AQA

General Certificate of Education
Advanced Level Examination
June 2015

Statistics   SS06

Unit Statistics 6

Monday 22 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.

SS06

Answer **all** questions.

Answer each question in the space provided for that question.

1 The plant *Ginkgo biloba* has been used safely in traditional medicine for thousands of years. Researchers wanted to carry out a trial in order to discover whether *Ginkgo biloba* could be used to treat symptoms of early-stage dementia caused by Alzheimer's disease.

The design for the researchers' trial is outlined in the following bullet points.

- 300 early-stage dementia sufferers volunteered to take part in the trial. It was required that approximately half of these volunteers received *Ginkgo biloba* and the remainder did not.

- The researchers provided all of the volunteers with tablets. The volunteers who were allocated to receive *Ginkgo biloba* were given tablets that contained *Ginkgo biloba* extract and the volunteers who were not allocated to receive *Ginkgo biloba* were given tablets, of identical size and colour, that contained inactive ingredients.

- During the trial, neither the volunteers nor the researchers knew which tablets contained *Ginkgo biloba* extract and which tablets contained inactive ingredients.

- Following the 52-week trial, the researchers then assessed dementia symptoms for all the volunteers.

(a) Describe a method that could be used to allocate the volunteers to receive *Ginkgo biloba*.

[2 marks]

(b) Identify, for the trial, which volunteers formed:

(i) the experimental group;

(ii) the control group.

[2 marks]

(c) (i) Justify the decision made by the researchers to provide **all** of the volunteers with tablets.

(ii) Explain why, during the trial, it was beneficial that neither the researchers nor the volunteers knew which tablets contained *Ginkgo biloba*.

[4 marks]

QUESTION PART REFERENCE	Answer space for question 1

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QUESTION PART REFERENCE	Answer space for question 1

QUESTION PART REFERENCE	Answer space for question 1

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2 (a)   The pulse rates, in beats per minute, of a sample of 12 patients who were undergoing the same minor dental treatment, were measured before and immediately after the treatment.

The results are given in **Table 1**.

Table 1

Patient	A	B	C	D	E	F	G	H	I	J	K	L
Pulse rate before	70	64	72	73	75	69	68	72	68	68	70	73
Pulse rate after	75	70	73	73	74	69	73	73	67	63	74	75

It is decided that a paired t-test should be carried out on these data in order to investigate whether average pulse rates differ before and immediately after the minor dental treatment.

(i)   State **two** necessary assumptions in order for a paired t-test on these data to be valid.

[2 marks]

(ii)   Carry out this test using the 5% level of significance.

[8 marks]

(iii)   State the type of error, if any, that might have occurred in carrying out the t-test in part **(a)(ii)**.

[1 mark]

QUESTION PART REFERENCE	Answer space for question 2(a)

QUESTION PART REFERENCE	Answer space for question 2(a)

Question 2 continues on the next page

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2 (b) Seven of the 12 patients were also asked to record their current levels of anxiety, on a scale of 0 to 10, where 0 indicates no anxiety, before and immediately after the minor dental treatment.

The results are given in **Table 2**.

Table 2

Patient	A	B	E	G	J	K	L
Anxiety level before	8.5	7	9.5	5	6	8	5.5
Anxiety level after	6	4	3	6.5	5	6	7

Carry out a Wilcoxon signed-rank test to investigate whether average anxiety levels are lower immediately after the minor dental treatment than before the treatment. Use the 10% level of significance.

[7 marks]

QUESTION PART REFERENCE

Answer space for question 2(b)

QUESTION PART REFERENCE	Answer space for question 2(b)

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3 (a) A home-improvement company is considering selecting a single provider for the printing of its publicity leaflets. The company uses sixteen different publicity leaflets for marketing the various types of home improvement offered.

Currently, four printing providers, A, B, C and D, are used.

It was decided that four leaflets would be allocated at random to each of the four current providers for printing.

