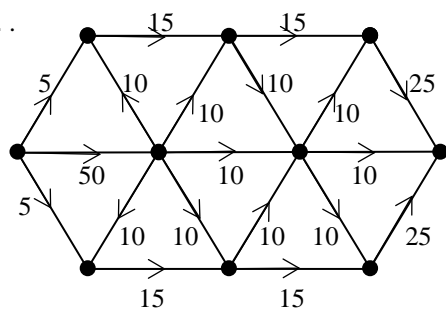
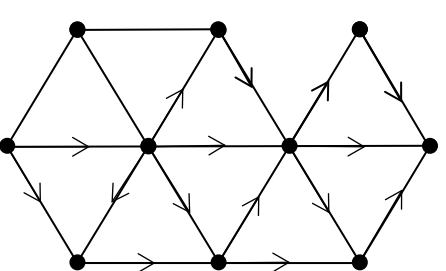
Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

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.**

Q	Solution	Mark	Total	Comment
1(a)				
(a)		M1 A2	3	Network diagram -1 each independent error (ignore extra 'end' box)
(b)		M1 A1	2	Forward pass, correct at D, E, F
(c)		M1 A1	2	Backward pass, correct at 3 of D, E, F, G ft
(d)	A, C, G, K, L (A), H, (L)	B1 B1	2 2	- 1 for each extra
	<b>Total</b>		<b>9</b>	

Q	Solution	Mark	Total	Comment
2(a)	Row min $-4, 0, -5$ Max (row min) = 0 Col max $5, 3, 0, 1$ Min (col max) = 0	M1	4	Attempt to find maximin and minimax  Accept 'F dominates G', col max $5, 3, 0$ All rowmin and colmax values correct and maximin and minimax identified Full statement involving maximin and minimax and both values = 0 If using dominance: Reduction to $2 \times 2$ M1 Reduction to $1 \times 1$ A1 Final statement E1
	Max (row min) = Min (col max) = 0 Hence game has a stable solution.	A1		
	Alex plays B Roberto plays F	E1		
(b)	Saddle point (B, F) ONLY	B1	1	
<b>Total</b>			<b>5</b>	

Q	Solution	Mark	Total	Comment
3(a)	$C_1 = 60$ $C_2 = 80$	B1 B1	2	Correct at D  Correct to D, E, F either by inspection or flow augmentation All correct
(b)	e.g. 	M1 A1	2	
(c)(i)		M1 A1	3	
	oe MAX = 45	B1		
(ii)	CUT THRU' EG, DG, DF, DC, AC Max flow = Min cut	B1 E1	2	
<b>Total</b>			<b>9</b>	

Q	Solution	Mark	Total	Comment																																																								
4(a)	<table border="1"> <thead> <tr> <th><i>P</i></th> <th><i>x</i></th> <th><i>y</i></th> <th><i>z</i></th> <th><i>r</i></th> <th><i>t</i></th> <th></th> </tr> </thead> <tbody> <tr> <td>1</td> <td>-3</td> <td>-6</td> <td>-2</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>3</td> <td>2</td> <td>1</td> <td>0</td> <td>11</td> </tr> <tr> <td>0</td> <td>3</td> <td>4</td> <td>2</td> <td>0</td> <td>1</td> <td>21</td> </tr> </tbody> </table>	<i>P</i>	<i>x</i>	<i>y</i>	<i>z</i>	<i>r</i>	<i>t</i>		1	-3	-6	-2	0	0	0	0	1	3	2	1	0	11	0	3	4	2	0	1	21	<b>B1</b> <b>B1</b>	<b>2</b>	1 <sup>st</sup> and 2 <sup>nd</sup> row correct 1 <sup>st</sup> and 3 <sup>rd</sup> row correct																												
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<i>P</i>	<i>x</i>	<i>y</i>	<i>z</i>	<i>r</i>	<i>t</i>																																																							
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<i>P</i>	<i>x</i>	<i>y</i>	<i>z</i>	<i>r</i>	<i>t</i>																																																							
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(d)	<p><math>P = 25.8</math>  <math>z = r = t = 0</math>  <math>x = 3.8, y = 2.4</math></p>	<b>A1</b> <b>B1</b> <b>B1</b> <b>B1</b>	<b>3</b> <b>3</b>	All correct																																																								
<b>Total</b>			<b>11</b>																																																									



