General Certificate of Education
Advanced Subsidiary Examination
January 2011

Mathematics MS/SS1B

Unit Statistics 1B

Statistics

Unit Statistics 1B

Friday 14 January 2011 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

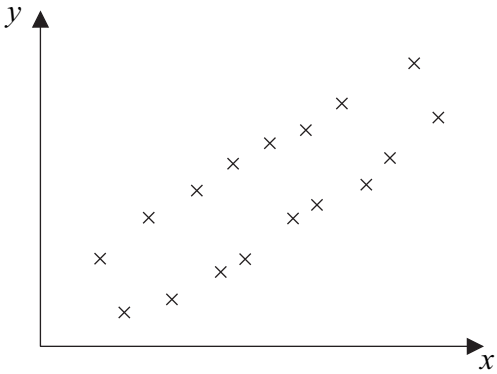
Instructions
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Write the question part reference (eg (a), (b)(i) etc) in the left-hand margin.
- You must answer the questions in the spaces provided. 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**.

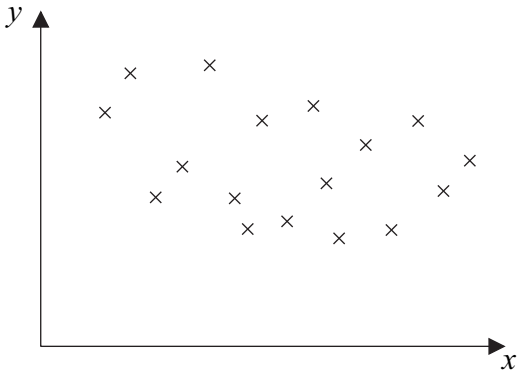
Advice
- Unless stated otherwise, you may quote formulae, without proof, from the booklet.

1 (a) Estimate, **without undertaking any calculations**, the value of the product moment correlation coefficient between the variables x and y for each of the two scatter diagrams.

(i)



(ii)



(2 marks)

(b) The table gives the circumference, x centimetres, and the weight, y grams, of each of 12 new cricket balls.

x	22.5	22.7	22.6	22.4	22.5	22.8	22.6	22.7	22.8	22.4	22.9	22.6
y	160.3	159.4	157.8	158.0	157.3	159.8	158.3	159.6	161.3	156.4	162.5	161.2

(i) Calculate the value of the product moment correlation coefficient between x and y.
(3 marks)

(ii) Assuming that the 12 balls may be considered to be a random sample, interpret your value in context. *(2 marks)*

2 The number of MPs in the House of Commons was 645 at the beginning of August 2009. The genders of these MPs and the political parties to which they belonged are shown in the table.

		Political Party				
		Labour	**Conservative**	**Liberal Democrat**	**Other**	**Total**
Gender	**Male**	255	175	54	35	519
	Female	94	18	9	5	126
	Total	349	193	63	40	645

(a) One MP was selected at random for an interview. Calculate, to three decimal places, the probability that the MP was:

(i) a male Conservative; *(1 mark)*

(ii) a male; *(1 mark)*

(iii) a Liberal Democrat; *(1 mark)*

(iv) Labour, given that the MP was female; *(2 marks)*

(v) male, given that the MP was **not** Labour. *(3 marks)*

(b) Two **female** MPs were selected at random for an enquiry. Calculate, to three decimal places, the probability that both MPs were Labour. *(2 marks)*

(c) Three MPs were selected at random for a committee. Calculate, to three decimal places, the probability that exactly one MP was Labour and exactly one MP was Conservative. *(4 marks)*

3 The volume, X litres, of orange juice in a 1-litre carton may be modelled by a normal distribution with unknown mean μ.

The volumes, x litres, recorded to the nearest 0.01 litre, in a random sample of 100 cartons are shown in the table.

