Version 1.0: 0608

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.

Set and published by the Assessment and Qualifications Alliance.

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales (company number 3644723) and a registered charity (registered charity number 1073334).
Registered address: AQA, Devas Street, Manchester M15 6EX
Dr Michael Cresswell Director General

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.

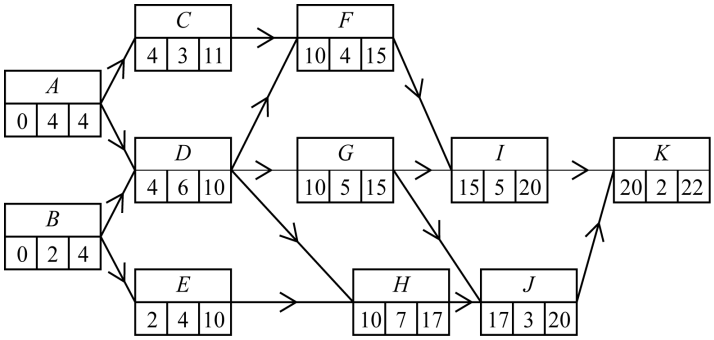
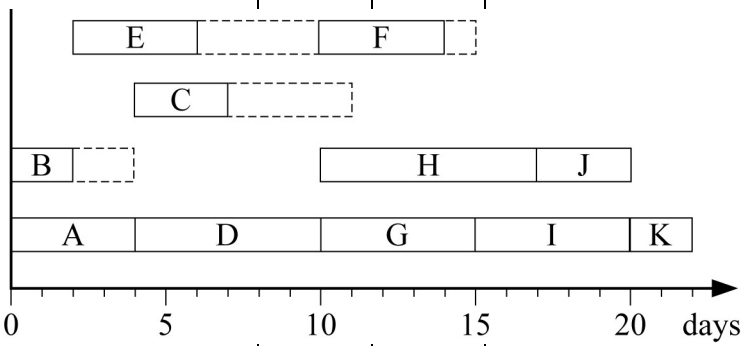
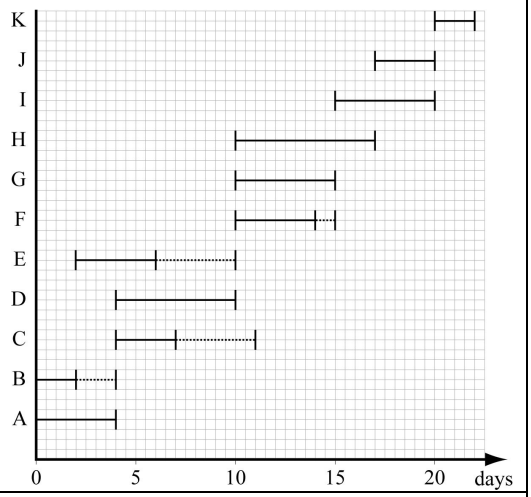
Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

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

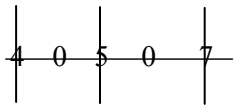
Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

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

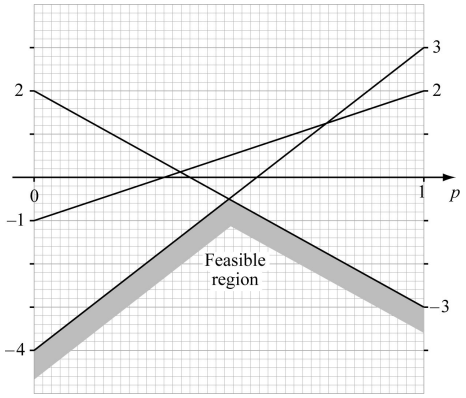
MD02

Q	Solution	Marks	Total	Comments
1				
(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		
	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)				
	A, *D*, *G*, *H*, *I*, *J*, *K* correct	B1		
	B, *C*, *E*, *F*	B1		2 correct with slack /float or 4 correct & no slack
		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 *I* is now unable to start until after 16 days or *I* starts 1 day later	E1		
	Minimum completion time now 23 days – one extra day etc	B1	2	
	Total		**12**	

MD02 (cont)

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

MD02 (cont)

