

General Certificate of Education  
June 2005  
Advanced Subsidiary Examination



**MATHEMATICS AND STATISTICS  
(SPECIFICATION B)  
Unit Statistics 3**

**MBS3**

Tuesday 7 June 2005 Afternoon Session

**In addition to this paper you will require:**

- an 8-page answer book;
- the AQA booklet of formulae and statistical tables.

You may use a graphics calculator.

Time allowed: 1 hour 15 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 MBS3.
- 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 60.
- Mark allocations are shown in brackets.

**Advice**

- Unless stated otherwise, formulae may be quoted, without proof, from the booklet.

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Answer **all** questions.

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- 1 In a large apartment building, a random sample of residents was asked their opinions regarding the proposed maintenance charges for the following year. Each resident occupies either a one-bedroomed or a two-bedroomed apartment.

They were each asked to indicate whether they felt the level of the charges was about right, slightly too high or excessive.

The following table summarises their replies.

Reply Apartment	About right	Slightly too high	Excessive
<b>One-bedroomed</b>	18	46	23
<b>Two-bedroomed</b>	35	39	9

A resident is selected at random.

$B$  is the event ‘resident occupies a one-bedroomed apartment’.

$R$  is the event ‘resident replied “about right”’.

$H$  is the event ‘resident replied “excessive”’.

$B'$  is the event ‘not  $B$ ’.

(a) Find:

(i)  $P(B)$ ; (1 mark)

(ii)  $P(B \cap R)$ ; (1 mark)

(iii)  $P(H \cup B)$ ; (2 marks)

(iv)  $P(H | B')$ . (3 marks)

(b) Describe in words, as simply as possible, the event  $(H \cap B')$ . (2 marks)

- 2 A consumer research company carries out an investigation into the prices of a random sample of 11 'own brand' food items in standard sized packages from two large supermarkets, X and Y. The price, in pence, of each food item in each supermarket is given in the following table.

Food item	A	B	C	D	E	F	G	H	I	J	K
Price in supermarket X	46	242	198	63	51	22	198	35	80	59	121
Price in supermarket Y	45	226	218	63	44	20	219	40	76	55	113

- (a) Carry out a sign test, at the 10% significance level, to investigate whether or not the median price difference between 'own brand' food items in the two supermarkets differs from zero. *(6 marks)*
- (b) Explain, in context, the meaning of a Type I error. *(2 marks)*
- (c) Name a distribution-free test that could be used, as an alternative to the sign test, to carry out the investigation in part (a). *(1 mark)*

**TURN OVER FOR THE NEXT QUESTION**

3 The data in the table below were compiled for 17 randomly selected states in the USA.

It shows the crime rate,  $x$ , measured as the number of offences reported per million population, together with the unemployment rate,  $y$ , of males aged 16–24 years per thousand population.

$x$	$y$
197	114
167	102
164	116
156	108
123	100
96	97
95	91
86	96
85	92
80	94
79	81
71	83
68	84
66	77
58	77
54	79
51	77

- (a) Calculate the value of Spearman's rank correlation coefficient between  $x$  and  $y$ .  
(6 marks)
- (b) (i) Carry out a hypothesis test, at the 5% level of significance, to determine whether the value that you calculated in part (a) indicates a positive association between  $x$  and  $y$ .  
(4 marks)
- (ii) Interpret your conclusion from part (b)(i) in the context of the question.  
(1 mark)

- 4 A new long-life battery is being launched. It is claimed that this new battery has a median lifetime of more than 250 hours.

A trial is carried out on 12 of the new batteries, and the measured lifetimes, in hours, of these batteries are given below.

245    283    275    242    248    222    259    260    258    281    235    292

- (a) Carry out a Wilcoxon signed-rank test, at the 5% level of significance, to investigate the claim.

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

- (b) State **two** assumptions that are necessary in order for the test in part (a) to be valid. (2 marks)

- 5 A random sample of fifteen school leavers, all of whom went to university and subsequently obtained jobs, is contacted and asked to state their starting salaries.

Six of the students went to 'Top League' universities and the remaining students went to other universities.

Their starting salaries are given in the following table.

<b>'Top League'</b>	22 300	19 850	24 500	24 350	26 400	31 650			
<b>Other</b>	17 850	19 400	20 200	21 990	22 000	23 250	27 500	24 600	18 500

- (a) Carry out a Mann-Whitney  $U$  test, at the 5% level of significance, to investigate whether or not the starting salaries of those students who went to 'Top League' universities are higher than those of students who went to other universities. (14 marks)
- (b) Suggest **two** possible improvements to the experimental design used in this investigation. (2 marks)
- (c) For a test such as the one required in part (a), with two samples, one of size 6 and one of size 9, find the maximum value possible for the test statistic  $U$ .

Assume that no two observations are equal. (3 marks)

**END OF QUESTIONS**

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