

A-LEVEL

Mathematics

Decision 2 – MD02

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
1a	Activity	Predecessor(s)	B1	1	All correct
	A	-			
	B	-			
	C	-			
	D	A, B			
	E	B			
	F	B, C			
	G	D			
	H	D, E, F			
	I	G, H			
J	G, H				
1b	Activity	Early	Late	M1 A1	Forward pass, correct at G and H. All correct
	A	0	7		
	B	0	5		
	C	0	5		
	D	7	13		
	E	5	13		
	F	5	13		
	G	13	19		
	H	13	19		
	I	19	28		
J	19	28			
1c	ADHJ		B1	2	One correct Both correct, and no more
	BFHJ		B1		
1d	1		B1	1	
1e	SCA		M1	3	Must be Gantt diagram Two of C, E, G, I correct
	Use of floats		B1		
	All correct		A1		
1f	65 (hours)		B1	1	
1g	34 (hours)		M1	2	Or any other correct allocation
	Worker 1: A, C, F, G, J Worker 2: B, E, D, H, I		A1		
Total				14	

Q2	Solution	Mark	Total	Comment
2a	Stan: Row(min) (-3, -4, -3) Max(min) -3	B1*		Earned here, all 3 values seen and -3 highlighted or stated, or BOTH correct playsafe stated. Both needed
	Playsafe 'A or C'	B1		
	Christine: Col(max) (3, 0, 2, 3) Min(max) 0	(B1)*		Or here, all 4 values seen and 0 highlighted or stated, or correct playsafe stated
	Playsafe E	B1	3	
2b	Maximin = -3 ≠ 0 = Minimax	E1	1	
2c	Col E 'dominates' Col D	E1		
	Col F 'dominates' Col G	E1		
	Original matrix shows Christine's losses, but as zero-sum game multiply by -1 to show Christine's gains	E1		
	Matrix transposed as now seen from Christine's perspective	E1	4	
	Total		8	

Q3	Solution	Mark	Total	Comment																																																		
3	Add extra column Reduce cols:	B1		with all values the same, at least 10.31																																																		
	<table border="1"> <tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0.44</td><td>0.15</td><td>0.26</td><td>0.35</td><td>0</td></tr> <tr><td>0.47</td><td>0.2</td><td>0.24</td><td>0.48</td><td>0</td></tr> <tr><td>0.2</td><td>0.16</td><td>0.21</td><td>0.31</td><td>0</td></tr> <tr><td>0.07</td><td>0.04</td><td>0.11</td><td>0.04</td><td>0</td></tr> </table>	0	0	0	0	0	0.44	0.15	0.26	0.35	0	0.47	0.2	0.24	0.48	0	0.2	0.16	0.21	0.31	0	0.07	0.04	0.11	0.04	0	M1		At least 3 cols correct.																									
	0	0	0	0	0																																																	
	0.44	0.15	0.26	0.35	0																																																	
	0.47	0.2	0.24	0.48	0																																																	
	0.2	0.16	0.21	0.31	0																																																	
	0.07	0.04	0.11	0.04	0																																																	
			A1		All correct																																																	
	Reduce by 0.04 (Covered with 2 lines),		m1		PI, by values in following matrix																																																	
	<table border="1"> <tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0.04</td></tr> <tr><td>0.4</td><td>0.11</td><td>0.22</td><td>0.31</td><td>0</td></tr> <tr><td>0.43</td><td>0.16</td><td>0.2</td><td>0.44</td><td>0</td></tr> <tr><td>0.16</td><td>0.12</td><td>0.17</td><td>0.27</td><td>0</td></tr> <tr><td>0.03</td><td>0</td><td>0.07</td><td>0</td><td>0</td></tr> </table>	0	0	0	0	0.04	0.4	0.11	0.22	0.31	0	0.43	0.16	0.2	0.44	0	0.16	0.12	0.17	0.27	0	0.03	0	0.07	0	0		A1		All correct																								
0	0	0	0	0.04																																																		
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0.16	0.12	0.17	0.27	0																																																		
0.03	0	0.07	0	0																																																		
Reduce by 0.11, (Covered with 3 lines)		m1		PI, by values in following matrix																																																		
