General Certificate of Education
January 2005
Advanced Subsidiary Examination

MATHEMATICS AND STATISTICS (SPECIFICATION B) Unit Statistics 3

MBS3

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;
- one sheet of graph paper for use in Question 3;
- a ruler.

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.

Answer **all** questions.

1 The probability that a climber chooses to attempt to ascend a mountain by the North Ridge is 0.5, by the West Face is 0.3, and by the East Face is 0.2.

The probability that a climber has a fall in an attempted ascent on the North Ridge is 0.2, on the West Face is 0.4, and on the East Face is 0.1.

(a) Find the probability that a climber chooses to ascend the mountain by the North Ridge and has a fall. *(2 marks)*

(b) Find the probability that a climber has a fall in a single attempted ascent of the mountain. *(3 marks)*

(c) Given that a climber is known to have had a fall, find the probability that the climber made the attempted ascent by the North Ridge. *(3 marks)*

(d) It may be assumed that a climber who does not have a fall reaches the summit.

Given that a climber reaches the summit, find the probability that the climber chose to ascend the mountain by the North Ridge. *(3 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. *(10 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)*

(c) (i) Why might a Wilcoxon signed-rank test be preferred to a sign test in the analysis of the effect of diet on the behaviour of rats as outlined in this question? *(1 mark)*

(ii) Give **one** situation when it would be appropriate to use a sign test to analyse paired data but it would **not** be appropriate to use a Wilcoxon signed-rank test. *(1 mark)*

3 [A sheet of graph paper is provided for use in this question.]

A sample of ten sales people is selected at random from those working for a large company. The sales people all have a company car and travel extensively as part of their work.

Each salesperson undertakes a self-perception stress analysis which produces a score, measured on a scale of 0 to 15, where 0 indicates no stress at all. The number of miles, in thousands, travelled for the company by each salesperson during the last twelve months is also recorded.

The results are given in the following table.

Person	**Miles travelled** (thousands)	**Stress score**
A	11.2	5.2
B	14.4	5.6
C	17.0	12.0
D	17.6	11.5
E	18.3	14.4
F	12.0	5.2
G	15.1	7.9
H	12.9	5.8
I	16.3	9.0
J	18.0	13.0

(a) Plot a scatter diagram to illustrate the above data. *(3 marks)*

(b) Calculate the value of Spearman's rank correlation coefficient between miles travelled and stress score. *(6 marks)*

(c) It is claimed that there is an association between miles travelled and stress score.

Investigate this claim by carrying out a hypothesis test, at the 1% level of significance, using your value calculated in part (b).

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

(d) Give **one** reason why, for the given data, Spearman's rank correlation coefficient is a more appropriate measure of association than the product moment correlation coefficient. *(1 mark)*

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'.

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

The results are given below.

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

(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. *(14 marks)*

(b) 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.

Out of 50 replies, 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

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