

General Certificate of Education
June 2004
Advanced Level Examination



**MATHEMATICS AND STATISTICS
(SPECIFICATION B)
Unit Statistics 6**

MBS6

Wednesday 9 June 2004 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 MBS6.
- 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.

Answer **all** questions.

- 1 A doctor measures the height, x cm, and the pulmonary anatomical dead space, y ml, for 15 randomly selected children. The results are given in the following table.

Child	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
x	110	174	150	129	155	164	116	159	153	131	168	142	156	138	124
y	44	101	56	45	92	88	31	64	58	56	112	57	78	79	43

- (a) Find the value of the product moment correlation coefficient between x and y .
(4 marks)
- (b) The doctor believes that there is a positive correlation between height and pulmonary anatomical dead space in children. Stating the null and alternative hypotheses used, carry out a hypothesis test, at the 1% significance level, to investigate this belief. (4 marks)
- 2 The following table shows the amount of carbon monoxide, in parts per million, in exhaust emissions from a random sample of 6 cars with a catalytic system and from a random sample of 7 cars without a catalytic system.

With catalytic system	1.6	1.8	2.8	2.4	2.2	2.7	
Without catalytic system	2.7	3.5	3.9	4.6	4.8	2.3	4.2

- (a) Use the Mann-Whitney U test to investigate whether there is any significant evidence, at the 5% level, that emissions from car exhausts fitted with a catalytic system contain less carbon monoxide than those from car exhausts without a catalytic system. State the null and alternative hypotheses. (12 marks)
- (b) Assuming that no two observations are equal, find the minimum and the maximum values possible for the test statistic U when a Mann-Whitney U test, as in part (a), is carried out on random samples, one of size 6 and one of size 7, taken from independent populations. (4 marks)

3 A company analyses the servicing of machinery at one of its large factories.

When a machine is serviced:

B is the event 'the bearings need replacement';

C is the event 'the compressor pump needs replacement';

S is the event 'the solenoid needs replacement'.

The events B, C and S are independent.

B' is the event 'not B'.

C' is the event 'not C'.

A machine is selected at random for servicing.

You are given that $P(B) = 0.1$ and $P(B \cup C) = 0.28$.

- (a) (i) Show that $P(C) = 0.2$. *(4 marks)*
- (ii) Find the value of $P(C' \cup B')$. *(2 marks)*
- (b) The probability that the solenoid will need replacement is 0.3.

Find the probability that:

- (i) the bearings will need replacement, but neither the compressor pump nor the solenoid will need replacement; *(2 marks)*
- (ii) exactly **one** of the three components will need replacement; *(3 marks)*
- (iii) the solenoid will need replacement, given that exactly one of the three components needs replacement. *(3 marks)*

TURN OVER FOR THE NEXT QUESTION

4 Trials are being carried out on a new tablet designed to aid sleeping.

- (a) A random sample of patients, all of whom have been experiencing difficulties sleeping, are given the new tablets. The numbers of hours slept by the patients on the fourth successive night of taking the new tablet are given below.

6.2 8.2 7.0 6.8 8.2 9.1 6.9 7.1 6.6 7.2 6.7 7.5 4.8 5.9 7.1 6.8

The median number of hours slept by patients taking an existing tablet is 6.6 hours. Carry out a sign test, at the 10% significance level, to investigate whether there is any difference in the median number of hours slept by patients taking the new tablet. (7 marks)

- (b) Another sample of patients is randomly selected for a further trial. Each patient is randomly assigned to take either the existing tablet or the new tablet for the first week of the trial.

Those patients who took the new tablet in the first week then took the existing tablet in the second week. Those patients who took the existing tablet in the first week then took the new tablet in the second week.

The number of hours slept on the fourth successive night by each patient with each tablet is given in the table below.

Patient	A	B	C	D	E	F	G	H	I	J
New tablet	7.2	6.3	5.8	4.2	8.1	6.9	7.5	7.8	7.4	7.2
Existing tablet	6.4	6.2	5.9	4.6	7.4	5.9	7.2	6.9	7.9	7.0

- (i) Carry out a Wilcoxon signed-rank test, at the 5% level of significance, to investigate whether the average number of hours slept is greater with the new tablet. (9 marks)
- (ii) Give a reason why the patients were assigned at random to the new or to the existing tablet for the first week of the trial. (1 mark)
- (iii) Explain why paired, rather than independent, samples are preferred for such a trial in which two sleeping tablets are to be compared. (2 marks)
- (c) A statistician, who looked at the analyses in parts (a) and (b)(i), thought it likely that errors had occurred in the data. Explain why the statistician came to this conclusion. (3 marks)

END OF QUESTIONS