AQA

Please write clearly in block capitals.

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

Surname _____

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A-level MATHEMATICS

Unit Statistics 2B

Tuesday 19 June 2018 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 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.

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	

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Answer **all** questions.

Answer each question in the space provided for that question.

1 The continuous random variable X has the probability density function defined by

$$f(x) = \begin{cases} \frac{1}{160}x & 8 \leqslant x \leqslant 16 \\ \frac{1}{10} & 16 \leqslant x \leqslant c \\ 0 & \text{otherwise} \end{cases}$$

where c is a constant.

(a) (i) Find the value of c.

[3 marks]

(ii) Hence find the 90th percentile of X.

[1 mark]

(b) Find the median value of X.

[3 marks]

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

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QUESTION PART REFERENCE

Answer space for question 1

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2 Rodney runs a game at a school fundraising event. In the game, 10 unbiased coins are tossed and the number of heads obtained, X, is counted.

The table below shows part of the probability distribution for X, giving values correct to three decimal places.

(a) Show that $\mathrm{P}(X = 10) = 0.001$, correct to three decimal places, and complete the table.

[2 marks]

(b) Rodney charges people 10p to play the game. He pays an $£8$ prize if 10 heads are obtained, a $£2$ prize if 9 heads are obtained, a 50p prize if 8 heads are obtained and no prize if 7 heads or fewer are obtained.

(i) Calculate the mean value of the prize paid per game, and show that the standard deviation of the prize lies between 33p and 34p.

[5 marks]

(ii) Someone complains that the three prizes are too small and suggests that Rodney should double the size of each prize. Make **two** comments on this suggestion.

[2 marks]

QUESTION PART REFERENCE

Answer space for question 2

(a)

x	7 or fewer	8	9	10
$\mathbf{P}(X = x)$	0.945	0.044		

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

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3 Nigella owns a restaurant where a free dessert is offered with each main course. She wants to know whether there is any association between the main course eaten by the diners and the dessert that they choose.

Table 1 shows the data Nigella obtained when she observed a sample of 250 diners who accepted the offer of a free dessert.

Table 1

	Main course				
	Beef	**Lamb**	**Chicken**	**Vegetarian**	**Total**
Fruit salad	36	16	16	12	80
Ice cream	33	24	28	20	105
Gâteau	16	10	16	23	65
Total	85	50	60	55	250

Nigella plans to use a χ^2-test, using the 5% significance level, to investigate whether these data indicate any such association.

(a) State, in context, the null hypothesis that Nigella should use.

[1 mark]

(b) Complete **Table 2** opposite to show the expected frequencies that must be used in the test.

[2 marks]

(c) Carry out the χ^2-test.

[6 marks]

(d) Make **one** comment about a significant difference between the observed values and the expected values.

[1 mark]

QUESTION PART REFERENCE

Answer space for question 3

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QUESTION PART REFERENCE

Answer space for question 3

Table 2

	Beef	Lamb	Chicken	Vegetarian
Fruit salad	27.2	16.0	19.2	17.6
Ice cream	35.7	21.0		
Gâteau	22.1	13.0		

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

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QUESTION PART REFERENCE

Answer space for question 3

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4 A fabric goes through a weaving process and a printing process during its production.

In the weaving process, flaws occur independently and randomly at a constant average rate of 0.3 per metre.

(a) Find the probability that:

(i) a 9-metre length of this fabric contains exactly 2 weaving flaws;

[2 marks]

(ii) a 30-metre length of this fabric contains at least 5 but no more than 10 weaving flaws.

[4 marks]

(b) In the printing process, flaws occur independently and randomly at a constant average rate of 0.2 per metre.

Find the probability that an 8-metre length of this fabric:

(i) contains a **total** of fewer than 6 flaws from the weaving and printing processes;

[1 mark]

(ii) has no flaws from one process but has 3 or more flaws from the other process.

[3 marks]

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

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QUESTION PART REFERENCE

Answer space for question 4

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5 The continuous random variable X has a rectangular distribution on the interval $[a, b]$.

The continuous random variable Y is related to X by the equation

$$Y = 2X - 5$$

(a) Given that $\mathrm{E}(Y) = 11$ and $\mathrm{Var}(Y) = 3$, find values for $\mathrm{E}(X)$ and $\mathrm{Var}(X)$.

[2 marks]

(b) Hence find values for:

(i) a and b;

[4 marks]

(ii) $\mathrm{P}(5 < X < 9)$.

[2 marks]

QUESTION PART REFERENCE

Answer space for question 5

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

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6 Hiran is a geologist searching for gold. He collects a sample of 10 rock specimens from a particular location and analyses each specimen to determine a value for its gold content in grams per tonne (gpt).

Using these 10 values, Hiran then calculates a 95% confidence interval for the mean gold content to be $(1.41, 1.87)$ gpt.

(a) (i) State the mean gold content that Hiran calculated from his values.

[1 mark]

(ii) Show that the value which Hiran used as his estimate of the population standard deviation was 0.322, correct to three significant figures.

[3 marks]

(b) Hiran's manager asks him to calculate a 90% confidence interval based on the same 10 values.

Calculate this 90% confidence interval, giving your answer to two decimal places.

[3 marks]

(c) When the mean gold content is at least 1.85 gpt, a particular location may be suitable for commercial mining.

With reference to **both** confidence intervals, comment on the suitability of this location for commercial mining.

[2 marks]

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

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

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7 Karen is the supervisor for waste collection from a village. Over many months, the time taken for the collection has had a mean of 334 minutes and a standard deviation of 17 minutes.

Karen changed the route for the collection and wanted to know whether collections using this new route had a lower mean time. She measured the times for a random sample of five waste collections from the village using the new route.

The times in Karen's sample were, in minutes,

345 308 312 329 310

It may be assumed that these times are from a normal distribution.

(a) Using these data, test, at the 5% significance level, whether the mean time for collections is lower using the new route:

(i) assuming that the standard deviation has remained at 17 minutes;

[7 marks]

(ii) without assuming that the standard deviation has remained at 17 minutes.

[5 marks]

(b) Further measurements show that the mean collection time using the new route is 327 minutes.

One of the conclusions in part **(a)(i)** or part **(a)(ii)** constitutes a Type I error or a Type II error.

State the part and the type of error.

[1 mark]

QUESTION PART REFERENCE

Answer space for question 7

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QUESTION PART REFERENCE

Answer space for question 7

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8 The continuous random variable X has a cumulative distribution function $\mathrm{F}(x)$ where

$$\mathrm{F}(x) = \begin{cases} 0 & x < 1 \\ \frac{1}{80}(x^4 - 1) & 1 \leqslant x \leqslant 3 \\ 1 & x > 3 \end{cases}$$

(a) Find $\mathrm{P}(X > 2)$.

[2 marks]

(b) The continuous random variable Y is defined by the equation

$$Y = \frac{1}{X}$$

Calculate the value of $\mathrm{Var}(Y)$.

[7 marks]

QUESTION PART REFERENCE

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QUESTION PART REFERENCE	**Answer space for question 8**

END OF QUESTIONS

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