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.

<table>
<tr><th>Q1</th><th>Solution</th><th>Mark</th><th>Total</th><th>Comment</th></tr>
<tr><td>1a</td><td>
<table>
<tr><th>Activity</th><th>Predecessor(s)</th></tr>
<tr><td>A</td><td>-</td></tr>
<tr><td>B</td><td>-</td></tr>
<tr><td>C</td><td>-</td></tr>
<tr><td>D</td><td>A, B</td></tr>
<tr><td>E</td><td>B</td></tr>
<tr><td>F</td><td>B, C</td></tr>
<tr><td>G</td><td>D</td></tr>
<tr><td>H</td><td>D, E, F</td></tr>
<tr><td>I</td><td>G, H</td></tr>
<tr><td>J</td><td>G, H</td></tr>
</table>
</td><td>B1</td><td>1</td><td>All correct</td></tr>
<tr><td>1b</td><td>
<table>
<tr><th>Activity</th><th>Early</th><th>Late</th></tr>
<tr><td>A</td><td>0</td><td>7</td></tr>
<tr><td>B</td><td>0</td><td>5</td></tr>
<tr><td>C</td><td>0</td><td>5</td></tr>
<tr><td>D</td><td>7</td><td>13</td></tr>
<tr><td>E</td><td>5</td><td>13</td></tr>
<tr><td>F</td><td>5</td><td>13</td></tr>
<tr><td>G</td><td>13</td><td>19</td></tr>
<tr><td>H</td><td>13</td><td>19</td></tr>
<tr><td>I</td><td>19</td><td>28</td></tr>
<tr><td>J</td><td>19</td><td>28</td></tr>
</table>
</td><td>M1
A1

M1

A1ft</td><td>4</td><td>Forward pass, correct at G and H.
All correct

Back pass correct at D, E, F from their final total time
All correct</td></tr>
<tr><td>1c</td><td>ADHJ
BFHJ</td><td>B1
B1</td><td>2</td><td>One correct
Both correct, and no more</td></tr>
<tr><td>1d</td><td>1</td><td>B1</td><td>1</td><td></td></tr>
<tr><td>1e</td><td>SCA
Use of floats
All correct</td><td>M1
B1
A1</td><td>3</td><td>Must be Gantt diagram
Two of C, E, G, I correct</td></tr>
<tr><td>1f</td><td>65 (hours)</td><td>B1</td><td>1</td><td></td></tr>
<tr><td>1g</td><td>34 (hours)
Worker 1: A, C, F, G, J
Worker 2: B, E, D, H, I</td><td>M1

A1</td><td>2</td><td>Or any other correct allocation</td></tr>
<tr><td></td><td>Total</td><td></td><td>14</td><td></td></tr>
</table>

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.
	Playsafe 'A or C'	**B1**		Both needed
	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 Col F 'dominates' Col G Original matrix shows Christine's losses, but as zero-sum game multiply by -1 to show Christine's gains Matrix transposed as now seen from Christine's perspective	**E1** **E1** **E1** **E1**	**4**	
	Total		**8**	

<table>
<tr><th>Q3</th><th>Solution</th><th>Mark</th><th>Total</th><th>Comment</th></tr>
<tr><td>3</td><td>Add extra column
Reduce cols:

<table><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>
Reduce by 0.04 (Covered with 2 lines),

<table><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>
Reduce by 0.11, (Covered with 3 lines)

<table><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>
Reduce by 0.05 (in 1 or more iterations) (Covered with 4 lines)

<table><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>
Correct final matrix, with no errors seen

Covered by 5 lines, (so optimal)
(Match) A3, B2, D1, E4
(Time) 36.82 (secs)</td><td>B1

M1

A1

m1

A1

m1

m1

A1

E1
B1
B1</td><td></td><td>with all values the same, at least 10.31

At least 3 cols correct.

All correct

PI, by values in following matrix

All correct

PI, by values in following matrix

Or,
Reduce by 0.01 (Covered with 4 lines)

<table><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>
AND
Covered with 4 lines, reduce by 0.04

<table><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>
There are other correct combinations but must reduce by 0.05

Must see statement
Condone C5</td></tr>
<tr><td></td><td>Total</td><td></td><td>11</td><td></td></tr>
</table>

Q 4	Solution	Mark	Total	Comment
4a				
	P x y z r t u V 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	**M1** **A1**	 2	3 rows correct All correct
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 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	**M1** **A1** **A1**	 3	SCA – row reduction, 1 row correct (other than pivot row - shaded) 3 rows correct All 4 correct
	OR			
	1 0 -1 0 2 0 0 40 0 1 1 2 1 0 0 20 0 5 3 0 -1 2 0 40 0 3 5 0 -1 0 2 60			As above

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)
	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
		A1	3	All 4 correct
	OR Pivot from *y*-col 20/1 (= 20), 40/3 (= 13.3), 60/5 (= 12)			
	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			As above
	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
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
3	B	E	2.8
		F	2.7*
	C	E	2.8
		F	2.5*
		G	2.6
	D	F	2.8
		G	2.7*
4	A	B	2.7
		C	2.5*
		D	2.7

	B1		7 values at stage 2
	M1		Using minimax – choosing at least 2 of EI, FJ, GI (PI by values seen at stage 3)
	A1		All values correct at stage 2
	B1		7 values at stage 3
	m1		At least 5 values correct
	A1		All values correct at stage 3
	B1		3 values at stage 4
	A1		**All** correct, with 2.5 identified as min
Route ACFJK	**B1**	**9**	In this order and not reverse
b (Tom's route) ACGIK	**B1**		In this order and not reverse
(Max height) 260 metres oe	**B1**	**2**	Must have units
	Total	**11**	

Q6	Solution	Mark	Total	Comment
6a	100	**B1**	**1**	
bi	<table><tr><td>Path</td><td>Value</td></tr><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></table>	**B1** **M1** **A1** **A1**		Correct initial diagram on AB, AE, AC Showing forward and back flows One correct path (including value) 3 correct paths (including values) 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 simult equs.
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) Jose plays D: A wins p + 3(1-p) p + 3(1-p) = 2.5 (p = 0.25) Arsene plays A with prob 0.25 Arsene plays B with prob 0.75	 **B1** **B1** **M1** **A1**	 **4**	 **oe** could be seen in part (b) **oe** Need both statements
b	0.25(x+3) + 0.75(x+1) = 2.5 x = 1	**M1** **A1**	 **2**	Replacing p by 0.25 in a correct expression, and equating to 2.5
	Total		**6**	