General Certificate of Education
January 2006
Advanced Subsidiary Examination

STATISTICS **SS03**
Unit Statistics 3

Wednesday 18 January 2006 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 blue or black ink or 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.
- All necessary working should be shown; 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, formulae may be quoted, without proof, from the booklet.

Answer **all** questions.

1 It has been suggested that babies take longer to learn to crawl in colder months than in warmer months.

A study in the USA recorded the average daily temperature, x °C, during the sixth month of a baby's life and the age, y weeks, at which the baby first learned to crawl.

The data for a random sample of 11 babies are given in the table.

Baby	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
x	19	23	22	17	11	4	1	0	1	3	14
y	29.9	30.6	29.7	31.9	28.6	31.4	33.6	32.9	33.9	33.3	32.3

(a) Calculate the value of the product moment correlation coefficient between x and y. *(3 marks)*

(b) Carry out a hypothesis test, at the 1% level of significance, to determine whether the value that you calculated in part (a) indicates a negative association between x and y.

Interpret your conclusion in context. *(5 marks)*

(c) Explain, in context, the meaning of a Type I error. *(2 marks)*

2 Treadwear measurements of tyres can be carried out by two methods, A and B. Method A is based on weight loss and Method B is based on groove wear. Twelve tyres were subject to measurement by each of the two methods. The treadwear, in thousands of miles, for each tyre, when measured by each method, is given in the table.

Tyre	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Method A	45.9	41.5	37.5	33.4	31.0	32.7	30.9	31.3	27.3	24.5	21.9	13.5
Method B	35.7	39.2	38.1	29.1	31.8	30.5	25.9	33.6	28.5	16.1	19.8	11.5

(a) Carry out a Wilcoxon signed-rank test, at the 5% significance level, to investigate whether there is any difference in the average treadwear measurement for the two methods.

Interpret your conclusion in context. *(10 marks)*

(b) It was suggested that it would save time if the treadwear measurements were made not on the same tyre each time, but on each of the two front tyres of a car, one tyre randomly allocated to Method A and the other allocated to Method B.

For the investigation in part (a), explain the advantage of using the original experimental design, rather than this new suggested experimental design. *(2 marks)*

(c) In a Wilcoxon signed-rank test applied to 12 paired differences, T, the sum of the ranks with positive differences, is calculated.

Find the maximum possible value of T. *(2 marks)*

Turn over for the next question

3 A consumer organisation analysed the sodium content and calorie content of a random selection of hot dog sausages from major brands. In these analyses, three types of hot dog sausage, beef, poultry and meat (mostly pork and beef, but up to 25% poultry), were examined.

(a) The following table was constructed to summarise the type and the sodium content, in milligrams, for each of 19 randomly selected hot dog sausages.

Sodium content \ **Type**	**Beef**	**Poultry**	**Meat**
Low (below 250 mg)	0	0	1
Medium (between 200 mg and 500 mg)	5	4	3
High (over 500 mg)	1	3	2

The consumer organisation suggested carrying out a χ^2 test on the given data to investigate whether there is an association between the amount of poultry content and the sodium level in a hot dog sausage.

Give **two** reasons why such a test would not be valid. *(4 marks)*

(b) The calorie content was measured for each of a random sample of 8 beef hot dog sausages and for each of a random sample of 8 poultry hot dog sausages. The results are given in the following table.

Beef	186	181	176	135	184	190	111	132
Poultry	129	137	102	106	94	142	113	149

Several manufacturers claim that poultry hot dog sausages have a lower calorie content than beef hot dog sausages.

Carry out a Mann–Whitney U test, at the 5% level of significance, to investigate this claim.

Interpret your conclusion in context. *(11 marks)*

4 An investigation was carried out into the differences in the prices paid for Chinook salmon at three fish markets in the USA.

Standard boxes of Chinook salmon were delivered to the three fish markets, A, B and C, during April. The prices obtained for each box, in cents per pound, at each market are given in the table.

Fish Market		
A	**B**	**C**
220.3	190.1	228.7
226.3	209.7	231.3
227.3	223.4	249.6
228.1	224.2	250.7
242.4	226.4	289.7

The test statistic H is given by

$$H = \frac{12}{N(N+1)} \sum_i \frac{T_i^2}{n_i} - 3(N+1)$$

(a) Carry out a Kruskal–Wallis test, using a 5% significance level, to investigate whether there is any difference between the average prices obtained for a box of Chinook salmon at the three fish markets.

Interpret your conclusion in context. *(14 marks)*

(b) Identify, with a reason, to which of the three fish markets you would send a box of Chinook salmon in order to obtain the best price. *(2 marks)*

Turn over for the next question

5 (a) In a crime survey, the incidence of violence in three types of offence is recorded for a random sample of convictions. The following table summarises the data obtained.

Violence level / Type of offence	No violence	Violence not involving weapons	Violence involving weapons
Non-drug-related theft or damage	58	10	7
Drug-related theft or damage	43	18	3
Other	24	4	2

Investigate, at the 5% level of significance, whether or not the violence level is independent of the type of offence involved.

Interpret your conclusion in the context of the question. *(10 marks)*

(b) Information regarding the sentences given to a random selection of convicted criminals was also gathered in the survey. The following table summarises the type of sentence given and whether firearms were used.

Firearms / Type of sentence	Not used	Used
Non-custodial	32	2
Custodial	46	22

(i) Test, at the 1% level of significance, whether the type of sentence given is independent of whether firearms were used. *(8 marks)*

(ii) Describe any differences found in the type of sentence for offences in which firearms were used as compared with those in which firearms were not used. *(2 marks)*

END OF QUESTIONS

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