The company then checked the printed publicity leaflets and gave each of them a score, out of a maximum of 75 marks, for quality. A higher score indicates a better quality of printing.

Unfortunately, one of the leaflets from printing provider D was lost by the delivery courier and therefore could not be allocated a score.

The results are given in the table.

Printing provider			
A	**B**	**C**	**D**
46	45	44	58
49	48	36	54
52	50	34	47
50	56	32	

(i) Carry out a one-way analysis of variance, using the 1% level of significance, to investigate for a difference in the mean printing quality scores between the four providers.

[10 marks]

(ii) Interpret your conclusion to the test in part **(a)(i)** in the context of the question. You should include advice to the company regarding which of the printing providers it should select.

[2 marks]

(iii) State **two** assumptions that are necessary in order for the test in part **(a)(i)** to be valid.

[2 marks]

(b) The company's marketing manager, Rio, is concerned about the way the quality of the four printing providers was compared.

Rio points out that the company uses leaflets that are of four different types of printing difficulty: Complex Colour, Two Colour, Single Colour, and Black & White.

There are four leaflets of each type of printing difficulty used.

Name the new experimental design that the company should now use for comparing printing providers which takes into account this additional information from Rio.

[2 marks]

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QUESTION PART REFERENCE	Answer space for question 3

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QUESTION PART REFERENCE	Answer space for question 3

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4 A pharmaceutical company manufactures antibiotic tablets, containing trimethroprim, with a nominal potency of $100\,\text{mg}$.

The manufacturing process is controlled by selecting, each hour, samples of size 6 and measuring the potency of the sampled tablets.

The potency of the tablets may be assumed to be normally distributed.

The means and the ranges of the measured potencies for the most recent eight samples are given in the table.

Sample	1	2	3	4	5	6	7	8
Mean	99.1	99.8	99.7	100.5	99.8	100.8	100.2	100.5
Range	1.9	0.7	2.8	1.5	1.8	0.8	2.3	2.0

(a) Use the ranges to show that an estimate of the current standard deviation of this manufacturing process is 0.68, correct to two decimal places.

[2 marks]

(b) Using 0.68 as the standard deviation, calculate upper and lower warning (95%) and action (99.8%) control limits for charts for:

(i) means;

(ii) ranges.

You are not required to draw the charts.

[6 marks]

(c) The potencies of the tablets in the next two samples, Sample 9 and Sample 10, are as follows:

Sample 9   99.4   101.1   99.8   100.7   100.3   99.6

Sample 10   99.5   101.4   99.9   102.5   102.2   100.1

State, with reasons, what action, if any, you would advise as a result of each of Sample 9 and Sample 10.

[5 marks]

(d) The pharmaceutical company specifies a tolerance of 100 ± 2.5 for the potency of the tablets.

Find the proportion of tablets outside this tolerance when the production process has a mean of 101 and a standard deviation of 0.68.

[3 marks]