Q	Solution	Marks	Total	Comments
3(a)(i)	Roseanne plays R_1 with prob p Expected value when Collette plays $C_1 : -3p + 2(1-p) = 2 - 5p$			
	$C_2 : 2p - (1-p) = 3p - 1$	M1		One correct unsimplified
	$C_3 : 3p - 4(1-p) = 7p - 4$	A1		All correct unsimplified
		M1		drawing 'their' lines (2 'correct' ft)
		A1		correct with values clear at $p = 0$ and $p = 1$
	Solving $2 - 5p = 7p - 4$ $6 = 12p$ $\Rightarrow p = \frac{1}{2}$	M1 A1		their highest point } SC B1 if $p = \frac{1}{2}$ found from graph
	Strategy is to play R_1 for 50% of time	E1√	7	
(ii)	Value $= 2 - 5\left(\frac{1}{2}\right)$ or $7\left(\frac{1}{2}\right) - 4 = -\frac{1}{2}$	B1	1	AG CSO $p = \frac{1}{2}$ and both expressions correct
(b)(i)	Let Collette play C_1 with prob p and C_2 with prob q $\Rightarrow C_3$ with prob $1 - p - q$	B1	1	
(ii)	$-3p + 2q + 3(1-p-q) = -\frac{1}{2}$ $2p - q - 4(1-p-q) = -\frac{1}{2}$	M1		Either equation LHS correct Condone $(1 - p + q)$ used
	$\Rightarrow 6p + q = 3\frac{1}{2}$ $6p + 3q = 3\frac{1}{2}$	A1		Either equation correct and simplified p & q coefficients
	$\Rightarrow p = \frac{7}{12}$, $q = 0$	A1		CSO
	$\Rightarrow$ Collette plays C_1 with prob $\frac{7}{12}$, (never plays C_2), and plays C_3 with prob $\frac{5}{12}$	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 $\frac{20}{4} = 5 < \frac{14}{2} = 7$ and $5 < \frac{8}{1} = 8$	B1 E1	2	Must have 3 values possibly unsimplified plus comment about smallest (positive) quotient
(ii)	$P\ x\ y\ z\ s\ t\ u\ v$ 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	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 ÷ 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)

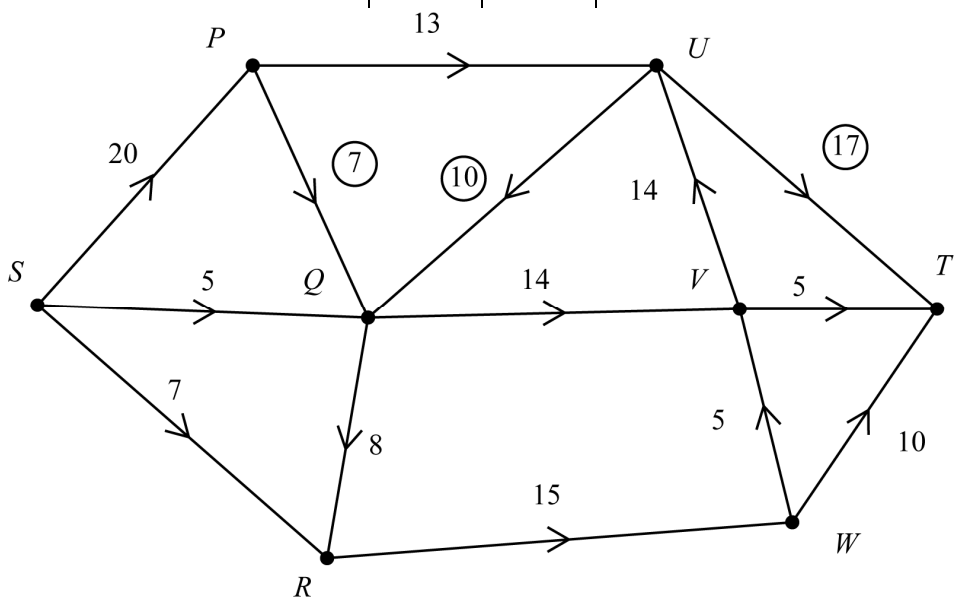
Q	Solution	Marks	Total	Comments
5(a)	Overhead cost = £300	M1		considering overhead and storage of 2 cabinets
	Storing 2 cabinets $= 2 \times £50$ $\Rightarrow$ Total cost = £400	A1	2	
(b)				
	March values £700 £750	B1 B1		
	Choosing minima for March (at least one), their 650 or 700 seen in February 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	8	SC: B1 for schedule without DP Should get 3 or 4 when table completed
(c)	Profit excluding answer to (b) $13 \times £(2000 - 300)$ $- 4 \times £2000$ $= £14100$	M1 A1		Generous
	Total profit over 4 months is £14100 − £1250 = £12850	A1√	3	Ft their £1250
	Total		**13**	

