Centre Number						Candidate Number				
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Other Names										
Candidate Signature										

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

General Certificate of Education
Advanced Level Examination
June 2015

Statistics SS04

Unit Statistics 4

Friday 12 June 2015 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 At the beginning of 2014, a bank found that 15 per cent of its savings account holders were aged 25 years or under. A new type of savings account was then launched that was intended to appeal specifically to this age group.

At the end of 2014, a random sample of 120 customers who held the new savings account was found to include 29 who were aged 25 years or under.

Use an approximation to the binomial distribution to test, at the 1% significance level, whether the new type of savings account had attracted a higher percentage of customers aged 25 years or under compared to the original savings account.

[8 marks]

QUESTION PART REFERENCE

Answer space for question 1

QUESTION PART REFERENCE

Answer space for question 1

2 A software company found that the proportion of personal computers with Internet access that are infected with spyware is 0.0025.

Rory, a computer engineer, examines a random sample of 240 personal computers with Internet access.

(a) Use a distributional approximation to find the probability that 3 or more of this sample are infected with spyware.

[4 marks]

(b) A computer infected with spyware may contain more than one separate infection. Rory finds a total of 45 separate infections in the sample.

Assuming that the number of separate infections in such a sample can be considered as an observation from a Poisson distribution with mean λ, construct an approximate 95% confidence interval for λ.

[3 marks]

QUESTION PART REFERENCE

Answer space for question 2

QUESTION PART REFERENCE

Answer space for question 2

3 Jamila is a marine biologist who, for several years, has been collecting data concerning shark attacks on swimmers off the coast where she lives. She has found that these sharks attack at random at a rate of 2.8 attacks per year. She has also found that the distance from the shore that the attacks take place can be modelled by a normal distribution with mean 52 metres.

Last year, there were 4 shark attacks, which took place at the following distances, in metres, from the shore.

$$55 \quad 20 \quad 46 \quad 31$$

A local newspaper reported on this under the headline:

"Shark Attacks on the Increase...
and they're Attacking Closer to Shore"

(a) Jamila wanted to test the two claims made in this headline, with each test using the 10% level of significance.

(i) Carry out an exact test to decide whether last year's data support the claim that the rate of shark attacks has increased from 2.8 per year.

[5 marks]

(ii) Test whether last year's data support the claim that, on average, shark attacks are now taking place closer to shore.

[8 marks]

(b) Jamila wrote to the newspaper's editor with the results of the tests. The newspaper then reported:

"Scientists have proved that shark attacks are NOT on the increase.
But they ARE getting closer to shore!"

In the light of your conclusions in part **(a)**, comment on each of these statements.

[2 marks]

QUESTION PART REFERENCE

Answer space for question 3

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4 A pet shop sells two types of loose dog biscuit, *Appydog* and *Boneybites*. The weights, in kilograms, sold per week of each type, W_A and W_B, can be modelled by independent normal distributions with means and standard deviations given in the table below. Also given for each type is the profit, in £, per kg sold.

	Mean weight sold (kg)	Standard deviation of weight sold (kg)	Profit per kg (£)
Appydog	78	5.8	0.22
Boneybites	126	7.4	0.15

(a) Calculate the mean and the variance of the **total weight** of loose dog biscuits sold per week in this pet shop.

[3 marks]

(b) Show that the mean and the standard deviation of the **total profit** per week obtained from the sales of these two types of dog biscuit are £36.06 and £1.69 respectively, correct to the nearest penny.

[4 marks]

(c) The random variable L is given by $L = 0.22W_A - 0.15W_B$.

(i) Find the probability that $L > 0$.

[5 marks]

(ii) Interpret this probability in the context of the question.

[1 mark]

(d) Vivian, the manager of the pet shop, introduced a sales campaign with the aim of increasing the sales of *Appydog* biscuits. Vivian collected sales data on *Appydog* for a period of 8 weeks following the campaign. This sample of 8 observations had a mean weight sold per week of 82 kg.

Assuming that the standard deviation of the weight of *Appydog* biscuits sold remains at 5.8 kg, test, at the 1% level of significance, whether Vivian can conclude that the sales campaign was successful.

You may regard this sample of 8 observations as being random.

[5 marks]

QUESTION PART REFERENCE

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5 (a) (i) A 90% confidence interval for a population mean, μ, is to be constructed. What is the probability that the interval will not include the value of μ?

[1 mark]

(ii) If 5 such confidence intervals are constructed from separate random samples from the same population, find the probability that at least one of them will not include μ.

[3 marks]

(b) Jurgen can run 100 metres in a mean time of 10.325 seconds. His coach changes his training programme to concentrate on his starting speed. After following the new training programme, a random sample of 6 of Jurgen's 100-metre running times has mean 10.280 seconds and standard deviation $s = 0.021$ seconds.

(i) Assuming Jurgen's 100-metre times are normally distributed, construct a 90% confidence interval for his new mean time to run 100 metres, giving the limits to three decimal places.

[4 marks]

(ii) Use these confidence limits to decide whether there is significant evidence that the new training programme has been effective. Justify your decision.

[2 marks]

QUESTION PART REFERENCE

Answer space for question 5

QUESTION PART REFERENCE

Answer space for question 5

6 Light fruit cakes produced at a commercial bakery contain, amongst other ingredients, currants, sultanas and cherries. These are added separately to a large batch of basic cake mixture. This is then thoroughly stirred so that all three of these ingredients are distributed independently and at random throughout the mixture.

The mixture used for an individual cake may be considered as a random sample of mixture from the large batch.

After baking, there is, on average, one currant per $2\,\text{cm}^3$ of cake, one sultana per $2\,\text{cm}^3$ of cake and one cherry per $30\,\text{cm}^3$ of cake.

(a) A cake made from this mixture is randomly selected and found to have a volume of $450\,\text{cm}^3$.

(i) Use an exact distribution to find the probability that there are more than 12 cherries in this cake.

[3 marks]

(ii) Use a distributional approximation to estimate the probability that there are at most 250 currants in this cake.

[5 marks]

(iii) Hence estimate the probability that there are more than 250 currants **and** more than 250 sultanas in this cake.

[2 marks]

(b) The same mixture is also used to make small cupcakes that each have a volume of $45\,\text{cm}^3$ for a party. There are 75 guests attending the party and each guest is given one of these cupcakes.

(i) The number of guests, G, who have a cupcake that contains no cherries has the distribution $\text{B}(n, p)$. State the value of n and show that $p = 0.223$, correct to three decimal places.

[4 marks]

(ii) Find the expected value of G.

[1 mark]

(iii) If, after adding the cherries, the original mix had not been stirred thoroughly enough, what effect, if any, would you expect this to have on the expected value of G? Justify your answer.

[2 marks]

QUESTION PART REFERENCE

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END OF QUESTIONS

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