Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
TOTAL	

General Certificate of Education
Advanced Level Examination
January 2013

Statistics SS04

Unit Statistics 4

Monday 28 January 2013 9.00 am to 10.30 am

For this paper you must have:
- the blue AQA booklet of formulae and statistical tables.

You may use 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 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 75.

Advice
- Unless stated otherwise, you may quote formulae, without proof, from the booklet.
- 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) Chao is the manager of a restaurant that has 50 tables suitable for couples. She knows from experience that, on average, only 80 per cent of couples who make a reservation for an evening meal actually turn up. One evening, she decides to overbook and accepts reservations from 60 couples.

Use a distributional approximation to find the probability that more than 50 of these couples will turn up. *(6 marks)*

(b) Would you recommend that Chao should continue with this overbooking policy? Give a reason for your recommendation with reference to your answer in part **(a)**. *(2 marks)*

QUESTION PART REFERENCE

Answer space for question 1

QUESTION PART REFERENCE

Answer space for question 1

2 (a) A large survey of adults was designed to find out about sleeping patterns. It included the question '*How many hours sleep do you typically get each night*?' The data for the sleeping times of 1403 males, aged between 20 and 60 years, had a mean of 6.75 hours and a standard deviation of 1.29 hours.

(i) Construct a 99% confidence interval for the mean sleeping time of males aged between 20 and 60 years. *(4 marks)*

(ii) The 99% confidence interval for the mean sleeping time of females, also aged between 20 and 60 years, was found to be (6.87, 7.05) hours.

Using this confidence interval together with that constructed in part **(a)(i)**, compare the mean sleeping times of males and females aged between 20 and 60 years. *(2 marks)*

(b) A bed manufacturer claims that 15 per cent of adults sleep on average for at least 8 hours each night. Rowan is asked by his teacher to investigate her belief that a higher percentage of teenagers sleep on average for at least 8 hours each night. Rowan finds that, of the 14 teenagers in his A-level Statistics class, 4 of them report an average of at least 8 hours sleep each night.

(i) Use Rowan's data and an exact distribution to test, at the 5% significance level, whether the corresponding population percentage for teenagers is higher than 15 per cent. *(6 marks)*

(ii) In addition to the sample size, give **two** reasons in context why you should be cautious about your conclusion in part **(b)(i)**. *(2 marks)*

QUESTION PART REFERENCE

Answer space for question 2

QUESTION PART REFERENCE

Answer space for question 2

QUESTION PART REFERENCE

Answer space for question 2

QUESTION PART REFERENCE

Answer space for question 2

3 Safeerah regularly cycles to and from work. She has a steel-framed bicycle that weighs 15 kg. Her mean journey time for the round trip is 90 minutes. Her friend, Josh, has a carbon-framed bicycle that weighs 10 kg. Safeerah is thinking of buying a carbon-framed bicycle to reduce her journey time, and Josh agrees to lend her his bicycle so that she can try it.

(a) The carbon-framed bicycle is sold using the slogan '*Less weight means more speed*'. Safeerah, who weighs 65 kg, is expecting that the $33\frac{1}{3}$ per cent reduction in bicycle weight will substantially reduce her journey times. Josh tells her not to expect this as the resultant weight reduction is actually closer to 6 per cent.

Justify Josh's figure of 6 per cent. *(2 marks)*

(b) Safeerah records her journey times with the carbon-framed bicycle on 12 typical days as follows:

86.7	93.2	86.7	86.2	81.3	90.7
89.0	88.0	99.4	84.7	84.3	87.9

Assuming that these times may be regarded as a random sample from a normal distribution, test, at the 5% significance level, whether her mean journey time with the carbon-framed bicycle is less than 90 minutes. *(8 marks)*

QUESTION PART REFERENCE

Answer space for question 3

QUESTION PART REFERENCE

Answer space for question 3

4 Dorian is a biologist who is concerned about the effects of recent pollution on the wildlife population in a roadside meadow. He is particularly interested in the effects on sub-species of lob worm, meadow ant and ground beetle. To investigate this, Dorian uses a one-metre square frame, known as a quadrat, which he randomly positions in the meadow. At each position, the numbers of these worms, ants and beetles found in the quadrat are recorded.

You may assume that the number of lob worms found in a quadrat can be modelled by a Poisson distribution.

(a) What does this assumption tell you about the occurrence of lob worms in this meadow? *(1 mark)*

(b) For an initial assessment of the effect of the pollution on lob worms, Dorian randomly positions his quadrat and finds that it contains 8 lob worms.

Perform an exact test, at the 10% significance level, to investigate whether the recent pollution has reduced the mean density of lob worms in the meadow from the value of 12 per square metre that existed before the pollution occurred. *(4 marks)*

(c) For the full study, Dorian randomly positions his quadrat 10 times and finds a total of 142 lob worms.

Use a distributional approximation to find a 95% confidence interval for the mean density per square metre of lob worms now in the meadow. *(5 marks)*

(d) In the full study, Dorian also found in the 10 quadrats a total of 560 meadow ants and a total of 130 ground beetles. Meadow ants are highly social insects living in colonies. Ground beetles are highly territorial and each beetle will fiercely defend its territory from other ground beetles.

The mean and the variance of the number of meadow ants per square metre, A, are denoted by M_A and V_A respectively.

The mean and the variance of the number of ground beetles per square metre, B, are denoted by M_B and V_B respectively.

(i) State estimates of M_A and M_B.

