

General Certificate of Education  
June 2004  
Advanced Level Examination



**MATHEMATICS AND STATISTICS  
(SPECIFICATION B)  
Unit Statistics 8**

**MBS8**

Friday 25 June 2004 Morning Session

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

- an 8-page answer book;
- the AQA booklet of formulae and statistical tables;
- an insert for use in Question 4 (enclosed).

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 MBS8.
- 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.
- Fill in the boxes at the top of the insert. Make sure that you attach this insert to your answer book.

**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 The diameters, in millimetres, of soft playballs manufactured by a particular machine may be assumed to be normally distributed with mean  $\mu$  and standard deviation  $\sigma$ .

The target value for  $\mu$  is 100 and a value for  $\sigma$  of 4 is considered satisfactory.

- (a) For samples of size 6, calculate to one decimal place, upper and lower warning (95%) and action (99.8%) control limits for:
- (i) sample means; *(4 marks)*
  - (ii) sample standard deviations. *(3 marks)*
- (b) State with reasons the action you would advise, if any, given that a sample of 6 playballs has diameters, in millimetres, of:
- (i) 100, 102, 101, 97, 101 and 102;
  - (ii) 107, 94, 102, 93, 108 and 96. *(5 marks)*

- 2 It is claimed that a particular diet programme for gradual weight reduction results in a mean weight loss for participants during the first three months of more than 5 kilograms.

The table below shows, for a random sample of 10 participants, their weights, in kilograms, on joining the programme and after three months.

Participant	Weight on joining	Weight after three months
1	67.7	62.2
2	83.6	77.4
3	102.7	95.3
4	114.7	105.0
5	75.4	70.7
6	93.4	86.1
7	83.2	76.6
8	74.2	71.1
9	111.5	102.6
10	93.2	86.6

- (a) Stating the necessary distributional assumption, use a paired  $t$ -test to investigate the claim at the 1% level of significance. *(11 marks)*
- (b) Indicate, with a reason, the benefit in using paired samples to investigate the claim. *(2 marks)*

**TURN OVER FOR THE NEXT QUESTION**

3 Naomi, a biologist, wishes to compare the effects of 4 different environments, labelled A, B, C and D, on the growth of lettuce seedlings. She has available 20 seedlings, numbered 1, 2, . . . , 20.

(a) (i) Copy and complete the following table to show a suitable experimental design.

Environment			
A	B	C	D
1			
		2	
			3
4			

(1 mark)

(ii) Write down the name of your design and the name of the technique you would then use to analyse the data collected. (2 marks)

(b) Naomi is then informed that seedlings numbered 1 to 4 are of Variety I, those numbered 5 to 8 are of Variety II, those numbered 9 to 12 are of Variety III, those numbered 13 to 16 are of Variety IV and those numbered 17 to 20 are of Variety V.

(i) Construct a table to show a suitable experimental design. (2 marks)

(ii) Write down the name of your design and the name of the technique you would then use to analyse the data collected. (2 marks)

(c) Given the additional information in part (b), state **one** advantage of your design in part (b) over your design in part (a). (1 mark)

4 [Figure 1, printed on the insert, is provided for use in this question.]

Before a producer delivers 10 kg bags of charcoal for barbecues to retail outlets, bags are chosen at random from large batches and the charcoal in each bag is weighed. These weights,  $X$  kilograms, are known to be normally distributed with mean  $\mu$  and standard deviation 0.2.

A proposed sampling scheme is that a batch is accepted when the mean weight,  $\bar{X}$  kilograms, of charcoal from a random sample of 4 bags exceeds 10.1.

(a) Show that the probability that a batch is accepted by this scheme,  $P(A)$ , is given by:

$$P(A) = P\left(Z > \left(\frac{10.1 - \mu}{0.1}\right)\right) \text{ where } Z \sim N(0, 1). \quad (2 \text{ marks})$$

(b) Hence copy and complete the following table.

$\mu$	9.8	9.9	10.0	10.1	10.2	10.3	10.4
$P(A)$		0.023		0.500			

(3 marks)

(c) Draw the associated operating characteristic curve on **Figure 1**. (2 marks)

(d) Using your graph in part (c), or otherwise, comment on the proposed sampling scheme's ability to meet **both** of the following requirements.

- Batches containing bags with a mean weight of 9.95 kg should have at most a 10% probability of acceptance.
- Batches containing bags with a mean weight of 10.25 kg should have at most a 10% probability of rejection. (3 marks)

**TURN OVER FOR THE NEXT QUESTION**

- 5 As part of an investigation into vehicle hire rates in Mediterranean countries during high season, a  $5 \times 5$  Latin square design was used.

The factors were as follows.

- Country 1, 2, 3, 4 and 5
- Vehicle group A, B, C, D and E
- Hire company a, b, c, d and e

The actual design used is shown in the table. The responses, in €, for all-inclusive 7-day rates, excluding fuel, are also shown.

