

General Certificate of Education
January 2005
Advanced Level Examination



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

MBS6

Friday 14 January 2005 Morning 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 The population of a country is suffering from an epidemic of a serious disease.

- (a) A hospital doctor is consulted by 250 people suffering from symptoms of this disease. Of the 250 people, 105 are male, of whom 55 have the disease. Of the females, 65 have the disease.

A person is selected at random from the 250 people who consulted the hospital doctor.

The following events are defined:

F is the event “the person is female”;
S is the event “the person has the disease”;
S' is the event “not S”.

Find:

- (i) $P(F)$;
- (ii) $P(F \cap S')$;
- (iii) $P(S)$;
- (iv) $P(F|S)$. *(5 marks)*
- (b) The probability that a person selected at random from a large population has the disease is 0.2.
- (i) Four people are selected at random from a large population. Find the probability that at least one of these four people has the disease. *(2 marks)*
- (ii) Of the people suffering from this disease, 90% give a positive reaction to the test designed to detect the disease, whereas 15% of the people who are not suffering from the disease also give a positive reaction to the test.

Calculate the probability that a person who gives a positive reaction to the test does not have the disease. *(4 marks)*

- 2 A matched pairs design was used to compare the effects of two diets, A and B, on behaviour in rats.

Ten pairs of rats are formed on the basis of their behaviour before the diets are administered.

After the diets have been administered for several weeks, each rat in the trial is assessed for aggressive behaviour: the higher the assessment mark, the more aggressive the behaviour.

The results of the trial are given in the following table.

| Pair | Assessment mark | |
|------|-----------------|--------|
| | Diet A | Diet B |
| 1 | 127 | 115 |
| 2 | 105 | 95 |
| 3 | 85 | 90 |
| 4 | 75 | 60 |
| 5 | 90 | 91 |
| 6 | 62 | 55 |
| 7 | 112 | 99 |
| 8 | 96 | 89 |
| 9 | 74 | 65 |
| 10 | 80 | 76 |

- (a) Carry out a Wilcoxon signed-rank test, at the 1% level of significance, to investigate the claim that, on average, rats exhibit more aggressive behaviour when administered diet A than when administered diet B.

State the null and alternative hypotheses used.

(9 marks)

- (b) For a Wilcoxon signed-rank test carried out on 10 matched pairs, find:

(i) the minimum value possible for the test statistic T ;

(ii) the maximum value possible for the test statistic T .

(3 marks)

- 3 A random sample of 12 right-handed male Introductory Psychology students took a test to assess their IQ. Magnetic Resonance Imaging (MRI) was used to determine the brain size, in thousands of pixels, for each of the 12 students. Each student's weight, in pounds, was also recorded. The results obtained are given in the following table.

| Student | IQ score | Brain size | Weight |
|---------|----------|------------|--------|
| A | 139 | 1038 | 143 |
| B | 133 | 965 | 172 |
| C | 89 | 905 | 134 |
| D | 133 | 956 | 172 |
| E | 141 | 1080 | 151 |
| F | 135 | 924 | 155 |
| G | 100 | 945 | 178 |
| H | 80 | 889 | 180 |
| I | 97 | 906 | 186 |
| J | 139 | 955 | 132 |
| K | 90 | 880 | 181 |
| L | 81 | 930 | 148 |

- (a) (i) Find the value of Spearman's rank correlation coefficient between IQ score and brain size. *(5 marks)*
- (ii) Carry out a hypothesis test, at the 5% level of significance, to determine whether your calculated value in part (a)(i) indicates a positive association between IQ score and brain size.

Interpret your conclusion in the context of the question. *(4 marks)*

- (b) Find the value of the product moment correlation coefficient between brain size and weight. *(4 marks)*
- (c) With reference to your answers to parts (a) and (b), comment on the claim that, for students, a larger brain size results in a higher IQ score. *(3 marks)*

- 4 The Human Resources department of a large company gives a questionnaire to its middle managers (all male) to determine their personality type. Two distinct personality types are 'Thinking' and 'Extrovert'.

Nine men from the 'Thinking' type and nine men from the 'Extrovert' type are selected at random and each has his diastolic blood pressure measured.

The results are given below.

| | | | | | | | | | |
|-------------|----|----|----|----|----|----|----|----|----|
| 'Thinking' | 79 | 85 | 75 | 75 | 73 | 82 | 89 | 68 | 72 |
| 'Extrovert' | 84 | 82 | 88 | 78 | 92 | 95 | 69 | 91 | 86 |

- (a) Carry out a Mann-Whitney U test, at the 5% level of significance, to investigate whether or not there is a difference in diastolic blood pressure between the two different personality types.

State the null and alternative hypotheses used.

(12 marks)

- (b) A paired comparison is often preferred as an experimental design.

(i) Give **one** reason why a paired comparison might be preferred to a comparison of two independent samples.

(1 mark)

(ii) Explain why a paired comparison would **not** be appropriate for investigating the difference in blood pressure between the two personality types given above.

(2 marks)

- (c) The Human Resources department also wishes to investigate the attitude of the middle managers to a new pay structure.

At the end of the personality questionnaire, the managers were asked to state whether they preferred the new pay structure to the old pay structure or had no opinion on pay structure.

Out of 53 replies, 3 stated that they had no opinion, 35 stated that they preferred the new pay structure to the old pay structure and the rest stated that they did not prefer the new pay structure to the old pay structure.

Use the sign test, with the 1% level of significance, to investigate the claim made by the Human Resources department that the managers prefer the new pay structure to the old pay structure.

(6 marks)

END OF QUESTIONS

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE