Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

A-level
STATISTICS

Unit Statistics 4

Tuesday 20 June 2017 Afternoon Time allowed: 1 hour 30 minutes

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

You may use a graphics calculator.

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 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.

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

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.

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Answer **all** questions.

Answer each question in the space provided for that question.

1 The number of births per week in the maternity unit of a large hospital may be modelled by a Poisson distribution with mean λ.

The number of births per week for the first 6 weeks of 2016 were:

$$32 \quad 38 \quad 50 \quad 37 \quad 44 \quad 33$$

(a) Find an approximate 99% confidence interval for λ.

[5 marks]

(b) Birthweights under 2.5 kg are defined as low-weight. The number of low-weight births per week in this unit may be modelled by a Poisson distribution with mean μ.

The mean number of such births per week for the first 6 weeks of 2016 was 1.5

Explain why the approach you used in part **(a)** should not be used to construct a confidence interval for μ.

[2 marks]

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

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QUESTION PART REFERENCE	Answer space for question 1

7

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2 A health food company has developed a soft drink called *Herbicola* that contains a new mix of herbal ingredients. The company claims that a daily intake of this drink will improve the examination performance of university students.

As a marketing exercise, the company offered to provide *Herbicola* free of charge to a large group of students at a particular university taking a first year mathematics examination.

Only 12 students took up this offer. The examination marks for these students were:

54 48 56 63 62 59 73 42 65 58 67 65

Examination marks are normally distributed. Previous first year mathematics examination marks at this university are known to have a mean of 53.4

(a) Investigate, at the 1% level of significance, whether students who drink *Herbicola* daily will have a mean mark greater than 53.4

[8 marks]

(b) Give **two** reasons in context why, even if the mean mark for a sample had been much higher, the company's claim may not be valid.

[2 marks]

(c) Make **two** suggestions for improving this investigation.

[2 marks]

QUESTION PART REFERENCE	**Answer space for question 2**

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QUESTION PART REFERENCE	Answer space for question 2

12

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3 Ken is a keen angler. The number of fish that he catches in a particular lake during daylight hours may be modelled by a Poisson distribution with mean 3.2 per hour.

(a) On Sundays in November, Ken always arrives at the lake at about noon.

Find the probability that within one hour of arriving at the lake, he catches:

(i) at least 5 fish, when he starts fishing as soon as he arrives;

(ii) at most 3 fish, when he spends the first 15 minutes eating his packed lunch before he starts fishing.

[4 marks]

(b) Ken visits the lake to fish for one hour every morning during a 10-day holiday in April.

Use a distributional approximation to find the probability that, during this 10-day period, the **total** number of fish that he catches at this lake is more than 40

[5 marks]

(c) Ken visits the lake to fish for one hour on each of 90 afternoons during the summer.

The random variable U denotes the number of afternoons out of these 90 on which he catches 5 or more fish.

(i) Describe, in context, two assumptions required for U to follow a binomial distribution $\mathrm{B}(n, p)$. State the values of n and p.

[4 marks]

(ii) Use a distributional approximation to find the probability that U is less than 25

[6 marks]

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

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QUESTION PART REFERENCE	Answer space for question 3

19

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4 Ruby is the purchasing manager for a clothing factory. She bought rolls of silk, rolls of linen and rolls of cotton from a particular supplier and wanted to check on the mean length of each of these materials on a roll. The length, in metres, of each material on a roll is known to follow a normal distribution.

(a) Ruby measured the length of silk, X metres, on each of a random sample of 5 rolls from a large delivery. She then obtained the following summarised data:

$$\bar{x} = 198.8$$
$$s^2 = 1.96$$

Construct 90% and 99% confidence intervals for μ_X, the mean length of silk on a roll.

[5 marks]

(b) Ruby plans to construct 90% and 99% confidence intervals for μ_L, the mean length of linen on a roll.

(i) State the probability that the 90% confidence interval **will not** contain μ_L.

(ii) State the probability that **both** the 90% and 99% confidence intervals **will** contain μ_L.

[2 marks]

(c) Ruby also intends to construct 90% and 99% confidence intervals for μ_C, the mean length of cotton on a roll. However, in this case, the 90% confidence interval will be constructed from one random sample and the 99% confidence interval will be constructed from a second independent random sample.

Find the probability that **neither** the 90% nor the 99% confidence intervals will contain μ_C.

[2 marks]

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

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QUESTION PART REFERENCE	Answer space for question 4

9

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5 It has been estimated that 10 per cent of the world's population are left-handed. Dev, a sports scientist, wanted to investigate the incidence of left-handedness amongst tennis players.

As part of this investigation, Dev selected a random sample of 50 male professional tennis players who have appeared in the top 100 world rankings during the past 40 years. He found that 10 of these elite players were left-handed.

He also selected a random sample of 30 male players from amateur tennis clubs. He found that 4 of these amateur players were left-handed.

(a) Use exact distributions to test, at the 5% level of significance, whether:

(i) more than 10 per cent of elite male tennis players are left-handed;

(ii) more than 10 per cent of amateur male tennis players are left-handed.

[8 marks]

(b) Dev carried out a similar investigation for female tennis players. He performed the same two tests as in part **(a)** and found that both tests were not significant at the 5% level.

Dev has a theory that left-handedness provides an advantage when playing tennis. Explain whether these results for female tennis players, and those for male tennis players in part **(a)**, support Dev's theory.

[2 marks]

(c) Dev extends his investigation to junior players to investigate whether there is a greater incidence of left-handed players in junior tennis than the estimated 10 per cent of the world's population.

He finds that 4 out of a random sample of 50 junior tennis players are left-handed.

Why is it now not necessary for Dev to carry out a significance test for this investigation?

[1 mark]

QUESTION PART REFERENCE	**Answer space for question 5**

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QUESTION PART REFERENCE	Answer space for question 5

11

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6 **In this question, you should state the values of the means and the variances of all normal distributions that you use.**

Morwenna, a baker, is preparing to make a batch of 12 traditional Cornish pasties. The filling for such a pasty requires meat and three vegetables: potato, swede and onion. Morwenna has a store of each of these vegetables.

The following table shows the means and the variances of the weights, in grams, of individual potatoes, swedes and onions in her store.

	Mean	**Variance**
Potatoes	300	625
Swedes	600	400
Onions	120	100

Assume that all weights may be modelled by independent normal distributions.

Morwenna randomly selects 3 potatoes, 1 swede and 7 onions to make the batch of pasties.

(a) Find the probability that the total weight of the 3 potatoes is more than 1000 grams.

[4 marks]

(b) Find the probability that the total weight of the 3 potatoes is more than the total weight of the 7 onions.

[5 marks]

(c) All the vegetables must be peeled before use. This process reduces the weight of each potato by 10 per cent, each swede by 10 per cent and each onion by 5 per cent.

(i) The recipe for the batch of 12 pasties requires 550 grams of swede after peeling. Find the probability that Morwenna's one randomly selected swede will be sufficient for the batch.

[4 marks]

(ii) Find the mean and the variance of the total weight, **after peeling**, of the vegetables (3 potatoes, 1 swede and 7 onions) that she has randomly selected to make the batch of pasties. Give your answers to four significant figures.

[4 marks]

QUESTION PART REFERENCE	**Answer space for question 6**

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END OF QUESTIONS

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