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	

AQA

General Certificate of Education
Advanced Subsidiary Examination
June 2014

Use of Mathematics UOM4/2

Applying Mathematics Paper 2

Friday 6 June 2014 1.30 pm to 3.00 pm

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 At sea level, water boils at a temperature of $100\,°\text{C}$. At higher altitudes, water boils at lower temperatures. The temperature, $T\,°\text{C}$, at which water boils at a height, h metres, above sea level can be modelled by the formula

$$T = 100 - \frac{h}{320} \text{ for } h \geqslant 0\,.$$

(a) Use this model to predict:

(i) the temperature at which water boils at a height of 2400 metres;

[2 marks]

(ii) the height at which water boils at a temperature of $90\,°\text{C}$.

[2 marks]

(b) Mountaineers on Mount Everest find that, at a height of 8000 metres, water boils at a temperature of $75.5\,°\text{C}$.

What is the error in the temperature predicted by the model?

[2 marks]

(c) (i) Draw a sketch of the graph of $T = 100 - \frac{h}{320}$ for $h \geqslant 0$.

[2 marks]

(ii) Describe fully how the temperature of boiling water varies with increasing altitude according to this model.

[2 marks]

(d) An alternative model to predict the temperature, $T\,°\text{C}$, at which water boils at a height, h metres, above sea level is

$$T = 100 - 0.15\sqrt{h} \text{ for } h \geqslant 0\,.$$

(i) At a café in an alpine ski resort at a height of 2000 metres, it is found that water boils at a temperature of $93.3\,°\text{C}$.

Which of the two models in this question most accurately predicts this?

[2 marks]

(ii) At what heights do the two models in this question give the same value for the temperature of boiling water?

[4 marks]

Do not write outside the box

QUESTION PART REFERENCE

Answer space for question 1

Turn over ▶

QUESTION PART REFERENCE

Answer space for question 1

QUESTION PART REFERENCE	Answer space for question 1

Do not write outside the box

2 Initially, the population of squirrels in a wood is 250. A pest control officer wishes to model how the population changes from year to year.

(a) As a first attempt, she assumes that the population grows by 20% each year. The recurrence relation

$$P_n = 1.2P_{n-1}$$

will calculate the population after n years, where P_n is the population after n years and $P_0 = 250$.

Using this recurrence relation:

(i) what is the predicted population after three years?

[2 marks]

(ii) how many years will it take for the predicted population to rise above 1000?

[3 marks]

(iii) describe the long-term trend that this recurrence relation predicts.

[1 mark]

(b) In reality, the wood will support only a certain population of squirrels. The pest control officer takes this into account using the improved recurrence relation

$$P_n = P_{n-1}\left(1.2 - \frac{P_{n-1}}{4000}\right)$$

where P_n is the population after n years and $P_0 = 250$.

(i) Using $P_0 = 250$, show calculations to confirm that $P_1 = 284.375$ (which can be rounded to 284).

[2 marks]

(ii) Complete the table on page 8 to show how many squirrels the improved recurrence relation predicts are in the wood up to the end of year 4. You should carry forward decimal values in your calculations but round the values for P_2, P_3 and P_4 to the nearest whole number in the table.

[4 marks]

(iii) Using this improved recurrence relation, find how many squirrels are predicted to be in the wood after many years.

[2 marks]

QUESTION PART REFERENCE	Answer space for question 2

Do not write outside the box

QUESTION PART REFERENCE

Answer space for question 2

Turn over ▶

Do not write outside the box

QUESTION PART REFERENCE

Answer space for question 2

n	P_n
0	250
1	284
2	
3	
4	

QUESTION PART REFERENCE

Answer space for question 2

Turn over ▶

3 A frozen chicken is taken out of a freezer. It is recommended that the chicken is left to thaw before cooking. The temperature of the chicken can be modelled by the formula

$$B = 20 - 35e^{-0.1t}$$

where B is the temperature in °C of the chicken and t is the time in hours after the chicken is taken out of the freezer.

(a) Using this model:

(i) what is the initial temperature of the frozen chicken?

[1 mark]

(ii) what is the temperature of the chicken after 2 hours?

[2 marks]

(iii) It is recommended that the temperature of the chicken reaches a temperature of $4\,°\mathrm{C}$ before it is put into the oven. How long does it take for the temperature of the chicken to reach $4\,°\mathrm{C}$? Give your answer in hours and minutes.

