Version

General Certificate of Education (A-level)
June 2012

Use of Mathematics UOM4/2

(Specification 5350)

Applying Mathematics

Final

Mark Scheme

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 events which all examiners 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 examiner understands and applies it in the same correct way. As preparation for standardisation each examiner 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, examiners encounter unusual answers which have not been raised 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 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.

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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.

Free-Standing Mathematics Qualification
Advanced Level – Use of Mathematics AS (UOM4/2)
Answers and Marking Scheme – June 2012

Q	Solution	Marks	Total	Comments
1(a)	$n = -25S + 125$			
	when $S = 1$ $n = -25 \times 1 + 125 = 100$	M1,A1		one statement
	when $S = 5$ $n = -25 \times 5 + 125 = 0$	A1	3	other statement accept alternative method M1, A1 gradient A1 work leading to intercept
(b)(i)	$P = nS - 50$	B1 B1	2	for nS for -50
(ii)	$P = (-25S + 125)S - 50$	M1		
	$= -25S^2 + 125S - 50$	A1	2	
(iii)	$P = -25 \times 1.6^2 + 125 \times 1.6 - 50$	M1		
	= 86 Profit = £86 000	A1	2	Accept 86
(c)	$-25S^2 + 125S - 50 = 0$	M1		
	$S = \dfrac{-125 \pm \sqrt{125^2 - 4 \times 25 \times 50}}{-50}$	A1		
	$= \dfrac{-125 \pm \sqrt{10625}}{-50}$	A1		
	= 4.56 (or 0.44)	A1	4	
(d)	$(S - 2.5)^2 = S^2 - 5S + 6.25$	M1		
	$S^2 - 5S + 6.25 - 4.25 = S^2 - 5S + 2$	A1	2	
(e)(i)	$P = -25(S^2 - 5S + 2)$			
	$S^2 - 5S + 6.25 - 4.25 = S^2 - 5S + 2$			
	This has a minimum value when $S - 2.5 = 0$, i.e. when i.e. £2.50	M1 A1ft	2	
(ii)	$P = -25 \times -4.25 = 106.25$	B1ft		
	maximum profit £106 250	B1ft	2	
	Total		**19**	

Use of Mathematics AS (UOM4/2)

Q	Solution	Marks	Total	Comments
2(a)	When $t = 5715$			o.e
	$\frac{m}{m_0} = \frac{1}{2} = e^{-\lambda 5715}$	M1		Alternative $e^{-0.000121\times 5715} = e^{-0.691515} = \frac{1}{2}$ M1, A1, A1
	$\ln\left(\frac{1}{2}\right) = -\lambda 5715 (= -0.693)$	M1		
	$\lambda = 1.21\times 10^{-4}\ (= 0.000121)$	A1	3	
(b)	$\frac{1}{8} = \frac{1}{2^3}$ that is 3 half lives	M1		alternatively $\frac{1}{8} = e^{-0.000121t}$ (M1)
	$3\times 5715 = 17145$ years = 17100	A1	2	leading to $t = 17185$ (A1) = 17200
(c)	$\frac{m}{m_0} = e^{-0.000121\times 3335} = 0.668$	M1 A1	2	
	Or 66.7%			allow 66.7 or 67(%)
(d)	$\frac{m}{m_0} = 15\% = 0.15$			
	$0.15 = e^{-0.000121t}$	M1		
	$\ln 0.15 = -0.000121t$	M1		
	$t = \frac{\ln 0.15}{-0.000121} = 15679 = 15700$	A1	3	allow 15600 ± 22380 SC2
(e)(i)	General shape	B1		
	Intercept at (0, 1)	B1		
	Clear horizontal asymprote	B1	3	
(ii)	Carbon 14 decays rapidly to start with <u>or</u> decays slowly later	B1		
	Never completely decays	B1	2	
	Total		**15**	

Use of Mathematics AS (UOM4/2)

<table>
<tr><th>Q</th><th>Solution</th><th>Marks</th><th>Total</th><th>Comments</th></tr>
<tr><td>3(a)</td><td>
<table>
<tr><td>n</td><td>Sn</td><td>Rn</td><td>Ln</td></tr>
<tr><td>0</td><td>14500</td><td>0</td><td>12000.00</td></tr>
<tr><td>1</td><td>16000</td><td></td><td></td></tr>
<tr><td>2</td><td>17500</td><td></td><td></td></tr>
<tr><td>3</td><td>19000</td><td></td><td></td></tr>
<tr><td>4</td><td>20500</td><td></td><td></td></tr>
<tr><td>5</td><td>22000</td><td></td><td></td></tr>
</table>
</td><td>B1
B1ft</td><td>2</td><td>for n = 1, n = 2
remaining values</td></tr>
<tr><td>(b)(i)</td><td>Loan repayments are 15 % (0.15)
of Sara’s salary above £15000 (i.e. $S_n - 15000$)</td><td>B1
B1</td><td>2</td><td></td></tr>
<tr><td>(ii)</td><td>Interest rate of 2 % is added to (1.02)
previous outstanding loan minus the
repayments made $\left(L_{n-1} - R_{n-1}\right)$</td><td>B1
B1</td><td>2</td><td></td></tr>
<tr><td>(c)(i)</td><td>$R_1 = 0.15\left(S_1 - 15000\right)$
$= 0.15\left(16000 - 15000\right)$
$= 0.15 \times 1000 = 150$</td><td>
M1
A1</td><td>

