General Certificate of Education
June 2005
Advanced Level Examination

MATHEMATICS AND STATISTICS (SPECIFICATION B)
Unit Statistics 8

MBS8

Friday 24 June 2005 Morning Session

In addition to this paper you will require:
- an 8-page answer book;
- the AQA booklet of formulae and statistical tables.

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.

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 As part of her university course in retailing, Huda records the price, x pence, of each of a random sample of 20 food items in a minimarket. She also records the price, y pence, of each of the same 20 items in a supermarket.

For each item, Huda calculates the difference in price, d pence, where $d = x - y$. From the 20 values of d, Huda then calculates that

$$\overline{d} = 5.5 \quad \text{and} \quad \sum \left(d - \overline{d}\right)^2 = 2577.0$$

where $\overline{d}$ denotes the sample mean.

(a) Stating the necessary distributional assumption, use a t-test and the 5% level of significance to examine the claim that, on average, food items are cheaper in supermarkets than in minimarkets. *(8 marks)*

(b) Joanne, on the same course as Huda, is asked to compare the prices of food items in 3 corner shops. She selects a random sample of 15 food items and then records their prices in each of the 3 shops.

Name the experimental design used by Joanne and state the technique used in its analysis. *(2 marks)*

2 In a hospital, trials were undertaken to assess the potential benefits of a new allergy-free stocking to help in the prevention of deep vein thrombosis. A sample of 50 hospital patients was selected. Based upon their medical histories, the patients were placed in pairs. One patient, chosen at random from each pair, was prescribed the new allergy-free stocking and the other patient was prescribed an existing stocking.

(a) State why paired, rather than independent, samples were used in these trials. *(1 mark)*

(b) State which sample of patients formed the experimental group. *(1 mark)*

(c) Double blind trials were used.

Explain, in context, the meaning and purpose of such trials. *(2 marks)*

(d) After a fixed period of time, the nurse in charge decided, for each pair of patients, which stocking was the better. After the same period of time, a consultant awarded, for each pair of patients, a score in the range from 0 to 9 for the performance of each stocking.

Name, with a reason, an appropriate test for the results obtained by:

(i) the nurse in charge; *(2 marks)*

(ii) the consultant. *(2 marks)*

TURN OVER FOR THE NEXT QUESTION

3 A producer of plastic cable ties decides to introduce a single sampling plan to monitor the quality of batches of ties.

Batches containing 1 per cent (or less) faulty ties are considered to be of acceptable quality, whereas batches containing 10 per cent (or more) faulty ties are considered to be of unacceptable quality. The risk of rejecting a batch of acceptable quality and the risk of accepting a batch of unacceptable quality should each be less than 5%.

The following sampling plan is proposed:

> Select 40 ties at random from a batch and accept the batch when there is at most 1 faulty tie; otherwise reject the batch.

(a) Use binomial distributions to find the probability that:

(i) a batch containing 1 per cent faulty ties is rejected by the sampling plan;

(ii) a batch containing 10 per cent faulty ties is accepted by the sampling plan. *(3 marks)*

(b) Hence comment on the suitability of the sampling plan. *(2 marks)*

(c) Following consultation with consumers, it is decided that the risk of rejecting a batch of acceptable quality and the risk of accepting a batch of unacceptable quality should each be less than 2.5%.

Use Poisson approximations to show that these risks are satisfied by the following sampling plan:

> Select 90 ties at random from a batch and accept the batch when there are at most 3 faulty ties; otherwise reject the batch. *(3 marks)*

(d) The producer decides to use the sampling plan described in part (c). Additionally, the producer decides to undertake a 100% inspection of all batches rejected by the plan. All faulty ties found during this inspection are replaced.

Show that, when batches are produced that contain 5 per cent faulty ties, the expected percentage of faulty ties after sampling, and where necessary 100% inspection, is less than 2.5 per cent. *(4 marks)*

4 Susan travels on the same train each weekday morning on her way from home to work. Over a period of time she records her journey time, x_{ij} minutes, on the train with the following results.

Weekday				
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
24	20	20	19	23
24	22	18	22	19
24	24	23	23	24
19	20	22	22	23
22	18	19	18	23
25	22	18	22	20

You may assume that:

$$\sum_i \sum_j x_{ij}^2 = 13\,878;$$

all x_{ij} are normally distributed with variance σ^2.

(a) Confirm, at the 5% level of significance, that there is insufficient evidence to reject the hypothesis that Susan's mean train journey time is the same on each weekday morning.
(11 marks)

(b) Hence, using your mean square within weekdays as an estimate of σ^2, construct a 95% confidence interval for Susan's mean train journey time on weekday mornings.
(4 marks)

TURN OVER FOR THE NEXT QUESTION

5 Tubs contain a nominal weight of 950 grams of salted peanuts. The actual weight, X grams, of peanuts delivered into a tub by a filling machine may be assumed to be normally distributed with mean μ and standard deviation 8.

The weights of peanuts in tubs are to be monitored by a quality control officer. The filling machine is set with a target value of 965 for μ. Samples of 5 tubs are selected at regular intervals.

(a) Calculate to one decimal place, **but do not graph**, upper and lower warning (95%) and action (99.8%) control limits for:

(i) sample means; *(4 marks)*

(ii) sample ranges. *(3 marks)*

(b) The table below shows, for each of eight samples of 5 tubs, the mean and range of the weights, in grams, of peanuts.

Sample	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Mean	961	969	961	968	961	960	970	962
Range	27	11	20	25	28	14	12	23

(i) Using your results from part (a), indicate, with reasons, what may be concluded regarding the quality of production for the period during which these samples were taken. *(2 marks)*

(ii) Calculate an estimate of μ from the above data. *(1 mark)*

(iii) Hence estimate the proportion of tubs containing less than 950 grams of peanuts. *(3 marks)*

(iv) Using your answer from part (b)(iii), comment on your conclusions in part (b)(i). *(2 marks)*

END OF QUESTIONS

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