Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
Notation	
Argument	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2013

Use of Mathematics UOM4/2

Applying Mathematics Paper 2

Friday 24 May 2013 9.00 am to 10.30 am

For this paper you must have:
- a graphics calculator
- a ruler.

Time allowed
- 1 hour 30 minutes

Instructions
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Write the question part reference (eg (a), (b)(i) etc) in the left-hand margin.
- You must answer each question in the space provided for that question. If you require extra space, use an AQA supplementary answer book; do **not** use the space provided for a different question.
- Do not write outside the box around each page.
- Show all necessary working; otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work that you do not want to be marked.
- The **final** answer to questions requiring the use of tables or calculators should normally be given to three significant figures.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 70.
- You will be awarded up to 3 marks for your ability to present information accurately using correct notation, **and** up to 3 marks for mathematical arguments presented clearly and logically.

Advice
- You do not necessarily need to use all the space provided.

Answer **all** questions.

Answer each question in the space provided for that question.

1 A car is stationary at a traffic light. It then accelerates along a straight road. After t seconds, the distance, d metres, of the car from the traffic light is given by the formula $d = 0.9t^2$.

(a) (i) How far has the car travelled after 3 seconds? *(1 mark)*

(ii) How long does it take for the car to travel 90 metres? *(2 marks)*

(b) A bus is moving with constant speed in the same direction as the car. The distance, s metres, of the bus from the traffic light is given by the formula $s = 5t + 50$, where t seconds is the time after the car sets off.

(i) How far from the traffic light is the bus when the car starts accelerating? *(1 mark)*

(ii) What is the speed of the bus? *(1 mark)*

(c) On the same set of axes, opposite, draw sketches of the graphs

$$y = 0.9t^2 \textbf{ and } y = 5t + 50$$

for values of $t \geqslant 0$.

Show clearly all significant features. *(4 marks)*

(d) (i) Calculate the value of t when the car catches up with the bus. *(4 marks)*

(ii) How far from the traffic light are the car and the bus at this time? *(1 mark)*

(e) When the car starts to accelerate, a cyclist, travelling in the opposite direction, is 300 metres away from the traffic light. She is cycling towards the traffic light at a steady speed of 4 metres per second.

What is the value of t when the **bus** and the **cyclist** pass each other? *(3 marks)*

QUESTION PART REFERENCE	**Answer space for question 1**

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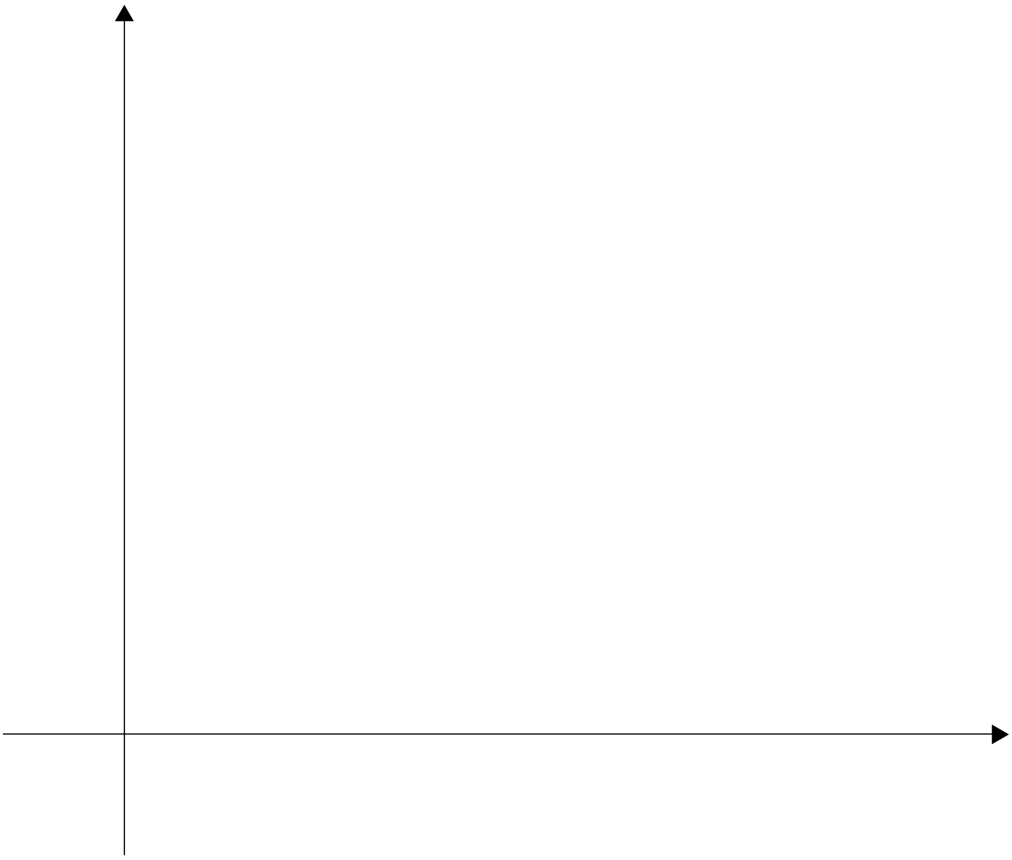
QUESTION PART REFERENCE

Answer space for question 1



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QUESTION PART REFERENCE

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2 A fish farm has two pools.