Q	Solution	Mark	Total	Comment											
<p><b>5(a)</b> <i>A</i> dominates <i>B</i></p> <p><b>(b)</b> Reduced matrix</p> <table border="1" data-bbox="237 495 746 600"> <tr> <td></td> <td><i>p</i></td> <td><i>q</i></td> <td><math>1-p-q</math></td> </tr> <tr> <td><i>A</i></td> <td>4</td> <td>1</td> <td>-1</td> </tr> <tr> <td><i>C</i></td> <td>-2</td> <td>0</td> <td>3</td> </tr> </table> <p>Mark plays <i>A</i>, Owen loses  <math>4p + q + -1(1-p-q)</math>                      Mark plays <i>C</i>, Owen loses  <math>-2p + 3(1-p-q)</math>  <math>5p + 2q = 1.6</math></p> <p><math>-5p - 3q = -2.4</math>  <math>q = 0.8</math>  <math>p = 0</math>  <math>1-p-q = 0.2</math>                      Owen plays <i>D</i> with prob 0                      Owen plays <i>E</i> with prob 0.8                      Owen plays <i>F</i> with prob 0.2</p>		<i>p</i>	<i>q</i>	$1-p-q$	<i>A</i>	4	1	-1	<i>C</i>	-2	0	3	<p><b>E1</b></p> <p><b>E1</b></p> <p><b>M1</b></p> <p><b>A1</b></p> <p><b>m1</b></p> <p><b>A1</b></p> <p><b>A1</b></p> <p><b>B1</b></p>	<p><b>1</b></p> <p><b>7</b></p> <p><b>8</b></p>	<p>Use of '<math>1-p-q</math>'</p> <p>One correct expression or reverse</p> <p>Both correct or reverse                      Correct use of 0.6 (or -0.6)                      Condone simplified equations                      2 correct equations                      At least 2 correct</p> <p>All correct in context of <i>D, E, F</i></p>
	<i>p</i>	<i>q</i>	$1-p-q$												
<i>A</i>	4	1	-1												
<i>C</i>	-2	0	3												
	<b>Total</b>		<b>8</b>												



Q	Solution	Mark	Total	Comment	
<b>6(a)</b>	Stage 2	<b>B1</b>		4 correct values	
		<b>M1</b>		Choosing 2 'mins' out of 4 expressions	
	Stage 3	<b>m1</b>		4 expressions	
		<b>A1</b>		EG chosen	
	Stage 4	<b>m1</b>		4 expressions, 1 in terms of $x$	
	Stage 5	<b>B1</b>		Final value 48, indicated or stated	
		<b>A1</b>	<b>7</b>	All correct (complete table)	
	<b>(b)</b>	$x + 41 = 48$	<b>M1</b>		Their $(x + 8 + k) = \text{their (min)}$
		$x = 7$	<b>A1</b>	<b>2</b>	
	<b>(c)</b>	ABDGIK ABEGIK ACFHIK	<b>B1</b> <b>B1</b> <b>B1</b>	<b>3</b>	Condone reverse (x3)
<b>Total</b>			<b>12</b>		

