AQA

General Certificate of Education
Advanced Subsidiary Examination
June 2013

Statistics

SS03

Unit Statistics 3

Thursday 6 June 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
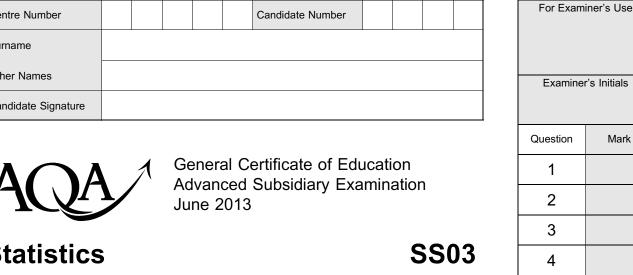• 1 hour 30 minutes

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.

SS03

Answer **all** questions.

Answer each question in the space provided for that question.

1   Each day, Jamal completes a crossword puzzle from a particular newspaper and records his completion time, to the nearest minute.

For 2011, his median completion time for a crossword puzzle from this newspaper was 32 minutes.

Jamal's completion times, to the nearest minute, for a random sample of 12 crossword puzzles, selected from those that he completed from the same newspaper during 2012, were as follows.

   40   20   18   11   27   36   38   35   22   14   12   21

Use a sign test, with the 10% significance level, to examine whether Jamal's median completion time for crossword puzzles from this newspaper during 2012 had decreased from that for 2011.

(6 marks)

QUESTION
PART
REFERENCE

Answer space for question 1

QUESTION PART REFERENCE	Answer space for question 1

Answer space for question 1

Turn over ▶

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2 As part of an investigation into trends in local authority spending in England, one of the categories of expenditure considered was 'Highways'.

For a random sample of 10 local authorities, the percentages of their total expenditure on 'Highways' during 2002 and also during 2012 are shown in the table.

		Local authority									
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Year	**2002**	5.6	8.4	8.7	9.3	9.9	9.4	7.9	8.1	9.6	8.6
	2012	8.9	8.4	7.9	8.4	10.2	10.1	8.3	9.8	9.5	9.7

(a) Carry out a Wilcoxon signed-rank test to investigate whether there was a change in the average percentage of local authority total expenditure on 'Highways' between 2002 and 2012. Use the 5% level of significance. *(9 marks)*

(b) (i) State the assumption necessary regarding the distribution of differences in percentage expenditures in order for the test in part **(a)** to be valid.

(ii) Suggest an alternative test that could be used for the investigation in part **(a)** if the assumption in part **(b)(i)** was known to be invalid. *(2 marks)*

(c) For a Wilcoxon signed-rank test carried out on 10 matched pairs, find:

(i) the minimum value possible for the test statistic T;

(ii) the maximum value possible for the test statistic T. *(3 marks)*

QUESTION PART REFERENCE

Answer space for question 2

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QUESTION PART REFERENCE	Answer space for question 2

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3   A car manufacturer investigated a new device to see whether it would reduce CO_2 emissions. For this investigation, 12 new mid-sized cars, each with an engine capacity of 1.4 litres, were obtained and 6 of these cars were fitted with the new device. The other 6 cars were not fitted with the new device.

The CO_2 emission, in grams per kilometre, from each car was measured. The results are given in the table.

Fitted with new device	139.1	134.6	128.9	139.8	129.5	140.9
Not fitted with new device	145.4	144.0	138.7	139.7	139.6	140.5

(a) (i) Carry out a distribution-free test, at the 5% level of significance, to investigate whether there is a reduction in the average CO_2 emission for cars fitted with the new device. *(10 marks)*

(ii) State the assumption that must be made regarding the 12 new cars in order for this test to be valid. *(1 mark)*

(b) Explain, in the context of this question, the meaning of a Type II error. *(2 marks)*

QUESTION PART REFERENCE

Answer space for question 3

QUESTION PART REFERENCE	Answer space for question 3

Turn over ▶

4   A group of adult patients, all of whom suffered from a particular disease, received a daily drug treatment that was known to commonly result in the occurrence of mouth infections after four weeks of treatment with the drug.

A trial was carried out to determine whether a new type of mouthwash would be more effective than the currently-used mouthwash at reducing the severity of such mouth infections.

