Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2015

Statistics SS03

Unit Statistics 3

Tuesday 9 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.

Answer **all** questions.

Answer each question in the space provided for that question.

1 A paediatric doctor measures the height, x cm, and the systolic blood pressure, y mmHg, of 12 randomly selected healthy boys aged between 5 years and 10 years.

The results are given in the following table.

Child	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
x	96	146	151	126	112	132	107	115	121	111	142	136
y	98	108	112	105	106	109	101	108	103	106	109	106

(a) Find the value of the product moment correlation coefficient between height and systolic blood pressure.

[3 marks]

(b) The paediatric doctor believes that there is a positive correlation between height and systolic blood pressure in healthy boys aged between 5 years and 10 years.

Carry out a hypothesis test, at the 1% significance level, to investigate this belief.

[4 marks]

(c) Give **one** reason why your conclusion in part **(b)** might **not** apply to all children aged between 5 years and 10 years.

[1 mark]

QUESTION PART REFERENCE

Answer space for question 1

QUESTION PART REFERENCE

Answer space for question 1

QUESTION PART REFERENCE

Answer space for question 1

QUESTION PART REFERENCE

Answer space for question 1

2 A survey was carried out into the employment status of students at a sixth form college.

The survey involved 65 students of whom 40 were in Year 13 and the remainder were in Year 12.

The students were asked to answer "Yes" or "No" to the following question:

"Do you have part-time employment?"

It was recorded that a total of 35 students answered "Yes" to the question asked and that 30 **per cent** of the students in Year 13 answered "No" to the question asked.

(a) Use this information to complete the contingency table below.

[3 marks]

(b) Carry out a χ^2-test, at the 1% significance level, to investigate whether the answer to the question asked is independent of the year of study of a student.

[7 marks]

QUESTION PART REFERENCE

(a)

Answer space for question 2

		Answer to question		
		Yes	**No**	**Total**
Year of study	**Year 13**			40
	Year 12			
	Total			65

QUESTION PART REFERENCE

Answer space for question 2

QUESTION PART REFERENCE

Answer space for question 2

QUESTION PART REFERENCE

Answer space for question 2

3 (a) In carrying out a Mann–Whitney U test, random samples, each of size 6, are taken from two independent populations. The complete set of 12 observations, no two of which are equal, is ranked in ascending order.

The sum of the ranks for one of the samples is denoted by T.

Find the minimum possible value for T.

[2 marks]

(b) Two manufacturers of heat probes used in coal power stations are being compared by a company that supplies such probes to power stations.

Seven probes are obtained from manufacturer A and eight from manufacturer B.

The accuracy of each of the fifteen probes is measured and the probes are put into rank order for accuracy of measurement. Rank 1 indicates the least accurate probe.

The total, T_{A}, of the ranks for manufacturer A is 46 and the total, T_{B}, for manufacturer B is 74.

Carry out a Mann–Whitney U test, at the 5% level of significance, to determine whether there is evidence of a difference between the accuracy of the probes from the two manufacturers.

[6 marks]

QUESTION PART REFERENCE

Answer space for question 3

QUESTION PART REFERENCE

Answer space for question 3

4 Banks are assessed annually in terms of customer satisfaction ratings. For the year 2014, the 'customer complaints upheld', the 'customer satisfaction rating' and the 'assets' are given in the table for a random sample of nine large banks.

The 'customer satisfaction rating' is measured on a scale from 0 to 20, where 20 is the highest level of customer satisfaction.

Bank	Customer complaints upheld (per cent)	Customer satisfaction rating	Assets ($ billion)
A	81	9	2562
B	77	11	2223
C	86	7	1510
D	62	18	588
E	35	19	485
F	25	16	460
G	65	13	260
H	29	14	81
I	27	18	72

(a) Find the value of Spearman's rank correlation coefficient between:

(i) customer complaints upheld and assets;

(ii) customer satisfaction rating and assets.

[9 marks]

(b) Carry out a hypothesis test, using the 5% level of significance, to determine whether:

(i) your value calculated in part **(a)(i)** indicates an association between customer complaints upheld and assets;

(ii) your value calculated in part **(a)(ii)** indicates an association between customer satisfaction rating and assets.

Interpret **each** conclusion in the context of the question.

[5 marks]

(c) A consumer organisation claims that the average customer satisfaction rating for large banks is less than 15.

The customer satisfaction ratings are based upon information from same-sized random samples of customers from each bank.

Carry out a sign test, using the 10% level of significance, to investigate this claim.

