Centre Number						Candidate Number				
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For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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5	
6	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2013

Mathematics MS/SS1B
Unit Statistics 1B

Statistics
Unit Statistics 1B

Friday 17 May 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.
- Unit Statistics 1B has a **written paper only**.

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 The average maximum monthly temperatures, u degrees Fahrenheit, and the average minimum monthly temperatures, v degrees Fahrenheit, in New York City are as follows.

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Maximum (u)	39	40	48	61	71	81	85	83	77	67	54	41
Minimum (v)	26	27	34	44	53	63	68	66	60	51	41	30

(a) (i) Calculate, to one decimal place, the mean and the standard deviation of the 12 values of the average **maximum** monthly temperature. *(2 marks)*

(ii) For comparative purposes with a UK city, it was necessary to convert the temperatures from degrees Fahrenheit (°F) to degrees Celsius (°C). The formula used to convert f °F to c °C is:

$$c = \frac{5}{9}(f - 32)$$

Use this formula and your answers in part **(a)(i)** to calculate, **in °C**, the mean and the standard deviation of the 12 values of the average maximum monthly temperature. *(3 marks)*

(b) The value of the product moment correlation coefficient, r_{uv}, between the above 12 values of u and v is 0.997, correct to three decimal places.

State, giving a reason, the corresponding value of r_{xy}, where x and y are the exact equivalent temperatures in °C of u and v respectively. *(2 marks)*

QUESTION PART REFERENCE

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2 The weight, X grams, of the contents of a tin of baked beans can be modelled by a normal random variable with a mean of 421 and a standard deviation of 2.5.

(a) Find:

(i) $P(X = 421)$;

(ii) $P(X < 425)$;

(iii) $P(418 < X < 424)$. *(6 marks)*

(b) Determine the value of x such that $P(X < x) = 0.98$. *(3 marks)*

(c) The weight, Y grams, of the contents of a tin of ravioli can be modelled by a normal random variable with a mean of μ and a standard deviation of 3.0.

Find the value of μ such that $P(Y < 410) = 0.01$. *(4 marks)*

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3 An auction house offers items of jewellery for sale at its public auctions. Each item has a reserve price which is less than the lower price estimate which, in turn, is less than the upper price estimate. The outcome for any item is independent of the outcomes for all other items.

The auction house has found, from past records, the following probabilities for the outcomes of items of jewellery offered for sale.

Outcome	Probability
Item does not achieve its reserve price	0.15
Item achieves at least its reserve price	0.85
Item achieves at least its lower price estimate	0.50
Item achieves at least its upper price estimate	0.175

For example, the probability that an item achieves at least its lower price estimate but not its upper price estimate is 0.325 .

A particular auction includes exactly 40 items of jewellery that may be assumed to be a random sample of such items.

(a) Use binomial distributions to find the probability that:

(i) at most 10 items do not achieve their reserve prices; *(1 mark)*

(ii) 25 or more items achieve at least their lower price estimates; *(2 marks)*

(iii) exactly 2 items achieve at least their upper price estimates; *(2 marks)*

(iv) more than 10 items but fewer than 15 items achieve at least their reserve prices but not their lower price estimates. *(4 marks)*

(b) How many of the 40 items of jewellery would you expect to achieve at least their reserve prices but not their upper price estimates? *(2 marks)*

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4 The girth, g metres, the length, l metres, and the weight, y kilograms, of each of a sample of 20 pigs were measured.

The data collected is summarised as follows.

$$S_{gg} = 0.1196 \quad S_{ll} = 0.0436 \quad S_{yy} = 5880 \quad S_{gy} = 24.15 \quad S_{ly} = 10.25$$

(a) Calculate the value of the product moment correlation coefficient between:

(i) girth and weight;

(ii) length and weight. *(3 marks)*

(b) Interpret, in context, **each** of the values that you obtained in part **(a)**. *(3 marks)*

(c) Weighing pigs requires expensive equipment, whereas measuring their girths and lengths simply requires a tape measure. With this in mind, the following formula is proposed to make an estimate of a pig's weight, x kilograms, from its girth and length.

$$x = 69.3 \times g^2 \times l$$

Applying this formula to the relevant data on the 20 pigs resulted in

$$S_{xx} = 5656.15 \quad S_{xy} = 5662.97$$

(i) By calculating a third value of the product moment correlation coefficient, state which of g, l or x is the most strongly correlated with y, the weight. *(2 marks)*

(ii) Estimate the weight of a pig that has a girth of 1.25 metres and a length of 1.15 metres. *(2 marks)*

(iii) Given the additional information that $\overline{x} = 115.4$ and $\overline{y} = 116.0$, calculate the equation of the least squares regression line of y on x, in the form $y = a + bx$. *(3 marks)*

(iv) Comment on the likely accuracy of the estimated weight found in part **(c)(ii)**. Your answer should make reference to the value of the product moment correlation coefficient found in part **(c)(i)** and to the values of b and a found in part **(c)(iii)**. *(4 marks)*

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5 Alison is a member of a tenpin bowling club which meets at a bowling alley on Wednesday and Thursday evenings.

The probability that she bowls on a Wednesday evening is 0.90. Independently, the probability that she bowls on a Thursday evening is 0.95.

(a) Calculate the probability that, during a particular week, Alison bowls on:

(i) two evenings;

(ii) exactly one evening. *(3 marks)*

(b) David, a friend of Alison, is a member of the same club.

The probability that he bowls on a Wednesday evening, given that Alison bowls on that evening, is 0.80. The probability that he bowls on a Wednesday evening, given that Alison does not bowl on that evening, is 0.15.

The probability that he bowls on a Thursday evening, given that Alison bowls on that evening, is 1. The probability that he bowls on a Thursday evening, given that Alison does not bowl on that evening, is 0.

Calculate the probability that, during a particular week:

(i) Alison and David bowl on a Wednesday evening; *(2 marks)*

(ii) Alison and David bowl on both evenings; *(2 marks)*

(iii) Alison, but not David, bowls on a Thursday evening; *(1 mark)*

(iv) neither bowls on either evening. *(3 marks)*

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6 The weight, X kilograms, of sand in a bag can be modelled by a normal random variable with unknown mean μ and known standard deviation 0.4.

(a) The sand in each of a random sample of 25 bags from a large batch is weighed. The **total** weight of sand in these 25 bags is found to be 497.5 kg.

(i) Construct a 98% confidence interval for the mean weight of sand in bags in the batch. *(5 marks)*

(ii) Hence comment on the claim that bags in the batch contain an average of 20 kg of sand. *(2 marks)*

(iii) State why use of the Central Limit Theorem is **not** required in answering part **(a)(i)**. *(1 mark)*

(b) The weight, Y kilograms, of cement in a bag can be modelled by a normal random variable with mean 25.25 and standard deviation 0.35.

A firm purchases 10 such bags. These bags may be considered to be a random sample.

(i) Determine the probability that the **mean** weight of cement in the 10 bags is **less** than 25 kg. *(4 marks)*

(ii) Calculate the probability that the weight of cement in **each** of the 10 bags is **more** than 25 kg. *(4 marks)*

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