

Centre Number						Candidate Number				
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Other Names										
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For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	



General Certificate of Education
Advanced Level Examination
June 2012

Mathematics

MS2B

Unit Statistics 2B

Thursday 21 June 2012 1.30 pm to 3.00 pm

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.



J U N 1 2 M S 2 B 0 1

Answer **all** questions.

Answer each question in the space provided for that question.

- 1** At the start of the 2012 season, the ages of the members of the Warwickshire Acorns Cricket Club could be modelled by a normal random variable, X years, with mean μ and standard deviation σ .

The ages, x years, of a random sample of 15 such members are summarised below.

$$\sum x = 546 \quad \text{and} \quad \sum (x - \bar{x})^2 = 1407.6$$

- (a)** Construct a 98% confidence interval for μ , giving the limits to one decimal place. (6 marks)

- (b)** At the start of the 2005 season, the mean age of the members was 40.0 years.

Use your confidence interval constructed in part **(a)** to indicate, with a reason, whether the mean age had changed. (2 marks)

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2 The times taken to complete a round of golf at Slowpace Golf Club may be modelled by a random variable with mean μ hours and standard deviation 1.1 hours.

Julian claims that, on average, the time taken to complete a round of golf at Slowpace Golf Club is greater than 4 hours.

The times of 40 randomly selected completed rounds of golf at Slowpace Golf Club result in a mean of 4.2 hours.

(a) Investigate Julian’s claim at the 5% level of significance. (6 marks)

(b) If the actual mean time taken to complete a round of golf at Slowpace Golf Club is 4.5 hours, determine whether a Type I error, a Type II error or neither was made in the test conducted in part (a). Give a reason for your answer. (2 marks)

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3 The continuous random variable X has a cumulative distribution function defined by

$$F(x) = \begin{cases} 0 & x < -5 \\ \frac{x+5}{20} & -5 \leq x \leq 15 \\ 1 & x > 15 \end{cases}$$

- (a) Show that, for $-5 \leq x \leq 15$, the probability density function, $f(x)$, of X is given by $f(x) = \frac{1}{20}$. (1 mark)
- (b) Find:
- (i) $P(X \geq 7)$; (1 mark)
- (ii) $P(X \neq 7)$; (1 mark)
- (iii) $E(X)$; (1 mark)
- (iv) $E(3X^2)$. (3 marks)

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4 A house has a total of five bedrooms, at least one of which is always rented.

The probability distribution for R , the number of bedrooms that are rented at any given time, is given by

$$P(R = r) = \begin{cases} 0.5 & r = 1 \\ 0.4(0.6)^{r-1} & r = 2, 3, 4 \\ 0.0296 & r = 5 \end{cases}$$

- (a) Complete the table below. (2 marks)
- (b) Find the probability that fewer than 3 bedrooms are **not** rented at any given time. (3 marks)
- (c) (i) Find the value of $E(R)$. (2 marks)
- (ii) Show that $E(R^2) = 4.8784$ and hence find the value of $\text{Var}(R)$. (3 marks)
- (d) Bedrooms are rented on a monthly basis.

The monthly income, £ M , from renting bedrooms in the house may be modelled by

$$M = 1250R - 282$$

Find the mean and the standard deviation of M . (3 marks)

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(a)

r	1	2	3	4	5
$P(R = r)$	0.5				0.0296



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5 (a) The number of **minor** accidents occurring each year at RapidNut engineering company may be modelled by the random variable X having a Poisson distribution with mean 8.5.

Determine the probability that, in any particular year, there are:

- (i) at least 9 minor accidents; (2 marks)
- (ii) more than 5 but fewer than 10 minor accidents. (3 marks)

(b) The number of **major** accidents occurring each year at RapidNut engineering company may be modelled by the random variable Y having a Poisson distribution with mean 1.5.

Calculate the probability that, in any particular year, there are fewer than 2 major accidents. (2 marks)

(c) The **total** number of minor and major accidents occurring each year at RapidNut engineering company may be modelled by the random variable T having the probability distribution

$$P(T = t) = \begin{cases} \frac{e^{-\lambda} \lambda^t}{t!} & t = 0, 1, 2, 3, \dots \\ 0 & \text{otherwise} \end{cases}$$

Assuming that the number of minor accidents is independent of the number of major accidents:

- (i) state the value of λ ; (1 mark)
- (ii) determine $P(T > 16)$; (2 marks)
- (iii) calculate the probability that there will be a total of more than 16 accidents in each of at least two out of three years, giving your answer to four decimal places. (3 marks)

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6

Fiona, a lecturer in a school of engineering, believes that there is an association between the class of degree obtained by her students and the grades that they had achieved in A-level Mathematics.

In order to investigate her belief, she collected the relevant data on the performances of a random sample of 200 recent graduates who had achieved grades A or B in A-level Mathematics. These data are tabulated below.

