Centre Number						Candidate Number				
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Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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TOTAL	

General Certificate of Education
Advanced Level Examination
January 2013

Mathematics MS2B

Unit Statistics 2B

Monday 28 January 2013 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 Dimitra is an athlete who competes in 400 m races. The times, in seconds, for her first six races of the 2012 season were

54.86 53.09 53.75 52.88 51.97 51.81

(a) Assuming that these data form a random sample from a normal distribution, construct a 95% confidence interval for the mean time of Dimitra's races in the 2012 season, giving the limits to two decimal places. *(5 marks)*

(b) For the 2011 season, Dimitra's mean time for her races was 53.41 seconds. After her first six races of the 2012 season, her coach claimed that the data showed that she would be more successful in races during the 2012 season than during the 2011 season. Make **two** comments about the coach's claim. *(2 marks)*

QUESTION PART REFERENCE

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QUESTION PART REFERENCE

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2 A large estate agency would like all the properties that it handles to be sold within three months. A manager wants to know whether the type of property affects the time taken to sell it. The data for a random sample of properties sold are tabulated below.

	Type of property				
	Flat	**Terraced**	**Semi-detached**	**Detached**	**Total**
Sold within three months	4	34	28	18	84
Sold in more than three months	9	18	8	6	41
Total	13	52	36	24	125

(a) Conduct a χ^2-test, at the 10% level of significance, to determine whether there is an association between the type of property and the time taken to sell it. Explain why it is necessary to combine two columns before carrying out this test. *(10 marks)*

(b) The manager plans to spend extra money on advertising for one type of property in an attempt to increase the number sold within three months. Explain why the manager might choose:

(i) terraced properties;

(ii) flats. *(2 marks)*

QUESTION PART REFERENCE

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3 A large office block is busy during the five weekdays, Monday to Friday, and less busy during the two weekend days, Saturday and Sunday. The block is illuminated by fluorescent light tubes which frequently fail and must be replaced with new tubes by John, the caretaker.

The number of fluorescent tubes that fail on a particular weekday can be modelled by a Poisson distribution with mean 1.5 .

The number of fluorescent tubes that fail on a particular weekend day can be modelled by a Poisson distribution with mean 0.5 .

(a) Find the probability that:

(i) on one particular Monday, exactly 3 fluorescent light tubes fail; *(2 marks)*

(ii) during the two days of a weekend, more than 1 fluorescent light tube fails; *(2 marks)*

(iii) during a complete seven-day week, fewer than 10 fluorescent light tubes fail. *(4 marks)*

(b) John keeps a supply of new fluorescent light tubes. More new tubes are delivered every Monday morning to replace those that he has used during the previous week. John wants the probability that he runs out of new tubes before the next Monday morning to be less than 1 per cent. Find the minimum number of new tubes that he should have available on a Monday morning. *(2 marks)*

(c) Give a reason why a Poisson distribution with mean 0.375 is unlikely to provide a satisfactory model for the number of fluorescent light tubes that fail between 1 am and 7 am on a weekday. *(1 mark)*

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

$$f(x) = \begin{cases} kx^2 & 0 \leqslant x \leqslant 3 \\ 9k & 3 \leqslant x \leqslant 4 \\ 0 & \text{otherwise} \end{cases}$$

(a) Sketch the graph of f. *(3 marks)*

(b) Show that the value of k is $\frac{1}{18}$. *(4 marks)*

(c) (i) Write down the median value of X.

(ii) Calculate the value of the lower quartile of X. *(4 marks)*

QUESTION PART REFERENCE

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5 Aiden takes his car to a garage for its MOT test. The probability that his car will need to have X tyres replaced is shown in the table.

x	0	1	2	3	4
$\mathbf{P}(X = x)$	0.1	0.35	0.25	0.2	0.1

(a) Show that the mean of X is 1.85 and calculate the variance of X. *(4 marks)*

(b) The charge for the MOT test is £c and the cost of **each** new tyre is £n. The total amount that Aiden must pay the garage is £T.

(i) Express T in terms of c, n and X. *(1 mark)*

(ii) Hence, using your results from part **(a)**, find expressions for $\mathrm{E}(T)$ and $\mathrm{Var}(T)$. *(4 marks)*

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6 The time, in weeks, that a patient must wait to be given an appointment in Holmsoon Hospital may be modelled by a random variable T having the cumulative distribution function

$$\mathrm{F}(t) = \begin{cases} 0 & t < 0 \\ \dfrac{t^3}{216} & 0 \leqslant t \leqslant 6 \\ 1 & t > 6 \end{cases}$$

(a) Find, to the nearest day, the time within which 90 per cent of patients will have been given an appointment. *(3 marks)*

(b) Find the probability density function of T for all values of t. *(3 marks)*

(c) Calculate the mean and the variance of T. *(6 marks)*

(d) Calculate the probability that the time that a patient must wait to be given an appointment is more than one standard deviation above the mean. *(4 marks)*

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7 A factory produces 3-litre bottles of mineral water. The volume of water in a bottle has previously had a mean value of 3020 millilitres. Following a stoppage for maintenance, the volume of water, x millilitres, in each of a random sample of 100 bottles is measured and the following data obtained, where $y = x - 3000$.

$$\sum y = 1847.0 \qquad \sum (y - \bar{y})^2 = 6336.00$$

(a) Carry out a hypothesis test, at the 5% significance level, to investigate whether the mean volume of water in a bottle has changed. *(8 marks)*

(b) Subsequent measurements establish that the mean volume of water in a bottle produced by the factory after the stoppage is 3020 millilitres. State whether a Type I error, a Type II error or no error was made when carrying out the test in part **(a)**. *(1 mark)*

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END OF QUESTIONS

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