AQA

MATHEMATICS AND STATISTICS **MBS4**
(SPECIFICATION B)
Unit Statistics 4

Friday 21 January 2005   Afternoon Session

In addition to this paper you will require:
- a 12-page answer book;
- 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 MBS4.
- 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.

MBS4

Answer **all** questions.

1 The contents, in grams, of a random sample of eight jars of yeast extract from a large batch were as follows:

<div align="center">

342   347   346   343   344   347   344   345

</div>

The contents of the jars in the batch can be assumed to be normally distributed. Calculate a 90% confidence interval for the mean contents of the jars in the batch. Give your answer to an appropriate number of significant figures. *(8 marks)*

2 The time taken to complete a tennis match varies. Boris is a professional tennis player who believes that, because of his excellent physical condition, the longer a match lasts the better his chance of winning. An analysis of a sample of matches in which Boris had taken part showed that:

> of 43 matches which lasted less than two hours, Boris had won 28;
> of 52 matches which lasted two hours or longer, Boris had won 22.

(a) Form the data into a 2×2 contingency table suitable for analysis using a χ^2 distribution. *(3 marks)*

(b) Analyse the table that you have formed in part (a) using the 5% significance level. *(9 marks)*

(c) Interpret your results in parts (a) and (b) in the context of the question. *(2 marks)*

3 A supermarket sells carrots in bags marked "2 kilograms". The amount, in grams, by which the weight of carrots in a bag differs from 2 kilograms may be modelled by the random variable, X, with probability density function

$$\text{f}(x) = \begin{cases} \dfrac{1}{3c} & -c < x < 2c \\ 0 & \text{otherwise} \end{cases} \quad \text{where } c \text{ is a constant}$$

(a) Write down the mean of X in terms of c. *(1 mark)*

(b) Using integration, show that $\text{E}(X^2) = c^2$. *(4 marks)*

(c) Find the standard deviation of X in terms of c. *(3 marks)*

(d) The carrots in a large sample of bags are weighed. For these bags, the mean value of X is found to be 22. Estimate:

  (i) the standard deviation of X; *(4 marks)*

  (ii) the minimum value of the weight of carrots in a bag. *(2 marks)*

4 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. *(10 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)*

Turn over ▶

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) Further examination of the till roll showed that, although customers could spend any amount they chose on petrol, the great majority of customers spent a multiple of £5. It was suggested that an adequate model for the amount, in £, spent on petrol by customers could be provided by the discrete random variable, X, with the following probability distribution.

x	$P(X=x)$
5	0.15
10	0.63
15	0.15
20	0.07

Calculate:

(i) the mean of X;

(ii) $E(X^2)$;

(iii) the standard deviation of X. *(6 marks)*

(c) Using the given data and the results of your calculations in parts (a) and (b), comment on the plausibility of X as a model for the amount spent by customers on petrol. *(3 marks)*

(d) 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. He hoped that most of his customers who would have spent £10 on petrol would then spend £15.

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) Using the 5% significance level, examine whether the mean amount spent on petrol by a customer, following the introduction of this offer, exceeds £11. The 200 customers may be regarded as a random sample of all customers using this petrol station. *(8 marks)*

 (ii) Explain to Miguel the implications of your result in part (d)(i). *(2 marks)*

 (iii) What further information would you require before advising Miguel whether or not to continue with the offer? *(2 marks)*

END OF QUESTIONS

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