Twenty-five patients were randomly allocated to receive either the new mouthwash or the currently-used mouthwash from the start of the drug treatment.

The patients were assessed after four weeks of receiving the daily drug treatment and mouthwash. They were then categorised as having a mouth infection that was either 'none or minor' or 'moderate or serious'. The information obtained during this trial is given in **Table 1**.

Table 1

Patient number	Type of mouthwash 1 = new 2 = currently-used	Category of mouth infection A = none or minor B = moderate or serious
1	1	A
2	1	A
3	1	B
4	2	B
5	2	B
6	1	A
7	2	A
8	1	B
9	1	A
10	2	B
11	2	B
12	2	B
13	1	A
14	2	B
15	2	A
16	1	A
17	1	A
18	2	B
19	2	B
20	2	A
21	1	A
22	2	B
23	1	B
24	2	A
25	1	A

(a)   Use the information given in **Table 1** to complete the contingency table, **Table 2**,
below.   *(3 marks)*

(b)   Using the 5% significance level, examine whether the type of mouthwash used is
associated with the category of mouth infection for such patients.   *(8 marks)*

QUESTION
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Table 2

		Category of mouth infection		
		None or minor	**Moderate or serious**	**Total**
Type of mouthwash	**New**			12
	Currently-used			
	Total	13		

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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   Three different psychological approaches, I, II and III, can be used by psychologists for the treatment of post-traumatic stress.

Sixteen adults, all of whom had suffered a similar traumatic event, were allocated at random to one of the three psychological approaches.

Each adult was assessed, following six months of treatment with a psychologist, and was given a post-traumatic stress score. A higher score indicates a greater level of post-traumatic stress.

The scores are given in the table.

Psychological approach		
I	**II**	**III**
7	11	16
8	18	20
10	21	23
12	26	27
17	34	30
19		

(a)   Carry out a distribution-free test, using the 5% significance level, to investigate whether there is any difference between the average post-traumatic stress scores for the three psychological approaches following six months of treatment with a psychologist.
(10 marks)

(b)   Pamela, a psychologist, wishes to reduce by as much as possible the post-traumatic stress scores of adults following their six months of treatment by her. Recommend, giving a reason for your choice, which of the three psychological approaches you would advise Pamela to use.
(2 marks)

QUESTION
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REFERENCE   **Answer space for question 5**

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6   Students were each classified, from their score on a personality test, as having either an introvert personality or an extrovert personality. The students were also each asked to state their colour preference – red, yellow, green or blue – with the purpose of investigating whether there is an association between personality type and colour preference. Data were collected from 400 students and are summarised in **Table 3**.

Table 3

		Colour preference				
		Red	**Yellow**	**Green**	**Blue**	**Total**
Personality type	**Introvert**	36	8	24	26	94
	Extrovert	164	32	56	54	306
	Total	200	40	80	80	400

(a) (i)   Carry out a χ^2-test, at the 5% level of significance, to investigate whether colour preference is independent of personality type.   *(9 marks)*

     (ii)   Describe the differences, if any, in colour preference for the two personality types as indicated by your solution in part **(a)(i)**. Give a reason for your answer.   *(2 marks)*

(b)   Nine randomly selected students with extrovert personalities were also asked to complete a subjective happiness assessment. For each selected student, the **rank order** of the score from this assessment and the **rank order** of the score from their personality test are given in **Table 4**.

     A higher rank for a happiness score indicates a higher level of happiness and a higher rank for a personality score indicates a more extrovert personality.

Table 4

	Student								
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Personality score rank	9	8	$3\frac{1}{2}$	6	7	5	2	1	$3\frac{1}{2}$
Happiness score rank	9	8	5	6	7	4	3	2	1

     (i)   Calculate the value of Spearman's rank correlation coefficient between personality score and happiness score.   *(3 marks)*

     (ii)   Carry out a hypothesis test, at the 1% level of significance, to determine whether the value that you calculated in part **(b)(i)** indicates an association between personality score and happiness score.   *(5 marks)*

QUESTION PART REFERENCE	Answer space for question 6

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QUESTION PART REFERENCE	Answer space for question 6

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END OF QUESTIONS