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	

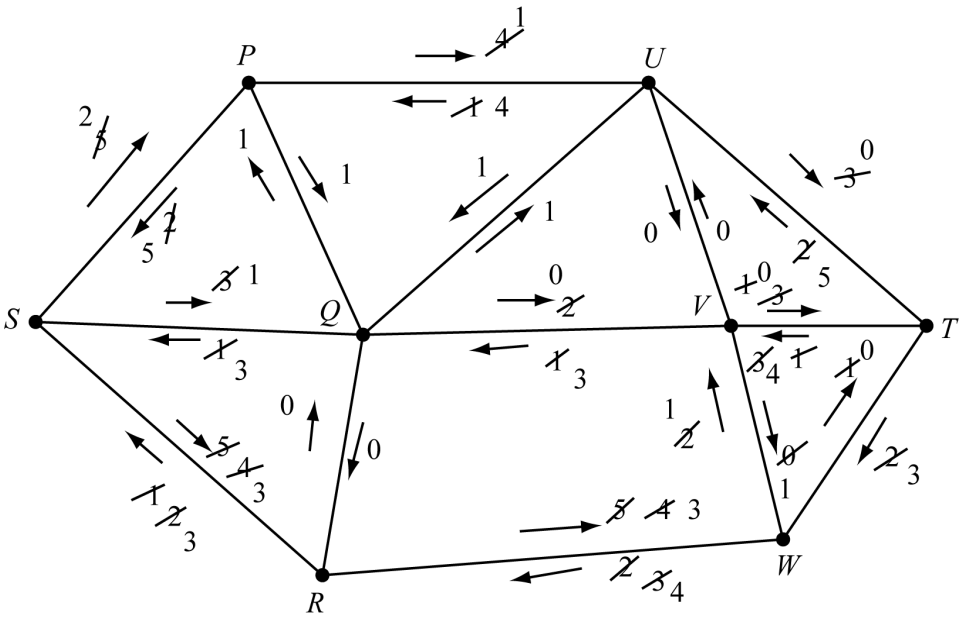
Jan	Feb	Mar	Apr
3	4	4	2

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	M1		5 pairs correct
	Correct	A1	2	

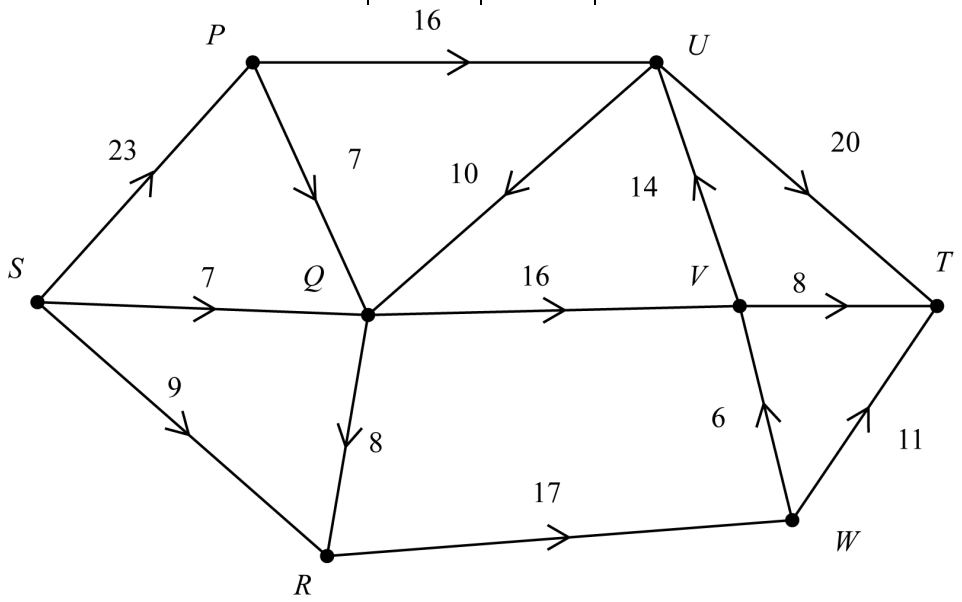


(ii)

Path	Additional Flow
SPUT	3
SQVT	2
SRWT	1
SRWVT	1

M1		adjusting flows on network (1 path shown correctly)
A1		correct
M1		additional flow in table
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**	