2</td><td>
(Substituting their 16000)
</td></tr>
<tr><td>(ii)</td><td>$L_1 = 1.02\left(L_0 - R_0\right) = 1.02 \times 12000 = 12240$</td><td>M1 A1</td><td>2</td><td></td></tr>
<tr><td>(d)</td><td>
<table>
<tr><td>n</td><td>Sn</td><td>Rn</td><td>Ln</td></tr>
<tr><td>0</td><td>14500</td><td>0</td><td>12000.00</td></tr>
<tr><td>1</td><td>16000</td><td>150</td><td>12240.00</td></tr>
<tr><td>2</td><td>17500</td><td>375</td><td>12331.80</td></tr>
<tr><td>3</td><td>19000</td><td>600</td><td>12195.94</td></tr>
<tr><td>4</td><td>20500</td><td>825</td><td>11827.85</td></tr>
<tr><td>5</td><td>22000</td><td>1050</td><td>11222.91</td></tr>
</table>
</td><td>B1ft
B1
B1ft
B1</td><td>4</td><td>for R_2 and R_3 ft from their S_2 and S_3
for L_2
for L_3 ft from their L_2 and R_2
for some indication of $n = 4$
from $L4 = 11827.85$</td></tr>
<tr><td></td><td>Total</td><td></td><td>14</td><td></td></tr>
</table>

Use of Mathematics AS (UOM4/2)

Q	Solution	Marks	Total	Comments
4(a)(i)	0.4	B1	1	or equivalent
(ii)	4 random integers are assigned out of 10	B1	1	C.A.O
(b)	Time for cars			
	D,E,F,G	B1		
	H,I,J,K	B1		
	Queue at 3 mins	B1		
	Queue at 3 mins 30 sec, 4 mins	B1ft		
	Queue at 4 mins 30 sec, 5 mins	B1ft	5	

Time of arrival	Car arriving	Random number	Time taken to pay	Pay Station 1
0	A	2	30 sec	A
30 sec	B	4	1 min	B
1 min	C	7	1 min 30 sec	B C
1 min 30 sec	D	1	30 sec	C D
2 min	E	5	1 min	C D E
2 min 30 sec	F	2	30 sec	C D E F
3 min	G	9	2 min	D E F G
3 min 30 sec	H	4	1 min	E F G H
4 min	I	3	30 sec	E F G H I
4 min 30 sec	J	0	30 sec	F G H I J
5 min	K	2	30 sec	G H I J K

(c)	Time for cars			
	C,D,E,F	B1		
	G, H, I, J, K	B1		
	Pay station columns correct			
	1 min, 1min 30 sec, 2 mins	B1		
	2 mins 30 sec, 3 mins, 3 mins 30 sec	B1		
	4 mins, 4 mins 30 sec, 5 mins	B1	5	

Time of arrival	Car arriving	Random number	Time taken to pay	Pay Station 1	Pay Station 2
0	A	1	30 sec	A	
30 sec	B	3	30 sec		B
1 min	C	7	1 min 30 sec	C	
1 min 30 sec	D	3	30 sec	C	D
2 min	E	4	1 min	C	E
2 min 30 sec	F	0	30 sec	F	E
3 min	G	8	1 min 30 sec	G	
3 min 30 sec	H	7	1 min 30 sec	G	H
4 min	I	2	30 sec	G I	H
4 min 30 sec	J	5	1 min	I J	H
5 min	K	8	1 min 30 sec	J	K

Use of Mathematics AS (UOM4/2) Q4 continued

Q	Solution	Marks	Total	Comments
(d)	No + reason Two pay stations is very effective as now only two cars have to queue	B1 + B1	2	without quantification with
(e)	Any sensible way of improving simulation e.g. More varied arrival times More varied times taken to pay	 B1 B1	 2	
	Total		**16**	
	TOTAL MARK FOR PAPER		**64**	

+ up to 3 marks for ability to present information accurately using correct notation.
+ up to 3 marks for mathematical arguments presented clearly and logically.

	TOTAL MARK		**70**	