Pool A	**Pool B**

A model for the numbers of fish in each of these pools assumes that:

- initially, there are 200 fish in pool A and 100 fish in pool B
- each day, a fixed percentage of fish in pool A is transferred to pool B
- each day, a fixed percentage of fish in pool B is transferred to pool A
- the total number of fish remains at 300.

After n days, the number of fish in pool A is represented by A_n and the number of fish in pool B is represented by B_n. Thus $A_0 = 200$ and $B_0 = 100$.

The number of fish in pool A is modelled using the recurrence relation

$$A_n = 0.85A_{n-1} + 0.1B_{n-1}$$

(a) Show calculations to confirm that $A_1 = 180$ and $B_1 = 120$. *(2 marks)*

(b) Complete the table opposite to show how many fish are in each pool up to the end of day 4. *(5 marks)*

(c) After a long period of time, how many fish does the model suggest will be in pool A? *(2 marks)*

(d) (i) What percentage of the fish in pool B is transferred to pool A each day? *(1 mark)*

(ii) What percentage of the fish in pool B remains in pool B each day? *(1 mark)*

(e) The number of fish in pool B is modelled by the recurrence relation

$$B_n = pA_{n-1} + qB_{n-1}$$

Find the values of p and q. *(3 marks)*

QUESTION PART REFERENCE

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QUESTION PART REFERENCE

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n	A_n	B_n
0	200	100
1	180	120
2		
3		
4		

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3 At a football stadium, the air temperature C, in degrees Celsius, can be modelled by the formula

$$C = 8\cos(15t)^\circ + 7$$

where t is the number of hours after 3 pm.

(a) Using this model:

(i) What is the maximum temperature? *(1 mark)*

(ii) At what time of day does the maximum temperature occur? *(1 mark)*

(iii) What is the minimum temperature? *(1 mark)*

(iv) At what time of day does the minimum temperature occur? *(2 marks)*

(b) At 10 am, the groundsman measures the temperature with a thermometer and he finds that it is 9 degrees Celsius. How accurate is the model at predicting this temperature? *(3 marks)*

(c) Sketch the graph of $C = 8\cos(15t)^\circ + 7$ for $0 \leqslant t \leqslant 24$. *(3 marks)*

(d) The groundsman has to turn the undersoil heating on whenever the air temperature is below 3 degrees Celsius.

If he uses the model, at what times will the groundsman have to turn the heating on and off? *(5 marks)*

QUESTION PART REFERENCE

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4 A small post office has one serving position. The regional manager carries out a simulation to consider whether to introduce another serving position during the Christmas period. She simulates the situation by assuming that customers are at the serving position for either 30, 60, 90 or 120 seconds. To do this, she allocates random numbers as follows.

Service time (seconds)	Random number(s)
30	0
60	1, 2
90	3, 4, 5, 6
120	7, 8, 9

(a) (i) Write down the probability that the service time is 90 seconds. *(1 mark)*

(ii) Explain how you deduced your answer. *(1 mark)*

(b) Complete the **Service time** column in the table opposite to show the service time for customers E–J. *(1 mark)*

(c) The regional manager models customers arriving at the post office by assuming that they have intervals of either 30, 60, 90 or 120 seconds between them. To do this, she allocates random numbers as follows.

Time between customers arriving (seconds)	Random number(s)
30	0, 1
60	2, 3, 4, 5
90	6, 7, 8
120	9

Complete the **Time between customers arriving** column in the table opposite. *(1 mark)*

Question 4 continues on page 16

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Customer	Service time		Time between customers arriving		Arrival time	Start time of service	Finish time of service	Length of wait
	Random number	Time (seconds)	Random number	Time (seconds)	(seconds)	(seconds)	(seconds)	(seconds)
A	2	60			0	0	60	0
B	0	30	1	30	30	60	90	30
C	7	120	5	60	90	90	210	0
D	6	90	6	90	180	210	300	30
E	3		5					
F	1		4					
G	4		3					
H	9		7					
I	5		0					
J	2		9					

Question 4 continues on the next page

(d) Complete all the other columns in the table, on page 15, showing **Arrival time**, **Start time of service**, **Finish time of service** and **Length of wait** for each customer.

Assume that:

- there is no time between one customer being served and the next customer starting to be served
- nobody leaves the queue
- there is no queue jumping
- customer A's arrival time is 0 seconds and A is served immediately. *(8 marks)*

(e) (i) Who waits the longest? *(1 mark)*

(ii) Would you recommend another service position?

Give a reason for your answer. *(2 marks)*

(f) How could you improve the simulation? *(2 marks)*

QUESTION PART REFERENCE

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