Vehicle group	Country				
	1	2	3	4	5
A	b 242	c 231	d 231	e 229	a 217
B	e 247	a 240	b 245	c 241	d 227
C	d 248	e 260	a 245	b 256	c 241
D	a 267	b 271	c 261	d 251	e 250
E	c 281	d 283	e 278	a 283	b 275

You may assume that:

$$\text{total sum of squares, } SS_T = 8606.0;$$

$$\text{between hire companies sum of squares, } SS_L = 269.2.$$

- (a) Carry out an analysis of variance to test, at the 5% level of significance, for a difference in vehicle hire rates between the five hire companies. *(13 marks)*
- (b) Indicate, with reasons, whether the use of countries and vehicle groups as two blocking factors has proved effective. *(4 marks)*

**END OF QUESTIONS**

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Surname					Other Names				
Centre Number					Candidate Number				
Candidate Signature									

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Insert for use in Question 4.

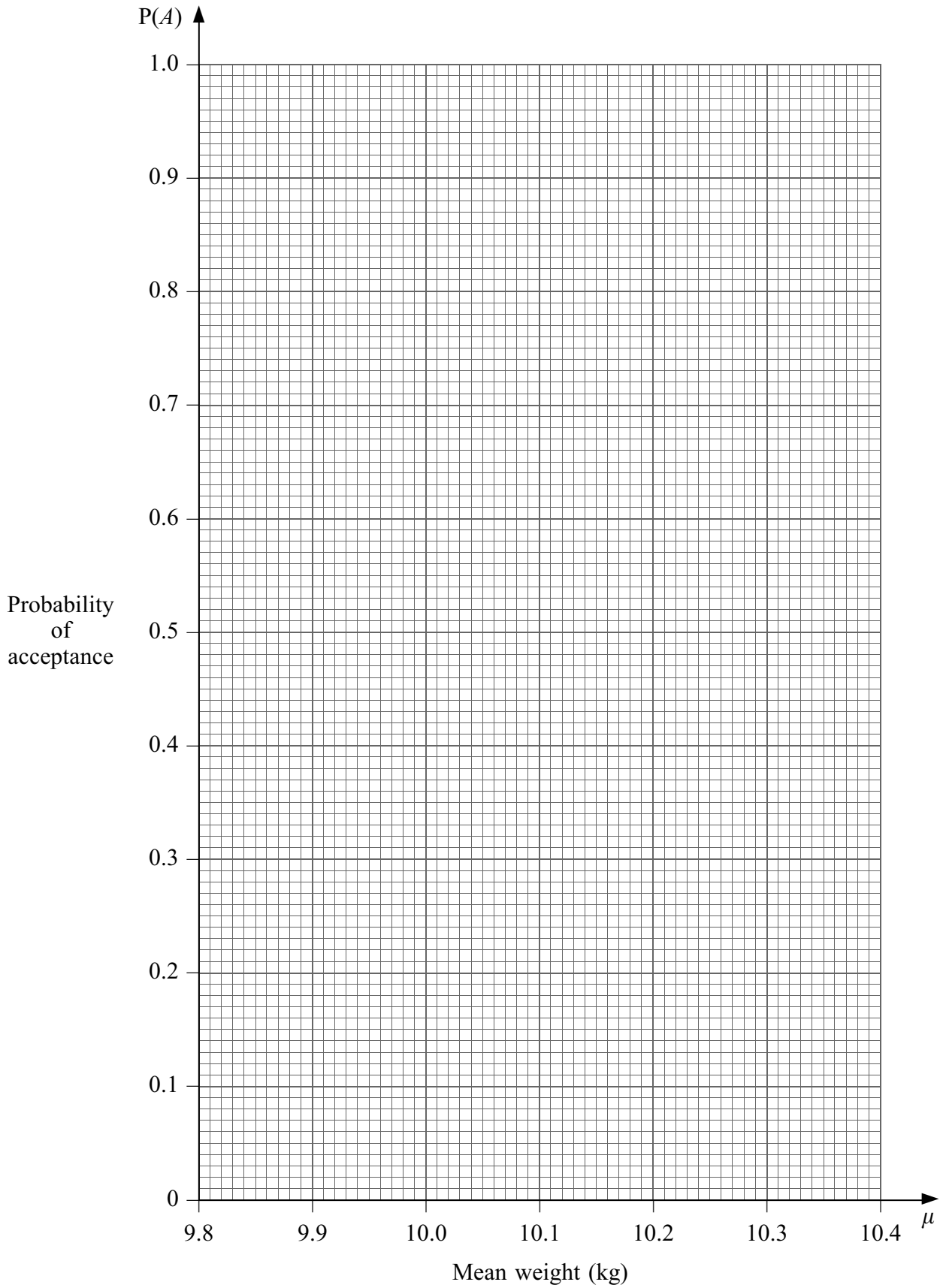
Fill in the boxes at the top of this page.

Attach this insert securely to your answer book.

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**TURN OVER**

### Operating Characteristic Curve



**Figure 1**