General Certificate of Education
June 2005
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

APPLYING MATHEMATICS **UOM4/2**
Paper 2

Monday 23 May 2005 Morning Session

In addition to this paper you will require:
- an 8-page answer book;
- an answer sheet for Questions 1, 2 and 4 (enclosed);
- a ruler;
- a graphics calculator.

Time allowed: 1 hour 30 minutes

Instructions
- Use blue or black ink or ball-point pen. Pencil should only be used for drawing.
- Write the information required on the front of your answer book **and** on the top of the answer sheet for Questions 1, 2 and 4.
- The *Examining Body* for this paper is AQA. The *Paper Reference* is UOM4/2.
- Answer **all** questions.
- All necessary working should be shown; otherwise marks for method may be lost.
- The **final** answer to questions requiring the use of a calculator should normally be given to three significant figures.
- At the end of the examination, remember to hand in both your answer book **and** the answer sheet for Questions 1, 2 and 4.

Information
- The maximum mark for this paper is 70.
- Mark allocations are shown in brackets.

SECTION A

Answer **all** questions.

1 A mass attached to a length of string can be used to form a simple pendulum. The time period, T seconds, for such a simple pendulum, of length l metres, is the time taken for the pendulum to swing from one side to another and back again.

The formula for T is

$$T = 2\pi\sqrt{\frac{l}{g}}$$

where the value of g depends on gravity.

On the surface of the Earth, g is approximately 10 .

(a) Find T if $l = 1$. *(2 marks)*

(b) Find l if $T = 1$. *(3 marks)*

(c) (i) The first set of axes on the answer sheet shows a graph of T plotted against l for $g = 10$.

On this set of axes, sketch a graph of the model $T = 2\pi\sqrt{\frac{l}{g}}$ for a planet where the value of g is smaller than 10 . *(2 marks)*

(ii) Describe what happens to the time period of a pendulum of a given length as g decreases. *(2 marks)*

A rod suspended at one end can act as a pendulum. In this case the time period, T, can be modelled by the function

$$T = 2\pi\sqrt{\frac{2l}{3g}}$$

where l is the length of the rod.

(d) (i) The second set of axes on the answer sheet shows a graph of T plotted against l for the simple pendulum model $T = 2\pi\sqrt{\frac{l}{g}}$.

On this set of axes, sketch a graph of the model $T = 2\pi\sqrt{\frac{2l}{3g}}$ for the rod. *(2 marks)*

(ii) Compare the time period of a rod pendulum to that of a simple pendulum of the same length. *(2 marks)*

(e) A simple pendulum of length l and a rod pendulum of length L have the same time period.

Find L in terms of l. *(4 marks)*

TURN OVER FOR THE NEXT QUESTION

SECTION B

Answer **all** questions.

2 A saver invests £500 in a bank that adds 2 % interest to his account at the end of each year. You can use the recurrence relation $A_{n+1} = 1.02A_n$ to model the amount in the saver's account on the first day of each successive year. At the start of the first year, the saver deposits £500 in the bank so $A_1 = 500$.

(a) Use the recurrence relation $A_{n+1} = 1.02A_n$ to complete the column of the table on the answer sheet that gives the amount in this saver's account on the first day of each successive year.
(Note – you should work with values of A to 3 or more decimal places but quote values to the nearest penny.) *(3 marks)*

A second saver invests £100 on the first day of each successive year in a different bank that adds 5 % interest to his account at the end of each year. You can use the recurrence relation $B_{n+1} = 1.05B_n + 100$ to model the amount in this saver's account on the first day of each successive year, with $B_1 = 100$.

(b) Use the recurrence relation $B_{n+1} = 1.05B_n + 100$ to complete the column of the table on the answer sheet that gives the amount in this saver's account on the first day of each year.
(Note – you should work with values of B to 3 or more decimal places but quote values to the nearest penny.) *(3 marks)*

(c) Explain clearly why the recurrence relation $B_{n+1} = 1.05B_n + 100$ gives the amount of money in the second saver's account. *(4 marks)*

(d) Explain clearly why, on the first day of the year, you can find the amount of interest earned in the second saver's account, £I_n, by using $I_n = B_n - 100n$. *(4 marks)*

(e) Use your completed table on the answer sheet to identify after how many years the second saver has first earned more total interest than the first saver. *(2 marks)*

SECTION C

Answer **all** questions.