Volume (x litres)	**Number of cartons (f)**
0.95 – 0.97	2
0.98 – 1.00	7
1.01 – 1.03	15
1.04 – 1.06	32
1.07 – 1.09	22
1.10 – 1.12	14
1.13 – 1.15	7
1.16 – 1.18	1
Total	**100**

(a) For the group '0.98 – 1.00':

(i) show that it has a mid-point of 0.99 litres;

(ii) state the minimum and the maximum values of x that could be included in this group. *(2 marks)*

(b) Calculate, to three decimal places, estimates of the mean and the standard deviation of these 100 volumes. *(3 marks)*

(c) (i) Construct an approximate 99% confidence interval for μ. *(4 marks)*

(ii) State why use of the Central Limit Theorem was **not** required when calculating this confidence interval. *(1 mark)*

(iii) Give a reason why the confidence interval is approximate rather than exact. *(1 mark)*

(d) Give a reason in support of the claim that:

(i) $\mu > 1$;

(ii) $\mathrm{P}(0.94 < X < 1.16)$ is approximately 1. *(2 marks)*

4 Clay pigeon shooting is the sport of shooting at special flying clay targets with a shotgun.

(a) Rhys, a novice, uses a single-barrelled shotgun. The probability that he hits a target is 0.45, and may be assumed to be independent from target to target.

Determine the probability that, in a series of shots at 15 targets, he hits:

(i) at most 5 targets; *(1 mark)*

(ii) more than 10 targets; *(2 marks)*

(iii) exactly 6 targets; *(2 marks)*

(iv) at least 5 but at most 10 targets. *(3 marks)*

(b) Sasha, an expert, uses a double-barrelled shotgun. She shoots at each target with the gun's first barrel and, only if she misses, does she then shoot at the target with the gun's second barrel.

The probability that she hits a target with a shot using her gun's first barrel is 0.85. The conditional probability that she hits a target with a shot using her gun's second barrel, given that she has missed the target with a shot using her gun's first barrel, is 0.80. Assume that Sasha's shooting is independent from target to target.

(i) Show that the probability that Sasha hits a target is 0.97. *(2 marks)*

(ii) Determine the probability that, in a series of shots at 50 targets, Sasha hits at least 48 targets. *(3 marks)*

(iii) In a series of shots at 80 targets, calculate the mean number of times that Sasha shoots at targets with her gun's second barrel. *(2 marks)*

Turn over ▶

5 Craig uses his car to travel regularly from his home to the area hospital for treatment. He leaves home at x minutes after 7.30 am and then takes y minutes to arrive at the hospital's reception desk.

His results for 11 mornings are shown in the table.

x	0	5	10	15	20	25	30	35	40	45	50
y	31	42	32	58	47	56	79	68	89	95	85

(a) Explain why the time taken by Craig between leaving home and arriving at the hospital's reception desk is the response variable. *(1 mark)*

(b) Calculate the equation of the least squares regression line of y on x, writing your answer in the form $y = a + bx$. *(5 marks)*

(c) On a particular day, Craig needs to arrive at the hospital's reception desk no later than 9.00 am. He leaves home at 7.45 am.

Estimate the number of minutes **before** 9.00 am that Craig will arrive at the hospital's reception desk. Give your answer to the nearest minute. *(5 marks)*

(d) (i) Use your equation to estimate y when $x = 85$. *(1 mark)*

(ii) Give **one** statistical reason and **one** reason based on the context of this question as to why your estimate in part **(d)(i)** is unlikely to be realistic. *(2 marks)*

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6 The volume of shampoo, V millilitres, delivered by a machine into bottles may be modelled by a normal random variable with mean μ and standard deviation σ.

(a) Given that $\mu = 412$ and $\sigma = 8$, determine:

(i) $\mathrm{P}(V < 400)$; *(3 marks)*

(ii) $\mathrm{P}(V > 420)$; *(2 marks)*

(iii) $\mathrm{P}(V = 410)$. *(1 mark)*

(b) A new quality control specification requires that the values of μ and σ are changed so that

$$\mathrm{P}(V < 400) = 0.05 \quad \text{and} \quad \mathrm{P}(V > 420) = 0.01$$

(i) Show, with the aid of a suitable sketch, or otherwise, that

$$400 - \mu = -1.6449\sigma \quad \text{and} \quad 420 - \mu = 2.3263\sigma$$ *(3 marks)*

(ii) Hence calculate values for μ and σ. *(3 marks)*