

General Certificate of Education
January 2005
Advanced Level Examination



**MATHEMATICS AND STATISTICS
(SPECIFICATION B)
Unit Statistics 5**

MBS5

Friday 21 January 2005 Afternoon Session

In addition to this paper you will require:

- a 12-page answer book;
- one sheet of graph paper for use in Question 3;
- the AQA booklet of formulae and statistical tables.

You may use a graphics calculator.

Time allowed: 1 hour 45 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 MBS5.
- 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 80.
- Mark allocations are shown in brackets.

Advice

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

Answer **all** questions.

- 1 The systolic blood pressure, x mm Hg, and the diastolic blood pressure, y mm Hg, of a group of ten patients were measured. The results are shown in the following table.

Patient	1	2	3	4	5	6	7	8	9	10
x	170	129	147	120	136	133	134	158	108	114
y	110	102	104	84	81	95	78	86	87	80

- (a) Calculate the product moment correlation coefficient between systolic blood pressure and diastolic blood pressure for these patients. *(3 marks)*
- (b) Interpret your result in part (a). *(2 marks)*
- 2 Jars of bolognese sauce, sold by a supermarket, are stated to have contents of weight 500 g. The weights, in grams, of the actual contents of jars in a large batch are normally distributed with mean 506 and standard deviation 5.
- (a) Find the probability that the contents of a randomly selected jar will weigh:
- (i) less than 500 g; *(3 marks)*
- (ii) between 495 g and 505 g. *(4 marks)*
- (b) Find the weight which is exceeded by the contents of 99.9% of the jars in this batch. *(4 marks)*
- (c) On receiving a new batch, Anu, the manager, selects a random sample of jars and weighs the contents. He will investigate further if the sample mean is less than 500 g. How many jars must Anu select in order to have a probability of at least 0.90 that the sample mean from a batch, with mean weight 498 g and standard deviation 5 g, is less than 500 g? Assume the distribution of weights is normal. *(5 marks)*

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

Three trainee technicians, Elizabeth (E), Nickolay (N) and Sita (S), are employed in a science laboratory. They carry out trials on a new material to determine its flexibility when immersed in water at different temperatures.

The following table shows, for each trial, the temperature of the water, x , in $^{\circ}\text{C}$, and the trainee technician's estimate of y , a measure of the flexibility of the material. The trainee technician who carried out each trial is also identified.

Technician	E	N	S	N	S	E	N	E	S
x	5	10	15	20	35	40	45	50	55
y	27	70	18	29	59	93	124	119	97

- (a) Plot a scatter diagram of the data. Label each point according to which technician carried out the trial. *(3 marks)*
- (b) Calculate the equation of the regression line of y on x . Draw the line on your scatter diagram. *(5 marks)*
- (c) It is known that between 5°C and 55°C there is an approximately linear relationship between x and y .
- (i) Comment on Nickolay's results.
- (ii) Compare the results of Sita and Elizabeth. *(3 marks)*
- (d) Herbert (H), an experienced and reliable technician, carried out two further trials with the following results.

Technician	H	H
x	25	30
y	38	47

- (i) Add these two points to your scatter diagram. *(1 mark)*
- (ii) Comment further on the performance of Sita. *(1 mark)*
- (iii) Use your scatter diagram and the given information to estimate the value of y for a temperature of 60°C . Do not carry out any further calculations. *(1 mark)*
- (iv) State your reservations, if any, about your estimate in part (d)(iii). *(2 marks)*
- (v) How would you estimate the value required in part (d)(iii) if one further trial could be carried out by a technician of your choice? *(2 marks)*

- 4 Eileen is the secretary of a book club. She wishes to purchase three copies of a particular novel for members to read, prior to discussion at the next meeting. There are two bookshops in the town: Sherrats and Hughes. The table below shows the number of copies of the novel in stock, together with their associated probabilities at each shop. The probabilities at each shop are independent of those at the other shop.

Number of copies in stock	Probability	
	Sherrats	Hughes
0	0.15	0.30
1	0.25	0.28
2	0.20	0.18
3 or more	0.40	0.24

- (a) Find the probability that:
- (i) neither bookshop has any copies in stock; *(1 mark)*
 - (ii) Sherrats has exactly one copy in stock and Hughes has two or more copies in stock; *(3 marks)*
 - (iii) the two bookshops have, between them, a total of 3 or more copies in stock. *(4 marks)*
- (b) Eileen decides to visit Sherrats and buy as many copies as possible, up to a maximum of 3. If she is unable to buy 3 copies at Sherrats, she will then visit Hughes. At Hughes, she will buy sufficient copies to make her total up to 3 or, if this is not possible, she will buy as many copies as are in stock.

Find the probability that Eileen buys:

- (i) three copies from the same shop; *(3 marks)*
- (ii) more copies from Hughes than from Sherrats. *(4 marks)*

5 An examination of the till roll at a petrol station showed that the previous 400 customers had spent a total of £4256 on petrol and that the standard deviation of the individual amounts spent on petrol was £3.68.

- (a) Calculate a 95% confidence interval for the mean amount spent on petrol by a customer. Assume that the 400 customers may be regarded as a random sample of all customers using this petrol station. *(5 marks)*
- (b) In the hope of increasing his takings, Miguel, the petrol station owner, decided to offer a £1 token, redeemable on goods at the petrol station, to all customers who spent at least £12 on petrol.

The first 200 customers, after the introduction of this offer, spent a total of £2342 on petrol and the standard deviation of the individual amounts spent on petrol was £3.42.

- (i) Calculate a 95% confidence interval for the mean amount spent on petrol by a customer following the introduction of the offer. Assume that the 200 customers may be regarded as a random sample of all customers using this petrol station. *(2 marks)*
- (ii) Explain to Miguel the implications of your results in part (a) and part (b)(i). *(2 marks)*
- (iii) What further information would you require before advising Miguel whether or not to continue with the offer? *(2 marks)*

TURN OVER FOR THE NEXT QUESTION

- 6 Sharon is considering opening a coffee bar. While preparing her business plan, she estimated that a customer will, on average, occupy a seat in the coffee bar for 18 minutes.

She observed customers in a coffee bar in a similar area and recorded the times, in minutes, for which they occupied a seat. The times recorded were as follows:

37.4 18.2 39.0 12.2 46.9 5.4 69.2 16.3 44.6 24.2 39.8

- (a) Using the 5% significance level, test the hypothesis that the mean time a customer occupies a seat is 18 minutes. Assume that the data are a random sample from a normal distribution with standard deviation 17 minutes. *(7 marks)*
- (b) If, in part (a), you had been asked to examine whether the mean time a customer occupied a seat was less than 18 minutes, state the changes, if any, which would have been necessary to:
- (i) the null hypothesis;
 - (ii) the alternative hypothesis;
 - (iii) the critical value(s);
 - (iv) the conclusion. Your conclusion should be stated in words; i.e. a conclusion such as “reject H_0 ” is not sufficient. *(4 marks)*
- (c) If, in part (a), you had been asked to examine a claim that the mean time a customer occupied a seat was 18 minutes or less, state the changes, if any, which would have been necessary to:
- (i) the null hypothesis;
 - (ii) the alternative hypothesis;
 - (iii) the critical value(s);
 - (iv) the conclusion. Your conclusion should be stated in words; i.e. a conclusion such as “reject H_0 ” is not sufficient. *(4 marks)*

END OF QUESTIONS

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