3 On one day, at a particular point on the tidal stretch of the River Tyne, the depth of water, h metres, can be modelled using the function

$$h = 4 + 2\sin 30(t - 12)^\circ$$

where t is the time in hours after midnight.

(a) (i) Calculate h at 12 noon. *(1 mark)*

(ii) Calculate h at 9 am. *(1 mark)*

(b) The function $h = 4 + 2\sin 30(t - 12)^\circ$ is a sine wave.

State:

(i) the amplitude of the wave;

(ii) the period of the wave.

(3 marks)

(c) Sketch a graph of h plotted against t for the complete day, i.e. for $0 \leq t \leq 24$, showing clearly all significant features. *(4 marks)*

(d) (i) State the greatest depth of water predicted by the model. *(1 mark)*

(ii) Find both times when the model predicts that h will have this greatest value. *(2 marks)*

(e) There is a danger of flooding when $h \geq 5.5$.

What is the earliest time that $h = 5.5$? Give your answer correct to the nearest minute. *(5 marks)*

TURN OVER FOR THE NEXT QUESTION

SECTION D

Answer **all** questions.

4 A small railway station employs one booking clerk to sell tickets. The clerk starts work at 6.50 am, ten minutes before the first train leaves the station at 7 am. The railway manager carries out a survey of when passengers arrive and how long it takes them to buy a ticket and then runs a simulation to find out whether another booking clerk is needed.

To run the simulation, the manager makes the following assumptions.

- All passengers that use the station must buy a ticket from the booking clerk.
- Either 0, 1, 2, 3 or 4 passengers arrive at the station at the start of each minute, with probabilities 0.2, 0.1, 0.2, 0.3, 0.2 respectively.
- Passengers take either 30 seconds, 1 minute or 1 minute 30 seconds to buy a ticket, with probabilities 0.5, 0.3 and 0.2 respectively.
- The first passenger arrives at 6.50 am.
- Passengers A to M arrive in alphabetical order.
- A passenger who has a ticket before 7 am will catch the first train.

The table below shows how integers generated randomly between 0 and 9 (inclusive) are assigned by the manager to simulate how many passengers arrive at the station each minute.

Number of passengers	**Probability**	**Random integer assigned to simulate the number of passengers arriving**
0	0.2	0, 1
1	0.1	2
2	0.2	3, 4
3	0.3	5, 6, 7
4	0.2	8, 9

(a) Explain why two randomly generated integers from the set 0 to 9 (inclusive) are assigned to simulate four passengers arriving. *(2 marks)*

The manager uses the sequence of random integers below to simulate the number of passengers arriving at the station each minute:

6, 0, 3, 0, 1, 2, 2, 1, 4, 2, 6, 5, 0, 8, 6, 8

(b) (i) Use this sequence to find the times at which passengers A to M arrive at the station, giving your answers in Table 1 on the answer sheet. The first five times have been completed for you.

(ii) Use your answers to part (i) to complete the column in Table 2 on the answer sheet that shows when each passenger arrives. *(4 marks)*

(c) Identify the first person who arrives at the station as the first train of the day leaves. *(1 mark)*

The table below shows how integers generated randomly between 0 and 9 (inclusive) are assigned by the manager to simulate how long passengers take to buy a ticket.

