General Certificate of Education
January 2004
Advanced Level Examination

MATHEMATICS AND STATISTICS (SPECIFICATION B)
Unit Statistics 4

MBS4

ASSESSMENT and QUALIFICATIONS ALLIANCE

Wednesday 21 January 2004 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.

Answer **all** questions.

1 Chandra, an estate agent, sells properties in a large conurbation. She classifies the areas of the conurbation as:

City Centre;
Inner City – close to but outside the City Centre;
Suburban – outside the Inner City.

The following table shows the number of properties she has for sale in each of these areas together with information on the Advertised Price.

		Area		
		City Centre	**Inner City**	**Suburban**
Advertised Price	**< £120 000**	2	58	20
	⩾ £120 000	34	12	44

(a) Use a χ^2 distribution and the 1% significance level to analyse this contingency table. *(9 marks)*

(b) Interpret your result in the context of this question. *(2 marks)*

(c) Chandra's colleague Michael suggests that a better way of analysing the relationship between price and area would be to calculate the product moment correlation coefficient between the Advertised Price of a property and its distance from the centre of the city.

Comment on this suggestion:

(i) in general terms; *(2 marks)*

(ii) as it relates to your conclusions in part (b). *(1 mark)*

2 A hospital kitchen buys oranges in large batches. In each batch, the vitamin C content of the flesh of the oranges, in milligrams per 10 grams, may be modelled by a normal distribution with standard deviation 0.11.

The vitamin C contents of the flesh of a random sample of 8 oranges from a particular batch were measured, with the following results:

1.32 1.11 1.39 1.22 1.25 1.57 1.42 1.36

(a) Calculate a 90% confidence interval for the mean vitamin C content of the flesh of oranges in this batch. *(5 marks)*

(b) A nutritionist, who draws up diets for individual patients, assumes that the flesh of oranges has a vitamin C content of at least 1.20. Comment on this assumption as it relates to this batch of oranges. *(2 marks)*

(c) The nutritionist requests that a 95% confidence interval of width not more than 0.03 should be calculated for the mean vitamin C content of the flesh of oranges in each batch. Calculate how large a random sample would have to be taken from each batch in order to achieve this. *(5 marks)*

3 The random variable X has probability density function:

$$f(x) = \begin{cases} px + q & 0 < x < 1 \\ 0 & \text{otherwise} \end{cases}$$

where p and q are constants.

(a) Show that $\frac{1}{2}p + q = 1$. *(3 marks)*

(b) Find the mean of X in terms of p and q. *(3 marks)*

(c) The mean of X is 0.6. Show that $p = 1.2$ and find the value of q. *(3 marks)*

(d) Find the standard deviation of X. *(4 marks)*

TURN OVER FOR THE NEXT QUESTION

4 A make of car battery is advertised as having a mean lifetime of at least 40 months. A car magazine suspects that the mean lifetime is less than 40 months and so monitors the lifetimes, in months, of a random sample of 12 batteries, with the following results:

44 32 46 39 38 30 35 40 38 41 34 36

(a) Assuming that lifetimes are normally distributed, investigate the magazine's suspicion, using the 5% significance level. *(10 marks)*

(b) A larger random sample of 160 car batteries is now monitored. The lifetimes are found to have a mean of 39.2 months and a standard deviation of 4.2 months. Use this information to investigate the magazine's suspicion, using the 5% significance level. *(4 marks)*

(c) State, with an explanation, which, if either, of the tests in parts (a) and (b) has the larger risk of:

(i) a Type I error;

(ii) a Type II error if the mean lifetime is 40 months;

(iii) a Type II error if the mean lifetime is 39 months. *(6 marks)*

5 Halina works at home. At 2 pm she takes a break to buy some skimmed milk. Hamid, Otto, Mary and Wesley each run a nearby convenience store. However, by 2 pm they may have sold all their skimmed milk and so have none available. The independent probabilities that they have skimmed milk available at 2 pm are:

Hamid 0.40 Otto 0.80 Mary 0.75 Wesley 0.90

Halina decides to visit the convenience stores in turn until she obtains skimmed milk or until she has visited all four. She will visit them in the order Hamid, Otto, Mary, Wesley.

(a) Show that on a particular day:

(i) the probability that Halina obtains skimmed milk from Otto is 0.48;

(ii) the probability that Halina obtains skimmed milk from Mary is 0.09;

(iii) the probability that Halina visits Wesley's store is 0.03. *(4 marks)*

(b) Find the probability that on a particular day Halina succeeds in obtaining skimmed milk. *(3 marks)*

(c) The following table shows the time she will be away from home depending on how many convenience stores she visits.

Last convenience store visited	**Time away from home (minutes)**	**Probability**
Hamid	14	0.40
Otto	19	
Mary	25	
Wesley	32	

(i) Copy and complete the table using the results from part (a) and hence find the mean and standard deviation of the time Halina is away from home. *(6 marks)*

(ii) Halina goes to buy skimmed milk at 2 pm on 40 days. Find approximately the probability that the mean time she spends away from home when attempting to buy skimmed milk is greater than 19 minutes. Assume the 40 days may be treated as a random sample. *(5 marks)*

(iii) As an alternative to her current strategy, Halina considers going directly to Wesley's store and returning straight home whether or not she obtains skimmed milk. If she did this, she would be away from home for 21 minutes. List **one** advantage and **two** disadvantages of this alternative strategy. *(3 marks)*

END OF QUESTIONS