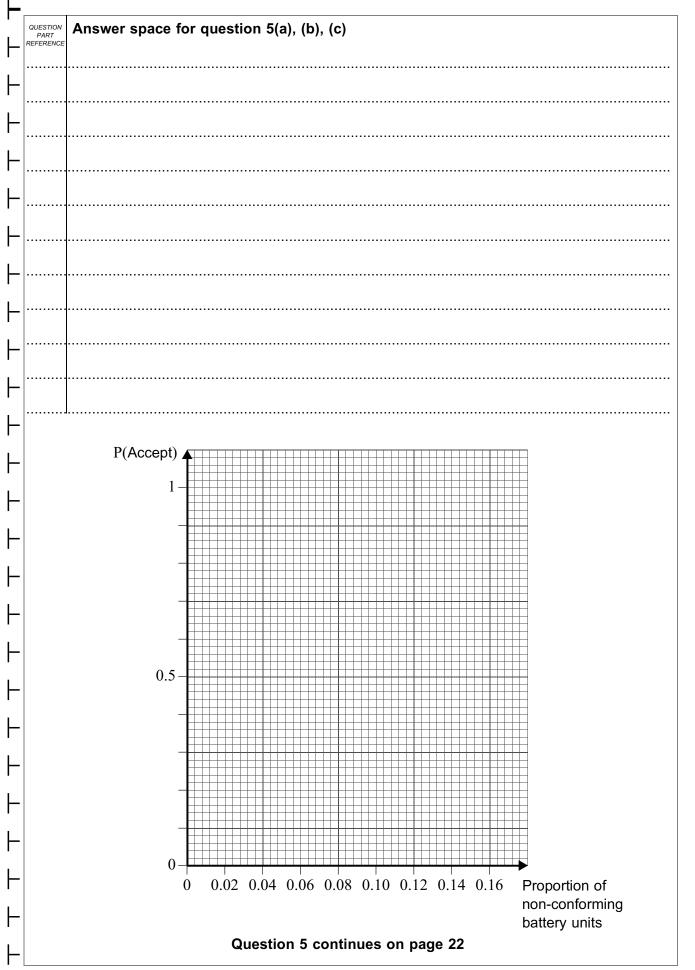| QUESTION PART REFERENCE	Answer space for question 4

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QUESTION PART REFERENCE	Answer space for question 4

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5 Shipments of batches of 2000 battery units for microcomputers are to be inspected by an importer. For such batches, the importer and the manufacturer wish to set up an acceptance sampling scheme with which they both agree.

The importer of the battery units requires that the probability that a batch is accepted is at most 5% when the proportion of non-conforming battery units is 15%.

The manufacturer of the battery units requires that the probability that a batch is rejected is at most 2% when the proportion of non-conforming battery units is 2%.

It is decided that a sample of 50 battery units is to be taken from each batch and that the batch will be accepted provided that r or fewer battery units are found to be non-conforming.

(a) Show that the value for r necessary to satisfy the requirements of both the importer and the manufacturer is 3.

[4 marks]

(b) For this value of r, determine the probability that a batch is accepted when the proportion of non-conforming battery units is:

(i) 5%;

(ii) 10%.

[2 marks]

(c) (i) Draw the operating characteristic for this acceptance sampling scheme on the grid on the page opposite.

[2 marks]

(ii) Also draw on the grid the ideal shape of the operating characteristic if the importer would like to accept all batches containing 4% or fewer non-conforming battery units and to reject all other batches.

[2 marks]

QUESTION PART REFERENCE

Answer space for question 5(a), (b), (c)

QUESTION PART REFERENCE	Answer space for question 5(a), (b), (c)

P(Accept)

1

0.5

0

0   0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16

Proportion of non-conforming battery units

Question 5 continues on page 22

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QUESTION PART REFERENCE	Answer space for question 5(a), (b), (c)

QUESTION PART REFERENCE	Answer space for question 5(a), (b), (c)

Question 5 continues on the next page

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5 (d)   Ruby, a statistician, then advises the importer that it would be preferable to use a double-sampling scheme instead of the single-sampling scheme. It is suggested by Ruby that the following double-sampling scheme should be used.

Select a random sample of size 40 and accept the batch if 2 or fewer non-conforming battery units are found; reject the batch if 4 or more non-conforming battery units are found.

If 3 non-conforming battery units are found, select a further random sample of size 40 and accept the batch if a **total** of 4 or fewer (out of 80) non-conforming battery units is found; otherwise reject the batch.

    (i)   Evaluate two probabilities in order to demonstrate that the double-sampling scheme suggested by Ruby would satisfy the manufacturer's requirement and also the importer's original requirement.

[5 marks]

    (ii)   Give **one** advantage and **one** disadvantage to the importer of Ruby's suggested double-sampling scheme compared with the initial single-sampling scheme.

[2 marks]

QUESTION PART REFERENCE | **Answer space for question 5(d)**

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QUESTION PART REFERENCE	Answer space for question 5(d)

END OF QUESTIONS