<table border="1"> <tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0.15</td></tr> <tr><td>0.29</td><td>0</td><td>0.11</td><td>0.2</td><td>0</td></tr> <tr><td>0.32</td><td>0.05</td><td>0.09</td><td>0.33</td><td>0</td></tr> <tr><td>0.05</td><td>0.01</td><td>0.06</td><td>0.16</td><td>0</td></tr> <tr><td>0.03</td><td>0</td><td>0.07</td><td>0</td><td>0.11</td></tr> </table>	0	0	0	0	0.15	0.29	0	0.11	0.2	0	0.32	0.05	0.09	0.33	0	0.05	0.01	0.06	0.16	0	0.03	0	0.07	0	0.11																													
0	0	0	0	0.15																																																		
0.29	0	0.11	0.2	0																																																		
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0.05	0.01	0.06	0.16	0																																																		
0.03	0	0.07	0	0.11																																																		
Reduce by 0.05 (in 1 or more iterations) (Covered with 4 lines)		m1		Or, Reduce by 0.01 (Covered with 4 lines)																																																		
<table border="1"> <tr><td>0</td><td>0.05</td><td>0</td><td>0</td><td>0.2</td></tr> <tr><td>0.24</td><td>0</td><td>0.06</td><td>0.15</td><td>0</td></tr> <tr><td>0.27</td><td>0.05</td><td>0.04</td><td>0.28</td><td>0</td></tr> <tr><td>0</td><td>0.01</td><td>0.01</td><td>0.11</td><td>0</td></tr> <tr><td>0.03</td><td>0.05</td><td>0.07</td><td>0</td><td>0.16</td></tr> </table>	0	0.05	0	0	0.2	0.24	0	0.06	0.15	0	0.27	0.05	0.04	0.28	0	0	0.01	0.01	0.11	0	0.03	0.05	0.07	0	0.16				<table border="1"> <tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0.16</td></tr> <tr><td>0.29</td><td>0</td><td>0.11</td><td>0.2</td><td>0.01</td></tr> <tr><td>0.31</td><td>0.04</td><td>0.08</td><td>0.32</td><td>0</td></tr> <tr><td>0.04</td><td>0</td><td>0.05</td><td>0.15</td><td>0</td></tr> <tr><td>0.03</td><td>0</td><td>0.07</td><td>0</td><td>0.12</td></tr> </table>	0	0	0	0	0.16	0.29	0	0.11	0.2	0.01	0.31	0.04	0.08	0.32	0	0.04	0	0.05	0.15	0	0.03	0	0.07	0	0.12
0	0.05	0	0	0.2																																																		
0.24	0	0.06	0.15	0																																																		
0.27	0.05	0.04	0.28	0																																																		
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				AND Covered with 4 lines, reduce by 0.04																																																		
				<table border="1"> <tr><td>0</td><td>0.04</td><td>0</td><td>0</td><td>0.20</td></tr> <tr><td>0.25</td><td>0</td><td>0.07</td><td>0.16</td><td>0.01</td></tr> <tr><td>0.27</td><td>0.04</td><td>0.04</td><td>0.28</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>0.01</td><td>0.11</td><td>0</td></tr> <tr><td>0.03</td><td>0.04</td><td>0.07</td><td>0</td><td>0.16</td></tr> </table>	0	0.04	0	0	0.20	0.25	0	0.07	0.16	0.01	0.27	0.04	0.04	0.28	0	0	0	0.01	0.11	0	0.03	0.04	0.07	0	0.16																									
0	0.04	0	0	0.20																																																		
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0	0	0.01	0.11	0																																																		
0.03	0.04	0.07	0	0.16																																																		
Correct final matrix, with no errors seen		A1		There are other correct combinations but must reduce by 0.05																																																		
Covered by 5 lines, (so optimal) (Match) A3, B2, D1, E4 (Time) 36.82 (secs)		E1 B1 B1		Must see statement Condone C5																																																		
	Total		11																																																			