		Class of degree				Total
		1	2(i)	2(ii)	3	
A-level grade	A	20	36	22	2	80
	B	9	55	48	8	120
Total		29	91	70	10	200

- (a) Conduct a χ^2 test, at the 1% level of significance, to determine whether Fiona’s belief is justified. *(9 marks)*
- (b) Make **two** comments on the degree performance of those students in this sample who achieved a grade B in A-level Mathematics. *(2 marks)*

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7 A continuous random variable X has probability density function defined by

$$f(x) = \begin{cases} \frac{1}{6}(4-x) & 1 \leq x \leq 3 \\ \frac{1}{6} & 3 \leq x \leq 5 \\ 0 & \text{otherwise} \end{cases}$$

- (a) Draw the graph of f on the grid opposite. (2 marks)
- (b) Prove that the mean of X is $2\frac{5}{9}$. (4 marks)
- (c) Calculate the **exact** value of:
- (i) $P(X > 2.5)$; (2 marks)
- (ii) $P(1.5 < X < 4.5)$; (3 marks)
- (iii) $P(X > 2.5 \text{ and } 1.5 < X < 4.5)$; (2 marks)
- (iv) $P(X > 2.5 \mid 1.5 < X < 4.5)$. (2 marks)

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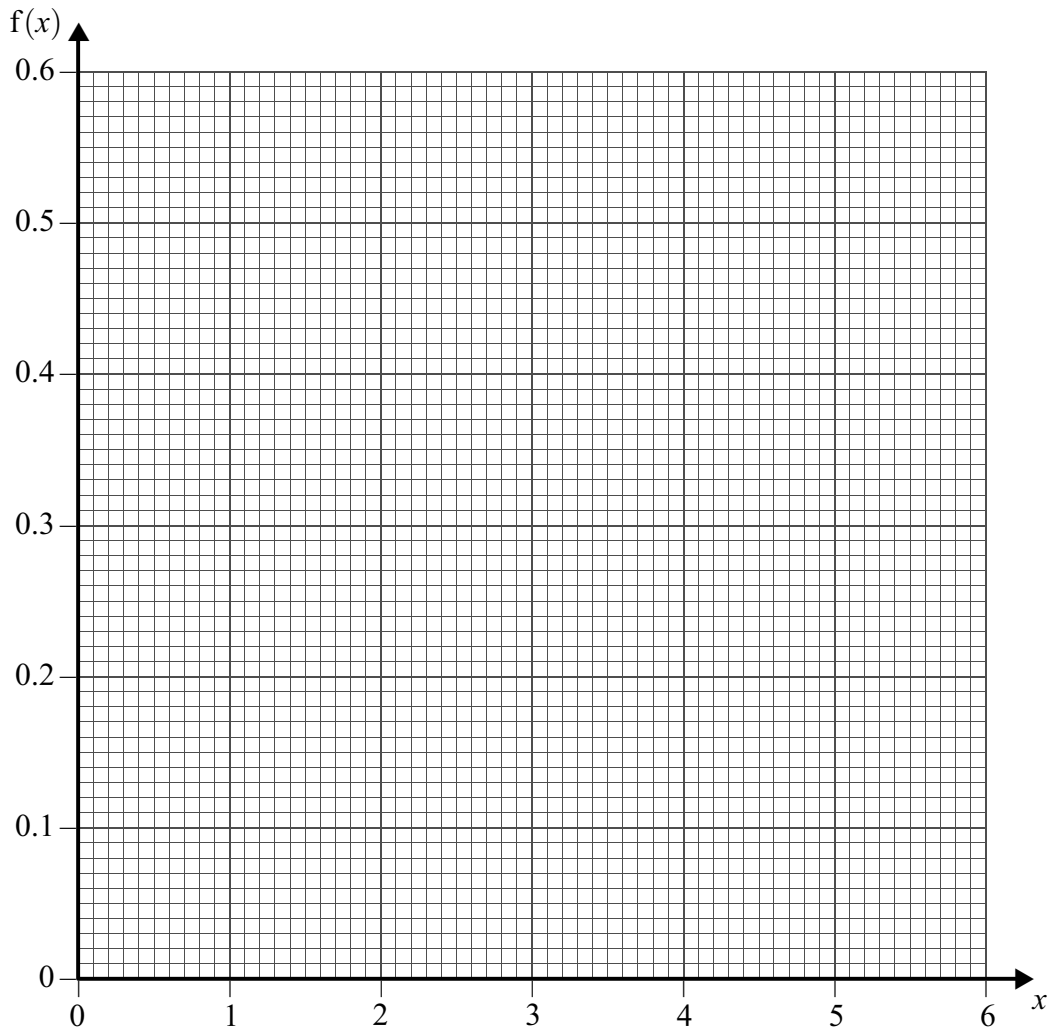
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(a)



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END OF QUESTIONS



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