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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4	
5	
6	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
January 2013

Statistics SS03

Unit Statistics 3

Friday 25 January 2013 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 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 The area manager of a bank obtained information on 180 randomly selected loans made by the bank during the previous two years.

The loan outcomes were categorised as 'Satisfactory' or as a 'Bad debt'.

The loan recipient types were categorised as 'Individual', 'Small business' or 'Large business'.

Recipient / Outcome	Individual	Small business	Large business
Satisfactory	40	55	48
Bad debt	10	21	6

Using a χ^2-distribution and the 1% level of significance, test whether the outcome of a loan is independent of the type of recipient.

Interpret your conclusion in the context of the question. *(8 marks)*

QUESTION PART REFERENCE

Answer space for question 1

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QUESTION PART REFERENCE

Answer space for question 1

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2 A country requires all students in Year 7 to take a Cognitive Assessment Test (CAT). An educational psychologist is interested in the difference in performance in this test between students who have autumn birthdays and those who have summer birthdays.

Nine pairs of siblings, where one sibling has an autumn birthday and the other a summer birthday, are selected. The score achieved by each of these eighteen students in their Year 7 CAT test is given in the table.

Assume that the pairs of siblings form a random sample.

	Sibling pair								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Autumn	82	76	62	58	74	65	60	53	81
Summer	81	61	49	49	68	51	65	60	72

(a) Explain the purpose of using sibling pairs in this comparison of CAT scores. *(2 marks)*

(b) Carry out a sign test, at the 10% significance level, to investigate whether, on average, students with autumn birthdays gain higher CAT scores than those with summer birthdays. *(6 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 chef decides to investigate whether the taste of food is influenced by the sounds heard whilst eating it. She selects 8 regular customers at her restaurant and asks them if they would each be willing to eat a free seafood dish on two separate occasions and score each dish on a scale of 0 to 20 for taste.

The seafood dishes are identical, but the background sounds played through the restaurant's speakers differ on the two occasions. Seaside sounds are played on one of the occasions when the seafood dish is eaten, but the usual background music is played on the other occasion when the seafood dish is eaten.

The scores are given in the table.

	Customer							
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Score with seaside sounds playing	17	15	14	9	16	19	11	10
Score with usual background music playing	13	9	12	12	17	16	6	3

Carry out a Wilcoxon signed-rank test, using the 5% significance level, to investigate whether, on average, the taste score for the seafood dish is higher when the seaside sounds are played than when the usual background music is played. *(8 marks)*

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 In order to boil water, a hospital uses urns made by three different manufacturers: P, Q and R.

The hospital catering manager, Giacomo, measures the times taken for water to boil on five separate occasions in a 10-litre urn made by manufacturer P. He similarly measures the times taken for water to boil on five separate occasions in a 10-litre urn made by manufacturer Q and on five separate occasions in a 10-litre urn made by manufacturer R.

The times, in minutes, taken for water to boil on each occasion are given in the table.

Manufacturer	**P**	23.6	21.1	20.9	20.2	18.9
	Q	19.4	18.5	18.2	17.9	17.8
	R	21.2	20.3	20.0	19.8	19.6

(a) Carry out a Kruskal–Wallis test, using the 5% significance level, to investigate whether there is a difference between the average times taken for water to boil in 10-litre urns made by the three manufacturers. *(10 marks)*

(b) Giacomo wishes to select one of the three manufacturers to supply urns to the hospital in the future. He wishes to select the manufacturer whose urns are the fastest to boil water.

(i) Advise Giacomo which manufacturer of 10-litre urns he should choose. Give a reason for your answer. *(2 marks)*

(ii) Suggest **one** other factor that Giacomo should consider before deciding which manufacturer to choose. *(1 mark)*

QUESTION PART REFERENCE

Answer space for question 4

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QUESTION PART REFERENCE

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5 High levels of impurity in an alloy are a concern to the company that produces the alloy. Two alternative processes, A and B, are used by the company for the production of the alloy.

The production manager of the company, Jess, decided to compare the levels of impurity in ten randomly selected pieces of alloy made by process A and ten randomly selected pieces of alloy made by process B. She wished to choose one of these two processes for the production of the alloy in the future.

The results, in suitable units, of her investigation are given in **Table 1**. A higher reading indicates a higher level of impurity.

Table 1

Process A	3.65	3.50	3.45	3.15	3.00	2.95	2.90	2.85	2.80	2.65
Process B	3.35	3.25	3.05	2.75	2.65	2.60	2.55	2.20	2.15	2.05

(a) Carry out an appropriate distribution-free test, using the 5% level of significance, to determine whether there is a difference, on average, between the level of impurity in the alloy made by process A and that in the alloy made by process B. *(10 marks)*

QUESTION PART REFERENCE

Answer space for question 5(a)

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QUESTION PART REFERENCE

Answer space for question 5(a)

Question 5 continues on the next page

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5 (b) Jess also wished to investigate the reliability of each process and obtained information from company records for a random sample of 100 occasions when the alloy was produced during the previous ten years.

She noted that on 10 out of the 46 occasions when process A was used to produce the alloy there was a fault in the process and the alloy could not be made. When process B was used, there was a similar fault on 6 out of the 54 occasions.

(i) Illustrate this information by placing frequencies in **Table 2** below. *(2 marks)*

(ii) Test, using the 10% level of significance, whether the occurrence of a fault is associated with the process used. *(9 marks)*

(c) By considering your conclusions in part **(a)** and in part **(b)(ii)**, advise Jess, with reasons, as to which process the company should use in future to make the alloy. *(2 marks)*

QUESTION PART REFERENCE

(b)(i)

Answer space for questions 5(b) and 5(c)

Table 2

	Process A	Process B	Total
Fault			
No fault			
Total			

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QUESTION PART REFERENCE

Answer space for questions 5(b) and 5(c)

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6 (a) Data were collected between 1995 and 2006 on the educational experience of children and their parents living in the UK.

Table 3 shows the number of years spent in full-time education beyond the age of 16 years for the mother, son and daughter of 10 families.

Table 3

		Mother	Son	Daughter
Family	**A**	8	7	7
	B	7	4	8
	C	6	8	6
	D	5	4	6
	E	4	6	6
	F	3	2	5
	G	3	3	4
	H	2	0	3
	I	1	1	2
	J	0	5	0

You may regard the 10 families as a random sample.

On the page opposite, **Table 4** shows some of the rank values for the data in **Table 3**.

Complete **Table 4**. *(4 marks)*

(b) Calculate the value of Spearman's rank correlation coefficient between the number of years spent in full-time education beyond the age of 16 years for:

(i) mother and son;

(ii) mother and daughter. *(4 marks)*

(c) Carry out hypothesis tests, at the 1% level of significance, to determine whether the values that you calculated in part **(b)(i)** and part **(b)(ii)** indicate a positive association between the number of years spent in full-time education beyond the age of 16 years for:

(i) mother and son;

(ii) mother and daughter. *(7 marks)*

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QUESTION PART REFERENCE

Answer space for question 6

(a)

Table 4

		Ranks		
		Mother	**Son**	**Daughter**
Family	**A**	1	2	2
	B	2	$5\frac{1}{2}$	1
	C	3	1	
	D		$5\frac{1}{2}$	
	E		3	
	F		8	
	G		7	
	H		10	
	I	9	9	9
	J	10	4	10

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QUESTION PART REFERENCE

Answer space for question 6

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QUESTION PART REFERENCE

Answer space for question 6

END OF QUESTIONS

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