

General Certificate of Education
January 2009
Advanced Subsidiary Examination



STATISTICS
Unit Statistics 3

SS03

Monday 19 January 2009 1.30 pm to 3.00 pm

For this paper you must have:

- an 8-page answer book
 - 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.
- Write the information required on the front of your answer book. The *Examining Body* for this paper is AQA. The *Paper Reference* is SS03.
- Answer **all** questions.
- Show all necessary working; otherwise marks for method may be lost.
- The **final** answer to questions requiring the use of tables or calculators should normally be given to three significant figures.

Information

- The maximum mark for this paper is 75.
- The marks for questions are shown in brackets.

Advice

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

Answer **all** questions.

- 1 A statistics teacher claims that her heart rate increases during visits by school inspectors. During a normal working day, when inspectors are not present, her median heart rate is 76 beats per minute.

During one visit by school inspectors, she wore a device that measured her heart rate on ten randomly selected occasions during the day. The results were as follows.

65 83 112 95 89 82 89 93 74 66

Investigate the statistics teacher's claim using the sign test and the 10% level of significance. *(6 marks)*

- 2 Environmentalists wished to examine the effects of two different preparations of a virus on a specific plant species. Ten leaves were obtained for use in the experiment. Each leaf was cut in half. One half of each leaf, selected at random, was treated with virus preparation A. The other half of each leaf was treated with virus preparation B.

The number of lesions appearing on each half leaf in response to the virus preparations was recorded. The results are given in the table.

Leaf	1	2	3	4	5	6	7	8	9	10
Virus preparation A	55	28	23	7	17	15	7	11	4	0
Virus preparation B	17	17	14	11	10	9	7	3	1	1

- (a) Carry out a Wilcoxon signed-rank test, at the 5% significance level, to investigate whether the average number of lesions differs between virus preparations A and B.

Interpret your conclusion in context.

(9 marks)

- (b) Give **one** reason why a Wilcoxon signed-rank test might be preferred to a sign test in carrying out an investigation such as the one in part (a).

(1 mark)

3 Researchers in the USA investigated the effects of alcohol consumption on brain size.

A sample of 10 non-drinkers and 8 heavy drinkers (more than 14 units of alcohol per week) was obtained and each person in the sample had a brain scan.

The ratios of brain volume to skull size obtained for the eighteen people in the sample are given in the table.

Non-drinkers	0.794	0.798	0.799	0.802	0.803	0.804	0.805	0.806	0.809	0.810
Heavy drinkers	0.785	0.787	0.789	0.791	0.792	0.796	0.797	0.801		

Assuming that the sample is random, carry out a Mann–Whitney U test, at the 5% level of significance, to investigate the claim that heavy drinkers have a smaller average ratio of brain volume to skull size than non-drinkers.

Interpret your conclusion in context.

(11 marks)

Turn over for the next question

Turn over ►

- 4 A sample of 152 adults with chronic osteoarthritis of the hip agreed to participate in a trial of some treatments for their condition. The adults were randomly assigned to treatment for six months at hydrotherapy classes, Tai Chi classes or conventional exercise classes.

After six months of treatment, each adult was then assessed for pain level and physical function and the outcome was recorded as ‘Much improved’, ‘Improved’, ‘Slightly improved’ or ‘No change’.

The results of the trial are summarised in the table.

Treatment Outcome	Hydrotherapy class	Tai Chi class	Conventional exercise class	Total
Much improved	19	23	7	49
Improved	22	17	10	49
Slightly improved	8	9	12	29
No change	6	5	14	25
Total	55	54	43	152

- (a) (i) Test, at the 1% level of significance, whether outcome is independent of treatment. *(10 marks)*
- (ii) Interpret your conclusion for part (a)(i) in the context of the question. *(2 marks)*
- (b) It was later discovered that a further 32 adults had been involved in this trial but had not attended for the full six months of treatment. Of these 32 adults, 9 had been assigned to hydrotherapy classes, 10 to Tai Chi classes and 13 to conventional exercise classes.
- (i) Construct a 2×3 contingency table to show, for each treatment, the number of adults, in each treatment category, who attended for the full six months and the number who did not attend for the full six months. *(3 marks)*
- (ii) The contingency table in part (b)(i) gives a value of 1.95 for $\sum \frac{(O - E)^2}{E}$.

No pooling was necessary.

Test, at the 5% level of significance, whether attendance for the full six months is independent of treatment. *(4 marks)*

- 5 A study was carried out into the life of mammals. The maximum recorded life span, w years, the mean gestation time, x days, and the mean daily sleep time, y hours, were obtained for a random sample of 11 species of mammal.

The results are given in the table.

Species	w	x	y
A	38	645	3.3
B	14	60	12.5
C	69	624	3.9
D	27	180	9.8
E	19	35	19.7
F	50	230	14.5
G	30	281	9.7
H	40	365	3.9
I	28	400	3.1
J	4	16	14.4
K	39	252	12.0

- (a) Find the value of the product moment correlation coefficient between:

(i) w and x ;

(ii) w and y .

(5 marks)

- (b) The product moment correlation coefficient between x and y is -0.853 , correct to three significant figures.

Carry out hypothesis tests, at the 5% level of significance, to determine whether the values of the three product moment correlation coefficients indicate an association between each of the three pairs of variables.

(7 marks)

- (c) Interpret your findings from parts (a) and (b) in the context of the question. (3 marks)

Turn over ►

- 6 A university psychology department carries out research into the effects of sleep deprivation on the time taken to solve a simple anagram puzzle. Student volunteers were randomly allocated to go without sleep for 20, 30 or 40 hours before they attempted to solve the puzzle.

The times, in minutes, taken by the 18 volunteers are given in the table.

Time without sleep		
20 hours	30 hours	40 hours
4.8	5.4	6.4
5.2	6.1	7.8
6.7	8.1	10.4
7.9	9.8	11.3
8.2	11.4	12.6
12.2	15.8	16.2

- (a) Carry out a Kruskal–Wallis test, using the 5% significance level, to investigate whether there is any difference between the average times taken to solve the puzzle for the different numbers of hours without sleep.

Interpret your conclusion in context.

(12 marks)

- (b) Explain, in the context of the question, the meaning of a Type II error.

(2 marks)

END OF QUESTIONS

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