[5 marks]

QUESTION PART REFERENCE

Answer space for question 4

QUESTION PART REFERENCE

Answer space for question 4

QUESTION PART REFERENCE

Answer space for question 4

5 Jemma, a psychologist, carried out research into a claim that, due to unrealistic ideas of having super-abilities, boys played more exuberantly when wearing particular superhero costumes.

The 22 boys involved in this research were all aged 8 years.

The boys involved in the research were given comic books featuring stories about four superhero characters: 'Terrific Teen', 'Beetleman', 'Hunk' and 'Warrior Crab'.

After the boys had read the comic books, each of them was given a costume of one of the four superheros to wear. Jemma then observed the boys playing.

The table below gives the score given by Jemma to each boy for the level of exuberance demonstrated when wearing a superhero costume.

The score given was on a scale of 0 to 100, where 100 was the score for the highest level of exuberance demonstrated.

(a) Complete the table by inserting the missing rank values.

[3 marks]

(b) Carry out a distribution-free test, using the 1% level of significance, to determine whether, for the four superhero characters, there is evidence of a difference, on average, between the levels of exuberance demonstrated by the boys when wearing one of the costumes.

Interpret your conclusion in the context of this question and indicate which of these costumes, if any, make boys play more exuberantly.

[10 marks]

QUESTION PART REFERENCE

(a)

Answer space for question 5

Costume worn							
Terrific Teen		**Beetleman**		**Hunk**		**Warrior Crab**	
Score	**Rank**	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**
58	4	86	1	54	6	42	
52	$7\frac{1}{2}$	71	2	43		32	
47		65	3	39		30	
45		57	5	35		26	
41		52	$7\frac{1}{2}$	25		18	
31				11			

QUESTION PART REFERENCE

Answer space for question 5

QUESTION PART REFERENCE

Answer space for question 5

QUESTION PART REFERENCE

Answer space for question 5

6 A pharmaceutical company developed a new drug that it claimed would alleviate sleep disorders experienced by shift workers.

(a) A trial of this drug was set up and 15 healthy adult volunteers, all of whom had no major sleep disorders, were each given the new drug to take half an hour before their allocated bedtimes.

The allocated bedtime for each volunteer was set to be five hours earlier than the regular bedtime for that volunteer.

The time taken to achieve persistent sleep by each of the 15 volunteers was measured.

The results, in minutes, are given below.

4.2 7.4 5.0 2.8 7.3 3.5 3.9 7.2 3.6 2.2 3.7 6.5 4.8 5.9 4.1

The **median time** taken to achieve persistent sleep by healthy adults who have no major sleep disorders and who **do not take the drug**, when their regular bedtimes are moved earlier by five hours, is known to be 6.5 minutes.

Carry out a Wilcoxon signed-rank test, at the 1% significance level, to investigate whether there is a difference between the median time taken to achieve persistent sleep by healthy adults taking the drug and that for those not taking the drug, when their regular bedtimes are moved earlier by five hours.

You may regard the sample of 15 volunteers as a random sample.

[8 marks]

QUESTION PART REFERENCE

Answer space for question 6(a)

QUESTION PART REFERENCE

Answer space for question 6(a)

Question 6 continues on the next page

6 (b) A further 10 healthy adult volunteers agreed to take part in a new trial.

On a particular Wednesday, each volunteer was randomly assigned to take, half an hour before bedtime, either 20 mg of the new drug or 50 mg of the new drug.

On the following Wednesday, those volunteers who originally took 20 mg of the new drug then took 50 mg and those volunteers who originally took 50 mg of the new drug then took 20 mg.

The time taken, in minutes, to achieve persistent sleep by each of the 10 volunteers on each Wednesday was measured.

These results are given in the table.

Adult	A	B	C	D	E	F	G	H	I	J
20 mg drug	3.2	4.3	3.8	4.2	4.1	2.9	3.2	4.8	4.4	3.5
50 mg drug	3.4	2.2	2.9	4.8	2.4	3.9	3.5	2.9	2.2	3.1

(i) Explain why the volunteers were **randomly assigned** to either the 20 mg or the 50 mg dose of the new drug.

(ii) Carry out a Wilcoxon signed-rank test, at the 5% level of significance, to investigate whether the average number of minutes taken by healthy adults to achieve persistent sleep is **lower** when taking 50 mg of the new drug half an hour before bedtime than when taking 20 mg of the new drug half an hour before bedtime.

[9 marks]

QUESTION PART REFERENCE

Answer space for question 6(b)

QUESTION PART REFERENCE

Answer space for question 6(b)

QUESTION PART REFERENCE

Answer space for question 6(b)

END OF QUESTIONS