Centre Number						Candidate Number				
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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 2010

Use of Mathematics UOM4/2

Applying Mathematics Paper 2

Thursday 27 May 2010 9.00 am to 10.30 am

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

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 the questions in the spaces provided. 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.

Section A

Answer **all** questions in the spaces provided.

1 (a) In the UK, weights are sometimes given in the imperial system of pounds and ounces, and sometimes in the metric system of kilograms.

$$1 \text{ kilogram} = 2.205 \text{ pounds}$$

There are 16 ounces in a pound, so a weight in pounds and ounces may need to be expressed in pounds before converting to kilograms, or vice versa. For example, a weight of 2 pounds and 5 ounces is 2.3125 pounds, since
5 ounces $= \frac{5}{16}$ pounds $= 0.3125$ pounds.

(i) Convert a weight of 7 kilograms to pounds and ounces, giving your answer to the nearest ounce. *(3 marks)*

(ii) Convert a weight of 5 pounds to kilograms. *(2 marks)*

(iii) Write down a formula that converts a weight of p pounds to k kilograms. *(2 marks)*

(b) A guideline when cooking meat is to allow 25 minutes per pound, plus 25 minutes.

(i) Use this rule to write down a formula giving the time, t minutes, you should allow to cook a piece of meat that weighs p pounds. *(2 marks)*

(ii) Use your formula to find the cooking time, in minutes, for a joint of beef that weighs 5 pounds. *(2 marks)*

(iii) Sketch a graph of t against p. *(2 marks)*

(c) An alternative rule when cooking meat is to allow 55 minutes per kilogram, plus 25 minutes.

(i) Use this rule to write down a formula expressing the time, t minutes, you should allow to cook a piece of meat that weighs k kilograms. *(2 marks)*

(ii) Use this formula to find the weight of meat, in kilograms, that would take 212 minutes to cook. *(2 marks)*

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QUESTION PART REFERENCE

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Section B

Answer **all** questions in the spaces provided.

2 A large college has two sites in two different towns, A and B, each with a resources centre. Each site has a collection of calculators, and students can borrow a calculator from the resources centre in either town and return it to whichever resources centre they wish. The manager of the resources centres wishes to explore what the effect of this will be on the movement of calculators. He uses recurrence relations to model the situation and assumes that:

- calculators are borrowed for one week and all are returned at the end of that period
- every week, all calculators are borrowed by students
- the number of calculators returned to the resources centre in town A at the end of the nth week is given by $A_{n+1} = 0.75A_n + 0.4B_n$
- the number of calculators returned to the resources centre in town B at the end of the nth week is given by $B_{n+1} = 0.25A_n + 0.6B_n$.

(a) (i) What percentage of the calculators borrowed from the resources centre in town A in any one week is returned there at the end of the week? *(2 marks)*

(ii) What percentage of the calculators borrowed from the resources centre in town B in any one week is returned to town A at the end of the week? *(2 marks)*

(b) The manager also assumes that:

- $A_0 = 100$
- $B_0 = 50$.

Show clearly calculations to confirm that at the end of the first week there are 95 calculators returned to the resources centre in town A and 55 returned to the resources centre in town B. *(3 marks)*

(c) (i) Complete the table **on page 8** to give the number of calculators in each town's resources centre at the end of each week. You should give whole numbers in the table but should calculate values more accurately than this. *(5 marks)*

(ii) How many calculators does this model suggest there will eventually be in each town's resources centre at the end of every week? *(1 mark)*

(d) Give two factors that could be considered to make a simulation that would model the situation more realistically. *(2 marks)*

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Week, n	A_n	B_n
0	100	50
1	95	55
2		
3		
4		
5		

QUESTION PART REFERENCE

Section C

Answer **all** questions in the spaces provided.

3 The table below shows how the daytime temperature, θ °Celsius, varies with the number of days, n, into the year ($n = 1$ on 1st January) during a year in London.