Stage	State	From	Calculation	Value
1	<i>I</i>	<i>K</i>	12	12
	<i>J</i>	<i>K</i>	14	14
2	<i>G</i>	<i>I</i>	$15 + 12$	27
		<i>J</i>	$14 + 14$	(28)
	<i>H</i>	<i>I</i>	$12 + 13$	25
		<i>J</i>	$14 + 12$	(26)
3	<i>D</i>	<i>G</i>	$27 + x + 2$	$29 + x$
	<i>E</i>	<i>G</i>	$27 + 9$	36
		<i>H</i>	$25 + 12$	(37)
	<i>F</i>	<i>H</i>	$25 + 13$	38
4	<i>B</i>	<i>D</i>	$29 + x + 4$	$33 + x$
		<i>E</i>	$36 + 4$	40
	<i>C</i>	<i>E</i>	$36 + 9$	(45)
		<i>F</i>	$38 + 6$	44
5	<i>A</i>	<i>B</i>	$33 + x + 8$	$41 + x$
		<i>B</i>	$40 + 8$	48
	<i>A</i>	<i>C</i>	$44 + 4$	48

Q	Solution	Mark	Total	Comment																																
<b>7(a)</b>	Row minima: $(x + 4), (x + 2), (x + 5)$	<b>M1</b> <b>A1</b>	<b>2</b>	1 correct All 3 correct																																
<b>(b)</b>	<table border="1"> <tr><td>4</td><td>0</td><td>2</td><td>5</td></tr> <tr><td>3</td><td>1</td><td>2</td><td>0</td></tr> <tr><td>3</td><td>2</td><td>0</td><td><math>x - 3</math></td></tr> <tr><td>2</td><td><math>x - 4</math></td><td><math>11 - x</math></td><td>0</td></tr> </table> <p>Reduce cols to give</p> <table border="1"> <tr><td>2</td><td>0</td><td>2</td><td>5</td></tr> <tr><td>1</td><td>1</td><td>2</td><td>0</td></tr> <tr><td>1</td><td>2</td><td>0</td><td><math>x - 3</math></td></tr> <tr><td>0</td><td><math>x - 4</math></td><td><math>11 - x</math></td><td>0</td></tr> </table> <p>4 lines needed to cover 0's</p> <p>Match <i>AZ, BW, CY, DX</i> stated</p>	4	0	2	5	3	1	2	0	3	2	0	$x - 3$	2	$x - 4$	$11 - x$	0	2	0	2	5	1	1	2	0	1	2	0	$x - 3$	0	$x - 4$	$11 - x$	0	<b>M1</b> <b>A1</b>  <b>M1</b> <b>A1</b>  <b>E1</b>  <b>B1</b>	<b>7</b>	Using correct/'their' row minima  3 rows correct All correct  oe  Their expression = 42
4	0	2	5																																	
3	1	2	0																																	
3	2	0	$x - 3$																																	
2	$x - 4$	$11 - x$	0																																	
2	0	2	5																																	
1	1	2	0																																	
1	2	0	$x - 3$																																	
0	$x - 4$	$11 - x$	0																																	
<b>(c)</b>	$4x + 14 = 42$  $x = 7$	<b>M1</b>  <b>A1</b>	<b>2</b>																																	
<b>Total</b>			<b>11</b>																																	

Q	Solution	Mark	Total	Comment
<b>8(a)</b>	$x = 4$ $y = 17$ $z = 17$	<b>B1</b> <b>B1</b>	<b>2</b>	Any 2 correct All 3 correct
<b>(b)</b>	<i>B D G I K</i>	<b>B1</b>	<b>1</b>	
<b>c(i)</b>	Reduce <i>G</i> to 5 (as critical) oe  Reduce <i>F</i> to 4 or 5 Reduce <i>F</i> to 5  Don't reduce <i>E</i> (as path through E still not critical)	<b>E1</b>  <b>E1</b> <b>E1</b> <b>E1</b>		Decrease <i>G</i> by 3  Decrease <i>F</i> by 2 or 3 Decrease <i>F</i> by 2 Condone new values shown on diagram
<b>(ii)</b>	25 (weeks)	<b>B1</b>		
<b>(iii)</b>	Cost $(3 \times 6 + 2 \times 7)$ PI by 32 = £32 000	<b>M1</b> <b>A1</b>	<b>7</b>	
<b>Total</b>			<b>10</b>	
<b>TOTAL</b>			<b>75</b>	