

**STATISTICS**  
**Unit Statistics 3**

**SS03**

Friday 5 June 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.

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Answer **all** questions.

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- 1 A clinical nutrition department at a large hospital carried out research into the levels of body fat in females.

The age,  $x$  years, and the body fat,  $y$  per cent, for each of 10 randomly selected females are given in the table.

<b>Female</b>	<b><math>x</math></b>	<b><math>y</math></b>
A	23	27.9
B	39	31.4
C	41	25.9
D	49	25.2
E	53	34.7
F	56	32.5
G	57	30.3
H	58	33.0
I	60	41.1
J	61	34.5

- (a) Calculate the value of Spearman's rank correlation coefficient between  $x$  and  $y$ .  
(6 marks)
- (b) Carry out a hypothesis test, at the 10% level of significance, to determine whether the value that you calculated in part (a) indicates an association between  $x$  and  $y$ .

Interpret your conclusion in context.

(4 marks)

- 2 A time of 9 minutes is allocated for the completion of a task on a production line.

The staff working on this production line complained to their line manager that the task took longer than the 9 minutes allocated. The line manager agreed to investigate by taking a sample of 8 measurements of the time taken, in minutes, to complete the task.

The times were as follows:

9.5 8.6 9.2 9.6 8.9 9.7 8.4 9.8

- (a) Carry out a Wilcoxon signed-rank test, at the 5% significance level, to investigate whether the average time taken to complete the task is greater than 9 minutes.

Interpret your conclusion in context.

*(9 marks)*

- (b) State **one** assumption that should be made for the test in part (a) to be valid. *(1 mark)*

- 3 A coin expert carries out an analysis to determine the percentage of silver in coins taken from two separate coin mintings during the reign of King Manuel I. The percentages for the coins in a sample from each minting are given in the table.

<b>First Minting</b>	5.8	6.6	6.3	6.9	7.5	7.0	6.7	6.1
<b>Second Minting</b>	6.7	8.8	6.5	8.2	9.4	9.1	8.4	

Carry out a distribution-free test to investigate the claim that coins from the second minting contain a higher percentage of silver than those from the first minting. Use the 5% level of significance and assume each sample to be random. *(10 marks)*

**Turn over for the next question**

**Turn over ►**

- 4 An eye clinic treats a large number of adult patients who have one normal eye but suffer from glaucoma in the other eye. The thickness, in microns, of the cornea of each eye was measured for each of a random sample of 8 such patients. The results are given in the table.

Patient	1	2	3	4	5	6	7	8
Normal eye	488	478	492	444	436	398	464	476
Eye with glaucoma	484	478	480	426	440	410	458	460

- (a) Carry out a sign test, at the 10% level of significance, to investigate whether there is any difference in the average cornea thickness between the normal eye and the eye with glaucoma. *(6 marks)*
- (b) Later it was discovered that the measurements from 5 other randomly selected adult patients had been lost. However, it is known that all 5 patients had a lower cornea thickness in the eye with glaucoma than in the normal eye.

Use this additional information, together with the information given in the table, to carry out a sign test, at the 5% level of significance, to investigate whether there is evidence that the average cornea thickness of the normal eye is greater than that of the eye with glaucoma. *(5 marks)*

- 5 A factory has four identical machines, A, B, C and D, that produce bottle caps. The production manager believes that there are some differences between the average daily outputs of the machines. In order to investigate his belief, he decides to select one of the machines at random on each of 21 days and to record the number of bottle caps that it produces during the day.

The **rank values** of the results are given in the table. A rank value of 1 indicates the lowest production.

Machine A	Machine B	Machine C	Machine D
$2\frac{1}{2}$	15	1	8
5	16	$2\frac{1}{2}$	9
10	18	4	11
14	20	6	12
17	21	7	13
19			

- (a) Carry out a Kruskal–Wallis test, using the 1% significance level, to investigate whether there is any difference between the average daily numbers of bottle caps produced by the four machines. *(12 marks)*
- (b) The maintenance engineer at the factory has money available to replace one of the four machines.

Identify, with a reason, which machine you would advise him to replace. *(2 marks)*

**Turn over for the next question**

**Turn over ►**

6 An institute for health and welfare carried out an investigation into ladder-related falls during 2004/05.

- (a) The place of occurrence of the fall and the sex of the person who fell were recorded and the results are summarised in **Table 1**.

**Table 1**

Place of occurrence of fall	Sex		
	Male	Female	Total
Home	1269	393	1662
School, other institution or sport area	35	5	40
Trade or service area	76	16	92
Industrial or construction area	156	6	162
Farm	31	6	37
<b>Total</b>	1567	426	1993

- (i) Test, at the 1% level of significance, whether the place of occurrence of a fall is independent of the sex of the person who falls. *(10 marks)*
- (ii) By comparing observed and expected frequencies, identify, in context, **two** important facts. *(2 marks)*
- (iii) Make one further general statement regarding the observed frequencies in **Table 1**. *(1 mark)*

- (b) The number of patients admitted to hospital during 2004/05 for the three admission categories involving ladder-related falls for males and for females was also recorded. The results are summarised in **Table 2**.

**Table 2**

Admission category	Sex	Male	Female
	<b>Direct ladder-related fall</b>		62.1%
<b>Transfer following ladder-related fall</b>		12.3%	10.5%
<b>Other incident also involving fall from ladder</b>		25.6%	38.6%
<b>Total admissions</b>		227	57

- (i) Use the information in **Table 2** to construct a contingency table with frequencies that could be analysed to investigate whether there is an association between admission category and the sex of the person who falls. *(3 marks)*
- (ii) For the contingency table in part (b)(i), the value of  $\sum \frac{(O - E)^2}{E}$  is 3.84, correct to three significant figures.

Test, at the 5% level of significance, whether admission category is independent of the sex of the person who falls. *(4 marks)*

**END OF QUESTIONS**

**There are no questions printed on this page**