θ can be modelled using the function

$$\theta = 14 - 8\cos(n - 30)°$$

Day number, n	Daytime temperature, θ° Celsius	
	Data	Model
16	6	6.2
47	7	6.3
75	10	8.3
106	13	12.1
136	17	16.2
167	20	19.9
197	22	21.8
228	21	21.6
259	19	19.2
289	14	15.5
320	10	11.3
350	7	7.9

(a) Use the model $\theta = 14 - 8\cos(n - 30)°$ to find:

(i) the maximum daytime temperature it predicts for London during a year; *(1 mark)*

(ii) the value of n for which the model predicts this maximum daytime temperature; *(1 mark)*

(iii) the minimum daytime temperature it predicts for London during a year. *(1 mark)*

(b) Calculate the first value of n for which the model predicts a daytime temperature of 15 °Celsius. *(4 marks)*

(c) Describe fully the transformations that map the graph of the function $\theta = \cos n°$ onto the graph of the function $\theta = 14 - 8\cos(n - 30)°$. *(5 marks)*

(d) The daytime temperature of another city over a year can be modelled using the function

$$\theta = 16 - 10\cos(n)°$$

Sketch a graph showing how the daytime temperature varies throughout a year for this city. *(3 marks)*

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Section D

Answer **all** questions in the spaces provided.

4 At a railway station, there are two windows at which you can buy tickets. The Travel Today window sells tickets only for immediate travel. The All Travel window sells tickets for travel in the future and also sells tickets for immediate travel.

In general, customers buying tickets at the Travel Today window are quicker than those at the All Travel window, but there are more customers who want tickets for immediate travel.

Every day, Jack buys a train ticket for immediate travel and often wonders which queue he should join. He carries out a simulation to help him decide.

The table below shows how Jack assigns randomly generated integers between 0 and 9 inclusive to simulate how long customers take to buy a ticket at the Travel Today window.

Travel Today window	
Time taken at window to buy a ticket (minutes)	**Random integer assigned**
1	0, 1, 2, 3
2	4, 5, 6
3	7, 8
4	9

(a) (i) Write down the probability that a customer at the Travel Today window takes one minute to complete their transaction. *(1 mark)*

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

Question 4 continues on page 16

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(b) To run his simulation, Jack further assumes that:

- a single customer arrives at the Travel Today window every minute
- no time is used between a customer finishing buying a ticket and the next starting
- no customer changes queue after having joined one.

Complete the tables **opposite** to show how long each customer takes to buy a ticket at the Travel Today window, who is being served and who is in the queue each minute. The first 4 rows in each table have been completed for you. *(5 marks)*

Question 4 continues on page 18

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Time since start of simulation, t	Customer	Time arrives	Random integer	Time taken at window to buy a ticket
0	A	0	2	1
1	B	1	1	1
2	C	2	5	2
3	D	3	4	2
4	E	4	0	
5	F	5	7	
6	G	6	3	
7	H	7	2	
8	I	8	7	
9	J	9	9	
10	K	10	2	

Time since start of simulation, t	Customer being served	Customer(s) in queue
0	A	–
1	B	–
2	C	–
3	C	D
4		
5		
6		
7		
8		
9		
10		

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(c) Jack similarly simulates customers buying tickets at the All Travel window, assigning randomly generated integers between 0 and 9 inclusive, as shown in the table below.

All Travel window	
Time taken at window to buy a ticket (minutes)	**Random integer assigned**
1	0
2	1, 2
3	3, 4, 5
4	6, 7, 8, 9

Again, Jack assumes that:

- a single customer arrives at the All Travel window every minute
- no time is used between a customer finishing buying a ticket and the next starting
- no customer changes queue after having joined one.

Complete the tables **opposite** to show how long each customer takes to buy a ticket at the All Travel window, who is being served and who is in the queue each minute. The first 4 rows in each table have been completed for you. *(5 marks)*

Question 4 continues on page 20

Time since start of simulation, t	Customer	Time arrives	Random integer	Time taken at window to buy a ticket
0	M	0	2	2
1	N	1	3	3
2	P	2	0	1
3	Q	3	9	4
4	R	4	1	
5	S	5	0	
6	T	6	5	
7	U	7	8	
8	V	8	9	
9	W	9	2	
10	X	10	2	

Time since start of simulation, t	Customer being served	Customer(s) in queue
0	M	–
1	M	N
2	N	P
3	N	P, Q
4		
5		
6		
7		
8		
9		
10		

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(d) Which queue would you advise Jack to join and why? *(2 marks)*

(e) Give three ways in which the simulations could be improved. *(3 marks)*

QUESTION PART REFERENCE

END OF QUESTIONS