(ii) State whether you would expect V_A to be greater than M_A, less than M_A or approximately equal to M_A. Justify your answer in context.

(iii) State whether you would expect V_B to be greater than M_B, less than M_B or approximately equal to M_B. Justify your answer in context. *(5 marks)*

QUESTION PART REFERENCE

Answer space for question 4

QUESTION PART REFERENCE

Answer space for question 4

QUESTION PART REFERENCE

Answer space for question 4

5 *Haemadown* is a new drug for reducing blood pressure. It has a number of side effects. These include dry skin with probability 0.01, dizziness with probability 0.12, and swollen joints with probability 0.15.

(a) The proportion of people taking *Haemadown* who suffer from both dizziness **and** swollen joints is 0.018.

By performing a calculation, decide whether the side effects of dizziness and swollen joints occur independently of each other. *(2 marks)*

(b) Lydia, a doctor in general practice, prescribes *Haemadown* to 90 of her patients who suffer from high blood pressure and asks them to complete a questionnaire on any side effects that they have suffered.

(i) Use an approximation to the distribution B(90, 0.01) to estimate the probability that more than 2 of these 90 patients will report suffering from dry skin. *(4 marks)*

(ii) Lydia finds that 21 of the 90 patients reported suffering from dizziness.

Use a distributional approximation to test, at the 1% significance level, whether the proportion of patients taking *Haemadown* who suffer from dizziness differs from the stated value of 0.12. *(8 marks)*

QUESTION PART REFERENCE

Answer space for question 5

QUESTION PART REFERENCE

Answer space for question 5

QUESTION PART REFERENCE

Answer space for question 5

QUESTION PART REFERENCE

Answer space for question 5

6 Five years ago, Raya inherited some land and planned to earn some money from it by growing Christmas trees. She therefore bought a large number of young Christmas trees for planting.

The initial height of these young trees is a random variable, H, having a normal distribution with mean 50 cm and standard deviation 1.49 cm.

After planting, the total growth over the next five years of each young tree is a random variable, G, having a normal distribution with mean 150 cm and standard deviation 2.67 cm.

The trees are then cut down using a machine. The machine is set to leave a stump in the ground of 10 cm in height, but the actual height of the stump is a random variable, S, having a normal distribution with mean 10 cm and standard deviation 0.51 cm.

(a) (i) Assuming that H, G and S are independent of each other, show that the mean and the standard deviation of the length, $L = H + G - S$, of cut-down trees are 190 cm and 3.10 cm respectively, correct to three significant figures. *(3 marks)*

(ii) Calculate the proportion of cut-down trees that will be less than 1.95 metres in length. *(2 marks)*

QUESTION PART REFERENCE

Answer space for question 6(a)

QUESTION PART REFERENCE

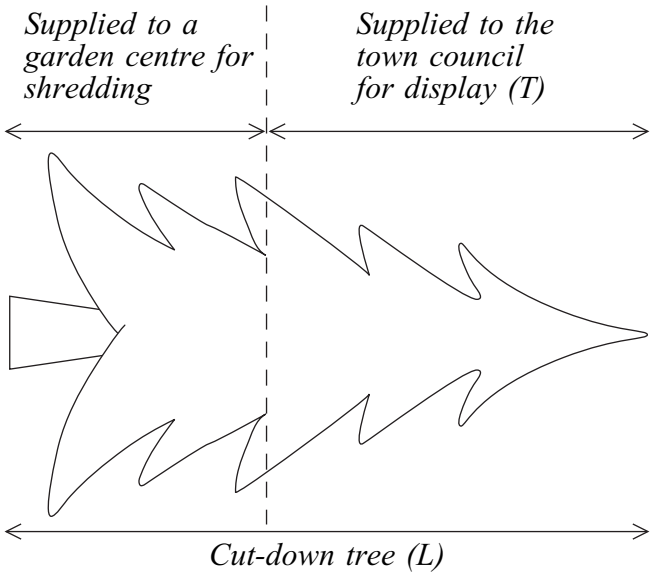
Answer space for question 6(a)

Question 6 continues on the next page

6 (b) After the trees were cut down, Raya's town council offered to buy 100 of them for a Christmas display for a total of £500. The town council required that all the trees supplied by Raya should have a length of approximately 1 metre. Raya agreed to this and randomly selected 100 of the cut-down trees. In order to satisfy the requirement of the town council, Raya arranged for each of these selected trees to be cut into two sections so that the upper sections had a length of approximately 1 metre.

These upper sections are then supplied to the town council for their Christmas display. The length of these display trees is a random variable, T, having a normal distribution with mean 100 cm and standard deviation 3 cm.

The lower sections not required by the town council are fit only for shredding and have a value of only 2 pence per centimetre. All of these sections are sold at this price to a garden centre.



(i) How many of the 100 trees supplied to the town council for display can be expected to have lengths of between 97 cm and 103 cm? *(3 marks)*

(ii) Find the distribution of Raya's **total** income from the 100 cut-down trees, which will include income from both the town council and the garden centre. *(4 marks)*

(iii) Assuming that Raya could alternatively have sold all her 100 cut-down trees to the general public for £7.50 each, was she wise to take up the town council's offer? Justify your answer. *(2 marks)*

QUESTION PART REFERENCE

Answer space for question 6(b)

QUESTION PART REFERENCE

Answer space for question 6(b)

QUESTION PART REFERENCE

Answer space for question 6(b)

END OF QUESTIONS

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED