AQA

ASSESSMENT and
QUALIFICATIONS
ALLIANCE

General Certificate of Education

Mathematics 6360

MD02   Decision 2

Mark Scheme

2008 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**.

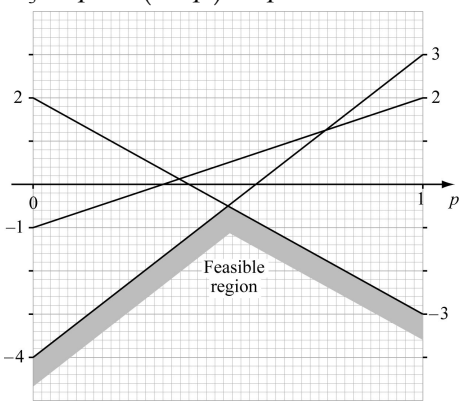**Otherwise we require evidence of a correct method for any marks to be awarded.**

MD02

Q	Solution	Marks	Total	Comments
1				

Q	Solution	Marks	Total	Comments
(a)	Earliest start times	M1		up to 2 errors ft
	All correct	A1		
	Latest finish times	M1		up to 2 errors ft from K
	Correct	A1	4	
(b)	Critical paths $A\ D\ G\ I\ K$	B1		
	$\qquad\qquad\ A\ D\ H\ J\ K$	B1		withhold if extra path such as $A\ D\ G\ J\ K$ given
	Minimum time for completion = 22 days	B1	3	Must be stated – not just a value in box on insert
(c)				

Q	Solution	Marks	Total	Comments
	A, D, G, H, I, J, K correct	B1		
		B1		2 correct with slack /float or 4 correct & no slack
	B, C, E, F			
		B1	3	all correct with slack/float; withhold if slack not shown dotted etc
(d)	F starts after 12 days at earliest			
	or F starts 2 days later			
		E1		
	I is now unable to start until after 16 days			
	or I starts 1 day later			
	Minimum completion time now 23 days – one extra day etc	B1	2	

	Total		**12**	

4

MD02 (cont)

Q	Solution	Marks	Total	Comments
2(a)	Hungarian algorithm minimises $20 - x$ indicates how many points NOT scored	E1 E1	 2	 idea of high becoming low
(b)	3 4 1 3 0 0 7 5 4 2 4 3 5 2 7 7 6 2 5 3 5 4 0 4 5 3 1 1 1 0 0 4 5 2 2 4 0 5 0 7 7 3 2 3 3 5 1 0 2 5 3 1 1 1 0 0 4 5 2 2 4 0 5 0 7 5 1 0 1 1 5 1 0 2 5	B1 M1 A1	 3	 column reduction, allow one slip from $20 - x$ table then row reduction AG but previous table must be correct
(c)	Lines drawn Reduce all uncovered by 1 and add 1 to all doubly covered 3 0 1 0 0 0 3 5 1 2 5 0 6 0 8 5 0 0 0 1 5 0 0 1 5	B1 M1 A1	 3	4 0 5 0 7 (with vertical lines drawn) allow M1A1 if lines not as above
(d)	Choosing zeros in first and last columns Alice – Game 2; Ede – Game 1 Possible options B – 3 ; D – 4 ; C – 5 B – 4 ; D – 3 ; C – 5 B – 5 ; C – 4 ; D – 3	 B1 B1 B1 B1	 4	Allow if only circles around these entries with no matching listed
(e)	Maximum score = 92	B1	1	
	Total		**13**	

5

MD02 (cont)

Q	Solution	Marks	Total	Comments
3(a)(i)	Roseanne plays R_1 with prob p Expected value when Collette plays $C_1 : -3p + 2(1-p) = 2 - 5p$ $C_2 : 2p - (1-p) = 3p - 1$ $C_3 : 3p - 4(1-p) = 7p - 4$	M1 A1		One correct unsimplified All correct unsimplified
		M1 A1		drawing 'their' lines (2 'correct' ft) correct with values clear at $p = 0$ and $p = 1$
	Solving $2 - 5p = 7p - 4$ $\qquad\quad 6 = 12p$ $\quad \Rightarrow p = \dfrac{1}{2}$	M1 A1		their highest point $\Big\}$ SC B1 if $p = \dfrac{1}{2}$ found from graph
	Strategy is to play R_1 for 50% of time	E1✓	7	
(ii)	Value $= 2 - 5\left(\dfrac{1}{2}\right)$ or $7\left(\dfrac{1}{2}\right) - 4 = -\dfrac{1}{2}$	B1	1	AG CSO $p = \dfrac{1}{2}$ and both expressions correct
(b)(i)	Let Collette play C_1 with prob p $\qquad\qquad$ and C_2 with prob q $\qquad\qquad \Rightarrow C_3$ with prob $1 - p - q$	B1	1	
(ii)	$-3p + 2q + 3(1-p-q) = -\dfrac{1}{2}$ $2p - q - 4(1-p-q) = -\dfrac{1}{2}$ $\Rightarrow 6p + q = 3\dfrac{1}{2}$ $6p + 3q = 3\dfrac{1}{2}$ $\Rightarrow \left.\begin{array}{l} p = \dfrac{7}{12} \\ q = 0 \end{array}\right\}$	M1 A1 A1		Either equation LHS correct Condone $(1-p+q)$ used Either equation correct and simplified p & q coefficients CSO
	$\Rightarrow$ Collette plays C_1 with prob $\dfrac{7}{12}$, (never plays C_2), and plays C_3 with prob $\dfrac{5}{12}$	E1	4	Must have statement with C_1 & C_3 **correct only**
	Total		13	

MD02 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	4 is chosen as pivot	B1		
	$\dfrac{20}{4} = 5 < \dfrac{14}{2} = 7$			
	and $5 < \dfrac{8}{1} = 8$	E1	2	Must have 3 values possibly unsimplified plus comment about smallest (positive) quotient
(ii)	$\begin{array}{cccccccc} P & x & y & z & s & t & u & v & \text{value} \\ 1 & 0 & 0 & 0 & 5 & 6 & 0 & 3 & 97 \\ 0 & 1 & 0 & 0 & 1 & 8 & 0 & 2 & 56 \\ 0 & 0 & 1 & 0 & 0 & \frac{3}{4} & 0 & \frac{1}{4} & 5 \\ 0 & 0 & 0 & 0 & -3 & \frac{1}{2} & 1 & -\frac{1}{2} & 4 \\ 0 & 0 & 0 & 1 & 2 & 4\frac{1}{4} & 0 & -\frac{1}{4} & 3 \end{array}$	B1 B1 B1 B1	4	may be left as $\{\,0\ 0\ 4\ 0\ 0\ 3\ 0\ 1\ 20\,\}$ or multiples of these rows SC MI for row operations if wrong pivot used SC B1+B1 max ft if pivot row incorrect after $\div 4$
(b)	Optimum since no negative values in first row	E1	1	Must have attempted row operations
(c)	Maximum $P = 97$ $x = 56,\ y = 5,\ z = 3$	B1✓ B1✓	2	
(d)	$s = 0,\ t = 0,\ v = 0,\ u = 4$ $\Rightarrow$ only 1 of original inequalities has some slack	B1✓ E1✓	2	Ft if >1 non-zero slack variables
	Total		**11**	

MD02 (cont)

Q	Solution	Marks	Total	Comments
5(a)	Overhead cost = £300 Storing 2 cabinets $= 2 \times £50$ $\Rightarrow$ Total cost $=$ £400	M1 A1	 2	considering overhead and storage of 2 cabinets

(b)

Month	State	Value	
Apr	0	$300 + 0 = 300$	A_3
	1	$300 + 50 = 350$	
Mar	1	$300 + 50 + 300 = 650$	A_2
	2	$300 + 100 + 300 = 700$	Min
		$300 + 100 + 350 = 750$	
Feb	0	$300 + 0 + 650 = 950$	A_1
	1	$300 + 50 + 650 = 1000$	Min
		$300 + 50 + 700 = 1050$	
	2	$300 + 100 + 650 = 1050$	
		$300 + 100 + 700 = 1100$	
Jan	0	$300 + 0 + 950 = 1250$	Min
		$300 + 0 + 1000 = 1300$	

(b) marks:

Solution	Marks
March values £700	B1
£750	B1
Choosing minima for March (at least one), their 650 or 700 seen in February values	M1
February state 0 $300 + 0 + 650 = 950$	B1
February state 1 $300 + 50 + 650 = 1000$ $300 + 50 + 700 = 1050$ February state 2 $300 + 100 + 650 = 1050$ $300 + 100 + 700 = 1100$	A1
January values 1250 and 1300	B1
Choosing least value of January and working backwards through table to select actions A_1, A_2 and A_3	M1
Schedule correct	A1 (Total 8)

SC: B1 for schedule without DP

Jan	Feb	Mar	Apr
3	4	4	2

Should get 3 or 4 when table completed

Q	Solution	Marks	Total	Comments
(c)	Profit excluding answer to (b) $13 \times £(2000 - 300)$ $- 4 \times £2000$ $= £14100$ Total profit over 4 months is $£14100 - £1250$ $= £12850$	M1 A1 A1√	 3	Generous Ft their £1250
	Total		**13**	

MD02 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	$17 - 9 + 16 + 20 = 44$	B1	1	
(ii)	Max flow ≤ 44	B1✓	1	
(b)		B1		7
		B1		10
		B1	3	17

(c)(i)	Initial forward and backward flows Correct	M1 A1	 2	5 pairs correct

	Path	Additional Flow			
(ii)			M1		adjusting flows on network (1 path shown correctly)
	SPUT	3			
	SQVT	2	A1		correct
	SRWT	1	M1		additional flow in table
	SRWVT	1	A1		second flow
			A1	5	all correct

MD02 (cont)

Q	Solution	Marks	Total	Comments
6(c)(iii)				

	Max flow of 39 (several possibilities of final flow diagram)	B1	1	
	Total		**13**	
	TOTAL		**75**	