[4 marks]

(iv) what value would the temperature of the chicken reach if it was left to thaw for a long time?

[2 marks]

(b) Sketch the graph of $B = 20 - 35e^{-0.1t}$ for $t \geqslant 0$. Show clearly the intercept with the B-axis and any asymptotes. You are not required to show the value of the intercept with the t-axis.

[3 marks]

(c) The graph of $B = e^{-0.1t}$ can be transformed on to the graph of $B = 20 - 35e^{-0.1t}$ using a series of different transformations.

Describe fully the transformations resulting from:

(i) the 35;

[1 mark]

(ii) the minus sign in front of the 35;

[1 mark]

(iii) the 20.

[1 mark]

QUESTION PART REFERENCE	**Answer space for question 3**

Do not write outside the box

QUESTION PART REFERENCE

Answer space for question 3

Do not write outside the box

QUESTION PART REFERENCE

Answer space for question 3

Do not write outside the box

QUESTION PART REFERENCE

Answer space for question 3

Turn over ▶

Do not write outside the box

4 A takeaway restaurant, which opens at 7.00 pm, has two chefs. Customers A, B, C, D and so on, arrive and place their orders.

The manager carries out a simulation to decide whether or not to employ another chef. To take into account the different time intervals between customer orders, called the 'gap time', he assumes that the time between orders being placed is either 2, 4, 6 or 8 minutes. To do this, he allocates random numbers as follows.

Gap time (minutes)	**Random numbers**
2	0, 1, 2, 3
4	4, 5, 6
6	7, 8
8	9

(a) (i) Write down the probability that the 'gap time' is 4 minutes.

[1 mark]

(ii) Explain how you deduced your answer.

[1 mark]

Question 4 continues on page 16

QUESTION PART REFERENCE

Answer space for question 4

Do not write outside the box

QUESTION PART REFERENCE

Answer space for question 4

Turn over ▶

(b) Complete the 'Gap time' column and 'Time customer places order' column in the table opposite.

[2 marks]

(c) Orders can be small, medium or large. Small orders take 2 minutes to prepare, medium orders take 5 minutes to prepare, and large orders take 10 minutes to prepare.

The manager models the time it takes for the chefs to prepare the orders. He allocates random numbers as follows.

Size of order	Preparation time (minutes)	Random numbers
Small (S)	2	0, 1
Medium (M)	5	2, 3, 4
Large (L)	10	5, 6, 7, 8, 9

Complete the 'Size of order' column (use S, M and L) and the 'Preparation time' column in the table opposite.

[2 marks]

(d) Complete the columns in the table opposite, showing which 'Chef' (X or Y) is involved, the 'Start time of preparation' and the 'Finish time of preparation'.

Assume that:

- customer A's order is placed at 7.00 pm
- the chefs prepare the next order as soon as they have finished their previous order
- the order is given to chef X if both chefs are free, otherwise it is given to the first chef that becomes free
- preparation time includes cooking, putting food into cartons and giving the order to the customer.

[6 marks]

(e) Complete the 'Time since order placed' column of the table which gives the time between an order being placed and the order being completed.

[2 marks]

Question 4 continues on page 18

QUESTION PART REFERENCE	**Answer space for question 4**

Do not write outside the box

QUESTION PART REFERENCE

Answer space for question 4

Customer	Random number	Gap time (minutes)	Time customer places order (pm)	Random number	Size of order	Preparation time (minutes)	Chef	Start time of preparation (pm)	Finish time of preparation (pm)	Time since order placed (minutes)
A			7.00	5	L	10	X	7.00	7.10	10
B	2	2	7.02	2	M	5	Y	7.02	7.07	5
C	5	4	7.06	8	L	10	Y	7.07	7.17	11
D	7	6	7.12	6	L	10	X	7.12	7.22	10
E	0			7						
F	9			0						
G	0			7						
H	4			4						
I	6			1						
J	2			8						

Turn over ▶

(f) Would the manager recommend that another chef should be employed? Give a reason for your answer.

[2 marks]

(g) (i) How could the manager make the result of this simulation more reliable?

[1 mark]

(ii) Suggest **two** improvements to this simulation.

[2 marks]

QUESTION PART REFERENCE

Answer space for question 4

QUESTION PART REFERENCE

Answer space for question 4

END OF QUESTIONS

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED