Centre Number						Candidate Number				
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For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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6	
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TOTAL	

General Certificate of Education
Advanced Level Examination
June 2015

Mathematics MS2B

Unit Statistics 2B

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.

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Answer **all** questions.

Answer each question in the space provided for that question.

1 In a survey of the tideline along a beach, plastic bottles were found at a constant average rate of 280 per kilometre, and drinks cans were found at a constant average rate of 220 per kilometre. It may be assumed that these objects were distributed randomly and independently.

Calculate the probability that:

(a) a $10\,\text{m}$ length of tideline along this beach contains no more than 5 plastic bottles;

[2 marks]

(b) a $20\,\text{m}$ length of tideline along this beach contains exactly 2 drinks cans;

[3 marks]

(c) a $30\,\text{m}$ length of tideline along this beach contains a **total** of at least 12 but fewer than 18 of these two types of object.

[4 marks]

QUESTION PART REFERENCE

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QUESTION PART REFERENCE

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2 The continuous random variable X has probability density function defined by

$$\mathrm{f}(x) = \begin{cases} \frac{1}{k} & a \leqslant x \leqslant b \\ 0 & \text{otherwise} \end{cases}$$

(a) Write down, in terms of a and b, the value of k.

[1 mark]

(b) (i) Given that $\mathrm{E}(X) = 1$ and $\mathrm{Var}(X) = 3$, find the values of a and b.

[4 marks]

(ii) Four independent values of X are taken. Find the probability that exactly one of these four values is negative.

[3 marks]

QUESTION PART REFERENCE

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3 A machine fills bags with frozen peas. Measurements taken over several weeks have shown that the standard deviation of the weights of the filled bags of peas has been 2.2 grams.

Following maintenance on the machine, a quality control inspector selected 8 bags of peas. The weights, in grams, of the bags were

910.4 908.7 907.2 913.2 905.6 911.1 909.5 907.9

It may be assumed that the bags constitute a random sample from a normal distribution.

(a) Giving the limits to **four** significant figures, calculate a 95% confidence interval for the mean weight of a bag of frozen peas filled by the machine following the maintenance:

(i) assuming that the standard deviation of the weights of the bags of peas is known to be 2.2 grams;

[4 marks]

(ii) assuming that the standard deviation of the weights of the bags of peas may no longer be 2.2 grams.

[4 marks]

(b) The weight printed on the bags of peas is 907 grams. One of the inspector's concerns is that bags should not be underweight.

Make **two** comments about this concern with regard to the data and your calculated confidence intervals.

[2 marks]

QUESTION PART REFERENCE

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4 Wellgrove village has a main road running through it that has a $40\,\text{mph}$ speed limit. The villagers were concerned that many vehicles travelled too fast through the village, and so they set up a device for measuring the speed of vehicles on this main road. This device indicated that the mean speed of vehicles travelling through Wellgrove was $44.1\,\text{mph}$.

In an attempt to reduce the mean speed of vehicles travelling through Wellgrove, life-size photographs of a police officer were erected next to the road on the approaches to the village. The speed, $X\,\text{mph}$, of a sample of 100 vehicles was then measured and the following data obtained.

$$\sum x = 4327.0 \qquad \sum (x - \bar{x})^2 = 925.71$$

(a) State an assumption that must be made about the sample in order to carry out a hypothesis test to investigate whether the desired reduction in mean speed had occurred.

[1 mark]

(b) Given that the assumption that you stated in part **(a)** is valid, carry out such a test, using the 1% level of significance.

[8 marks]

(c) Explain, in the context of this question, the meaning of:

(i) a Type I error;

(ii) a Type II error.

[2 marks]

QUESTION PART REFERENCE

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5 In a particular town, a survey was conducted on a sample of 200 residents aged 41 years to 50 years. The survey questioned these residents to discover the age at which they had left full-time education and the greatest rate of income tax that they were paying at the time of the survey.

The summarised data obtained from the survey are shown in the table.

Greatest rate of income tax paid	Age when leaving education (years)			
	16 or less	**17 or 18**	**19 or more**	**Total**
Zero	32	3	4	39
Basic	102	12	17	131
Higher	17	5	8	30
Total	151	20	29	200

(a) Use a χ^2-test, at the 5% level of significance, to investigate whether there is an association between age when leaving education and greatest rate of income tax paid.

[9 marks]

(b) It is believed that residents of this town who had left education at a later age were more likely to be paying the higher rate of income tax. Comment on this belief.

[1 mark]

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6 The continuous random variable X has the cumulative distribution function

$$\mathrm{F}(x) = \begin{cases} 0 & x < 0 \\ \frac{1}{2}x - \frac{1}{16}x^2 & 0 \leqslant x \leqslant 4 \\ 1 & x > 4 \end{cases}$$

(a) Find the probability that X lies between 0.4 and 0.8.

[2 marks]

(b) Show that the probability density function, $\mathrm{f}(x)$, of X is given by

$$\mathrm{f}(x) = \begin{cases} \frac{1}{2} - \frac{1}{8}x & 0 \leqslant x \leqslant 4 \\ 0 & \text{otherwise} \end{cases}$$

[1 mark]

(c) (i) Find the value of $\mathrm{E}(X)$.

[3 marks]

(ii) Show that $\mathrm{Var}(X) = \frac{8}{9}$.

[4 marks]

(d) The continuous random variable Y is defined by

$$Y = 3X - 2$$

Find the values of $\mathrm{E}(Y)$ and $\mathrm{Var}(Y)$.

[2 marks]

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7 Each week, a newsagent stocks 5 copies of the magazine *Statistics Weekly*. A regular customer always buys **one** copy. The demand for **additional** copies may be modelled by a Poisson distribution with mean 2.

The number of copies sold in a week, X, has the probability distribution shown in the table, where probabilities are stated correct to three decimal places.

x	1	2	3	4	5
$\mathbf{P}(X = x)$	0.135	0.271	0.271	a	b

(a) Show that, correct to three decimal places, the values of a and b are 0.180 and 0.143 respectively.

[3 marks]

(b) Find the values of $\mathrm{E}(X)$ and $\mathrm{E}(X^2)$, showing the calculations needed to obtain these values, and hence calculate the standard deviation of X.

[5 marks]

(c) The newsagent makes a profit of £1 on each copy of *Statistics Weekly* that is sold and loses $50\,\mathrm{p}$ on each copy that is not sold. Find the mean weekly profit for the newsagent from sales of this magazine.

[2 marks]

(d) Assuming that the weekly demand remains the same, show that the mean weekly profit from sales of *Statistics Weekly* will be greater if the newsagent stocks only 4 copies.

[5 marks]

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