Length of time to buy a ticket	**Probability**	**Random integer assigned to simulate the length of time it takes to buy a ticket**
30 seconds	0.5	0, 1, 2, 3, 4
1 minute	0.3	5, 6, 7
1 minute 30 seconds	0.2	8, 9

The manager uses the sequence of random integers below to simulate how long it takes each passenger to buy a ticket:

7, 1, 2, 4, 2, 1, 8, 8, 5, 5, 7, 3, 6, 5, 0, 9, 5, 3

(d) This sequence is repeated in the third column of Table 2. Use this to complete the fourth column, showing how long it takes each passenger to buy a ticket. *(3 marks)*

(e) Complete the table on the answer sheet by filling in the column that shows the time at which each passenger has bought a ticket. *(4 marks)*

(f) On a morning on which the first train leaves on time at exactly 7 am, who, according to this simulation, is the first passenger who will definitely miss the train? *(1 mark)*

(g) If the railway manager were to use the results of this run of the simulation to decide whether or not to employ another booking clerk, what do you think he would decide and why? *(2 marks)*

(h) Give **three** ways in which the simulation could be improved. *(3 marks)*

END OF QUESTIONS

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE

Surname		Other Names	
Centre Number						Candidate Number				
Candidate Signature										

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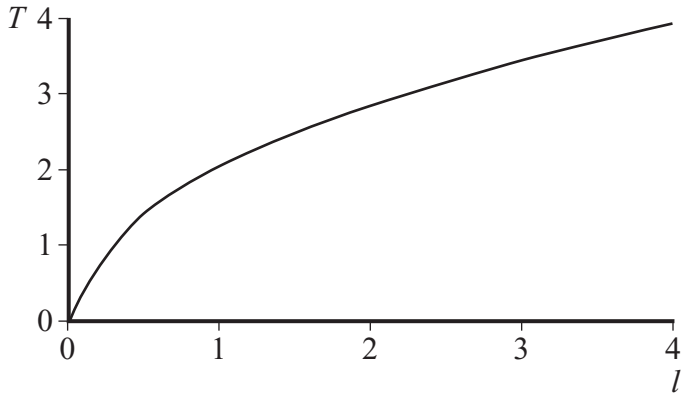
APPLYING MATHEMATICS **UOM4/2AS**
Paper 2

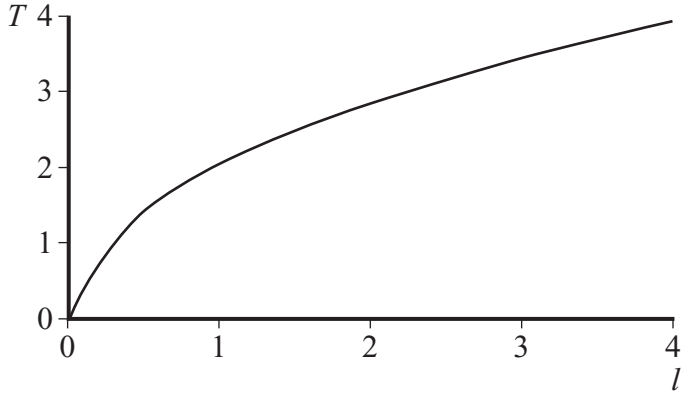
This answer sheet is to be used when answering Questions 1, 2 and 4, as indicated.

Fasten this sheet securely to your answer book.

Question 1 (c)



Question 1 (d)



Question 2

A_1	500.00
A_2	
A_3	
A_4	
A_5	
A_6	

B_1	100.00
B_2	
B_3	
B_4	
B_5	
B_6	

Question 4

Table 1

Time	0650	0651	0652	0653	0654	0655	0656	0657	0658	0659	0700
Random number	6	0	3	0	1	2	2	1	4	2	6
Number of passengers arriving	3	0	2	0	0						
Passengers arriving	*A, B, C*	–	*D, E*	–	–						

Table 2

Order in which passengers arrive and join queue at ticket office	**Time passenger arrives**	**Time to buy ticket**		**Time at which passenger has bought ticket**
		Random number	**Length of time to buy ticket (minutes seconds)**	**(hours minutes seconds)**
A	0650	7	100	065100
B	0650	1	030	065130
C	0650	2	030	065200
D	0652	4	030	065230
E	0652	2	030	065300
F		1		
G		8		
H		8		
I		5		
J		5		
K		7		
L		3		
M		6		

END OF ANSWER SHEET

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