Q 4	Solution								Mark	Total	Comment
4a	P	x	y	z	r	t	u	V	M1	2	3 rows correct
	1	-2	-3	-4	0	0	0	0			
	0	1	1	2	1	0	0	20			
	0	3	2	1	0	1	0	30			
	0	2	3	1	0	0	1	40			
bi	Row 2 in z-col 20/2 (= 10) (min), 30/1 (= 30), 40/1 (= 40)								B1 E1	2	May be seen in part (a)
	For all following matrices, accept any multiple of any row shown										
b ii	1	0	-1	0	2	0	0	40	M1 A1 A1	3	SCA – row reduction, 1 row correct (other than pivot row - shaded) 3 rows correct All 4 correct
	0	0.5	0.5	1	0.5	0	0	10			
	0	2.5	1.5	0	-0.5	1	0	20			
	0	1.5	2.5	0	-0.5	0	1	30			
	OR										
1	0	-1	0	2	0	0	40	M1 A1 A1	3	As above	
0	1	1	2	1	0	0	20				
0	5	3	0	-1	2	0	40				
0	3	5	0	-1	0	2	60				

ci	Pivot from y-col 10/0.5 (= 20), 20/1.5 (= 13.3), 30/2.5 (= 12)	B1ft		May be seen in part (b)(ii)																																
	<table border="1"> <tr><td>1</td><td>0.6</td><td>0</td><td>0</td><td>1.8</td><td>0</td><td>0.4</td><td>52</td></tr> <tr><td>0</td><td>0.2</td><td>0</td><td>1</td><td>0.6</td><td>0</td><td>-0.2</td><td>4</td></tr> <tr><td>0</td><td>1.6</td><td>0</td><td>0</td><td>-0.2</td><td>1</td><td>-0.6</td><td>2</td></tr> <tr><td>0</td><td>0.6</td><td>1</td><td>0</td><td>-0.2</td><td>0</td><td>0.4</td><td>12</td></tr> </table>	1	0.6	0	0	1.8	0	0.4	52	0	0.2	0	1	0.6	0	-0.2	4	0	1.6	0	0	-0.2	1	-0.6	2	0	0.6	1	0	-0.2	0	0.4	12	m1		SCA – row reduction, 1 row correct (other than pivot row - shaded), must have scored at least M1 in (b)(ii), but allow any one row correct from a previous error
1	0.6	0	0	1.8	0	0.4	52																													
0	0.2	0	1	0.6	0	-0.2	4																													
0	1.6	0	0	-0.2	1	-0.6	2																													
0	0.6	1	0	-0.2	0	0.4	12																													
	OR	A1	3	All 4 correct																																
	Pivot from y-col 20/1 (= 20), 40/3 (= 13.3), 60/5 (= 12)			As above																																
	<table border="1"> <tr><td>5</td><td>3</td><td>0</td><td>0</td><td>9</td><td>0</td><td>2</td><td>260</td></tr> <tr><td>0</td><td>2</td><td>0</td><td>10</td><td>6</td><td>0</td><td>-2</td><td>40</td></tr> <tr><td>0</td><td>16</td><td>0</td><td>0</td><td>-2</td><td>10</td><td>-6</td><td>20</td></tr> <tr><td>0</td><td>3</td><td>5</td><td>0</td><td>-1</td><td>0</td><td>2</td><td>60</td></tr> </table>	5	3	0	0	9	0	2	260	0	2	0	10	6	0	-2	40	0	16	0	0	-2	10	-6	20	0	3	5	0	-1	0	2	60			
5	3	0	0	9	0	2	260																													
0	2	0	10	6	0	-2	40																													
0	16	0	0	-2	10	-6	20																													
0	3	5	0	-1	0	2	60																													
	For this part, answers must be from a row of 'positives' in 'profit'																																			
ii	Max/Optimal $P = 52$ $x = 0, y = 12, z = 4$ $r = 0, t = 2, u = 0$	B1ft B1ft B1ft	3	Must include Max/Optimal Must be non-negative values																																
Total			13																																	

Q5	Solution				Mark	Total	Comment
5a	Stage	State	From	Value	B1 M1		7 values at stage 2 Using minimax – choosing at least 2 of EI, FJ, GI (PI by values seen at stage 3)
	1	H	K	2.7			
		I	K	2.3			
		J	K	2.5			
	2	E	H	2.7			
			I	2.4*			
		F	H	2.7			
			I	2.6			
			J	2.5*			
		G	I	2.6*			
			J	2.9			
					A1		All values correct at stage 2
	3	B	E	2.8	B1 m1		7 values at stage 3 At least 5 values correct
			F	2.7*			
		C	E	2.8			
			F	2.5*			
			G	2.6			
		D	F	2.8			
			G	2.7*			
				A1		All values correct at stage 3	
	4	A	B	2.7	B1 A1		3 values at stage 4 All correct, with 2.5 identified as min
			C	2.5*			
			D	2.7			
	Route ACFJK				B1		In this order and not reverse
b	(Tom's route) ACGIK				B1	9	In this order and not reverse
	(Max height) 260 metres oe				B1		
Total						11	

Q6	Solution	Mark	Total	Comment														
6a	100	B1	1															
bi	<table border="1"> <thead> <tr> <th>Path</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>ABDGJ</td> <td>3</td> </tr> <tr> <td>ABDEGJ</td> <td>1</td> </tr> <tr> <td>AEHJ</td> <td>3</td> </tr> <tr> <td>AEGJ</td> <td>1</td> </tr> <tr> <td>AFIJ</td> <td>5</td> </tr> <tr> <td>AEIJ</td> <td>5</td> </tr> </tbody> </table>	Path	Value	ABDGJ	3	ABDEGJ	1	AEHJ	3	AEGJ	1	AFIJ	5	AEIJ	5	B1		Correct initial diagram on AB, AE, AC Showing forward and back flows
	Path	Value																
	ABDGJ	3																
	ABDEGJ	1																
	AEHJ	3																
	AEGJ	1																
	AFIJ	5																
AEIJ	5																	
		M1		One correct path (including value)														
		A1		3 correct paths (including values)														
		A1		Total increase in flows of exactly 18														
	Oe these are examples of a set of complete flows, but they are not unique	A1		Fully correct diagram														
			5															
ii	Max flow 118 Correct diagram	M1 A1	2															
c	Cut through GJ, GH, EH, EI, FI Edges listed	B1 B1	2	Could be shown on diagram														
d	Current flow is 35, subtract 5 113	E1 B1	2	113 scores 2/2														
Total																		

Q	Solution	Mark	Total	Comment
7	Marks for this question can be earned in either order			Eg, finding x first from similt equ.
a	Arsene plays A with prob p, plays B with prob 1-p			
	Jose plays C: A wins $p(x+3) + (1-p)(x+1)$	B1		oe could be seen in part (b)
	Jose plays D: A wins $p + 3(1-p)$	B1		oe
	$p + 3(1-p) = 2.5$	M1		
	(p = 0.25) Arsene plays A with prob 0.25 Arsene plays B with prob 0.75	A1	4	Need both statements
b	$0.25(x+3) + 0.75(x+1) = 2.5$	M1		Replacing p by 0.25 in a correct expression, and equating to 2.5
	$x = 1$	A1	2	
Total			6	

