AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

A-level STATISTICS

Unit Statistics 4

Tuesday 21 June 2016 Morning 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 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 It has been reported that 10 per cent of people in the UK are unable to detect the scent of freesias. Gloria is a florist who wants to see whether this percentage applies to the residents of her town.

She collects her data by standing outside her shop in the high street, before she opens it in the morning, and asking a sample of 20 people, chosen at random, whether they can detect the scent of a bunch of freesias that she is holding. She finds that, out of the 20 people, 5 are unable to do so.

(a) Use an exact test, at the 5% level of significance, to investigate whether the percentage in Gloria's town differs from that reported for the UK.

[6 marks]

(b) Apart from chance, give **two** reasons, in context, why Gloria's sample might not represent the town as a whole.

[2 marks]

QUESTION PART REFERENCE

Answer space for question 1

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

2 Roy maintains a website for railway enthusiasts. His records show that, on Saturday afternoons, the website has an average of 4 hits per minute. The records also show that 80 per cent of hits on Saturday afternoons come from within the UK.

Assume that hits on Roy's website occur at random and independently of each other.

(a) Find the probability that, during a particular one-minute period on a Saturday afternoon, his website has:

(i) exactly 3 hits;

[2 marks]

(ii) exactly 3 hits **and** all of them come from within the UK.

[3 marks]

(b) Using a distributional approximation, which must be specified, estimate the probability that Roy's website has more than 220 hits during a particular **one-hour** period on a Saturday afternoon.

[5 marks]

(c) Roy has exactly 240 hits on his website during a particular one-hour period on a Saturday afternoon. Use a distributional approximation to estimate the probability that fewer than 40 of these hits are from **outside** the UK.

[6 marks]

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

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3 Fifteen years ago, a species of shore crab that preys on blue mussels invaded the northern region of the east coast of the USA. Before the arrival of these shore crabs, the shell centre thickness (SCT) of blue mussels on this coast was found to have mean $0.215\,\text{mm}$.

(a) Olga is a marine biologist. She suspects that, in the time since the arrival of the shore crabs, the blue mussels will have developed thicker shells as a defence mechanism. To investigate this suspicion, she obtains a random sample of 7 blue mussels from the northern region of the east coast of the USA and finds each mussel's SCT, in millimetres, to be as follows.

$$0.23 \quad 0.25 \quad 0.21 \quad 0.24 \quad 0.24 \quad 0.22 \quad 0.25$$

Assuming that SCT measurements may be modelled by a normal distribution, investigate, at the 1% level of significance, whether these data support Olga's suspicion.

[8 marks]

(b) Olga's colleague, Toby, suggests that she should also take SCT measurements from blue mussels in the southern region of the east coast of the USA where shore crabs have not invaded.

Justifying your answer, state whether you believe that this is a sensible suggestion.

[2 marks]

(c) Toby plans to carry out a similar-sized investigation to that carried out by Olga but using shell edge thickness (SET) instead of SCT. He intends to analyse his data by applying a similar test to the one used on Olga's data in part **(a)**. However, previous research has shown that the distribution of SET measurements is not symmetrical.

(i) Why might the shape of the distribution of SET measurements invalidate Toby's intended analysis?

(ii) Suggest the change that Toby could make to his investigation of SET in order that his intended analysis would be valid. Justify your suggestion.

[3 marks]

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

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QUESTION PART REFERENCE

Answer space for question 3

4 Mahshid, an optometrist, is investigating various aspects of visual ability amongst women in a particular population.

Previous research has established that, for **men** in this population:

- 9 per cent have red-green colour blindness (RGCB);
- the mean time taken to focus (TTF) on an object held close to the eyes is 0.125 seconds.

In order to decide whether these results also apply to **women**, Mahshid also examines a random sample of 70 women using the same procedures as in the previous research for men. She finds that, for the 70 women:

- 8 have RGCB;
- the TTF has mean 0.118 seconds and standard deviation 0.019 seconds.

(a) (i) Construct an approximate 90% confidence interval for the **proportion** of women in the population with RGCB.

[5 marks]

(ii) Construct a 90% confidence interval for the mean TTF of women.

[3 marks]

(b) Use the confidence intervals constructed in part **(a)** to assess whether Mahshid can conclude that women in this population differ from men in this population with regard to:

(i) the percentage with RGCB;

(ii) mean TTF.

Justify your assessments.

[4 marks]

QUESTION PART REFERENCE

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Answer space for question 4

5 The final stage in the manufacture of a violin is to spray a finishing coat of varnish onto the outside surface of the violin. One measure of the quality of this finish is the number of visible air bubbles in the varnish.

Production records up to 2014 show that the number of visible air bubbles in the varnish on a violin can be modelled by a Poisson distribution with mean 1.6

(a) When a violin contains more than a certain number, c, of visible air bubbles, the varnish must be removed and the violin re-varnished. The manufacturer requires that this should happen to less than 1% of violins.

To meet this requirement, what should be the minimum value of c? Justify your choice of the value of c by quoting relevant probabilities.

[3 marks]

(b) A violin selected at random from those manufactured during 2015 was found to have 4 visible air bubbles in the varnish.

Test, at the 5% level of significance, whether this provides evidence that the mean rate of occurrence of visible air bubbles has increased.

[5 marks]

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

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6 A biscuit is made with 5 layers that alternate between a wafer layer (W) and a chocolate layer (C) in the order WCWCW.

The thickness of a wafer layer is a random variable having a normal distribution with mean $1.8\,\text{mm}$ and standard deviation $0.07\,\text{mm}$.

The thickness of a chocolate layer is a random variable having a normal distribution with mean $2.4\,\text{mm}$ and standard deviation $0.15\,\text{mm}$.

Assume that the thicknesses of the layers within a biscuit are independent of each other, and independent of the thicknesses of the layers in other biscuits.

(a) Find the mean and the variance of each of the following random variables.

(i) The total thickness of wafer layers in a biscuit (U).

(ii) The total thickness of chocolate layers in a biscuit (V).

(iii) $U + V$.

(iv) $U - V$.

[6 marks]

(b) One biscuit is randomly selected. Find the probability that:

(i) the total thickness of the biscuit is less than $10\,\text{mm}$;

(ii) the total thickness of the 3 wafer layers in the biscuit is greater than the total thickness of the 2 chocolate layers.

[7 marks]

(c) Four biscuits are randomly selected.

The probability that **all four** of these biscuits are individually less than $10\,\text{mm}$ in thickness is denoted by p_1

The probability that the **total thickness** of these four biscuits is less than $40\,\text{mm}$ is denoted by p_2

(i) Find the value of p_1

[2 marks]

(ii) Without performing any further calculations, state, with justification, whether you would expect p_2 to be greater than, equal to, or less than p_1

[3 marks]

QUESTION PART REFERENCE

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END OF QUESTIONS