General Certificate of Education
June 2005
Advanced Level Examination

MATHEMATICS AND STATISTICS (SPECIFICATION B)
Unit Statistics 5

MBS5

Thursday 16 June 2005 Afternoon Session

In addition to this paper you will require:
- a 12-page answer book;
- the AQA booklet of formulae and statistical tables;
- one sheet of graph paper for use in Question 1;
- a ruler.

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

Applicants for a course in architecture were given a set of photographs and asked to estimate the ages of the nine buildings pictured in the photographs. The actual ages of the buildings, x years, together with the estimates, y years, made by Eamon, one of the applicants, are shown below.

Building	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
x	24	12	103	37	63	158	86	120	41
y	17	4	88	44	48	167	88	109	33

(a) Draw a scatter diagram of the data. *(3 marks)*

(b) Calculate the equation of the regression line of y on x and draw the line on your scatter diagram. *(5 marks)*

(c) Calculate the residuals for buildings B and G. *(3 marks)*

(d) Using the residuals for buildings B and G as examples, discuss whether or not a small residual indicates a good estimate. *(3 marks)*

(e) It was later discovered that, at the time the estimates were made, the values of x, the actual ages of the buildings, were correct but that the photographs were already seven years old. How, if at all, does this affect your opinion of Eamon's estimates? *(2 marks)*

2 In an office a machine dispenses hot water for use in making tea, coffee or hot chocolate. The machine is filled with water at the beginning of each day. When 20 litres of water have been used the machine must be refilled.

(a) The daily demand for hot water from the machine may be modelled by a normal distribution with mean 26 litres and standard deviation 8 litres. Find the probability that, on a particular day, the machine:

(i) will not need to be refilled;

(ii) will need to be refilled exactly once. *(5 marks)*

(b) Find the probability that during a five-day week:

(i) the demand for hot water from the machine will be less than 20 litres on each day; *(2 marks)*

(ii) the mean daily demand for hot water will be less than 20 litres. *(3 marks)*

(c) The machine is moved to a different office. Following the move, it is observed that the machine needs refilling at least once on 84% of days and needs refilling more than once on 12% of days. Assuming that the daily demand for hot water, following the move, may still be modelled by a normal distribution, find the mean and standard deviation. *(6 marks)*

TURN OVER FOR THE NEXT QUESTION

3 While examining a water company's finances, an auditor selected a random sample of 90 customers, who owed the company money, in order to scrutinise their accounts. The amounts owed by these 90 customers had a mean of £197 and a standard deviation of £103.

(a) For customers who owed the company money:

(i) calculate a 95% confidence interval for the mean amount owed; *(4 marks)*

(ii) state the width of the confidence interval that you have calculated in part (a)(i); *(1 mark)*

(iii) find the percentage which would be associated with a confidence interval of width £30 calculated from the given data; *(5 marks)*

(iv) find, approximately, the size of sample which would be required in order to calculate a 99% confidence interval of width £30 for the mean amount owed. *(4 marks)*

(b) Explain why:

(i) your calculations in part (a) are valid whether or not the amounts owed may be modelled by a normal distribution; *(2 marks)*

(ii) a normal distribution will **not** provide a good model for the amounts owed. *(2 marks)*

4 Veronica reviews films for a weekly magazine. She awards each film one, two, three or four stars according to how much she enjoys it. She classifies films as *comedy*, *drama* or *other*. The following table shows the probability that Veronica awards a given number of stars to each class of film.

	One star	**Two star**	**Three star**	**Four star**
Comedy	0.25	0.45	0.24	0.06
Drama	0.20	0.35	0.30	0.15
Other	0.40	0.10	0.32	0.18

(a) Find the probability that Veronica will award more than two stars to a *comedy*. *(1 mark)*

During a particular six-week period, Veronica reviews 30 films: 10 *comedies*, 15 *dramas* and 5 *others*.

(b) One of these 30 films is selected at random. Find the probability that it is:

(i) a *comedy*; *(1 mark)*

(ii) a *comedy* awarded four stars by Veronica; *(1 mark)*

(iii) a *drama* awarded more than two stars by Veronica; *(2 marks)*

(iv) awarded four stars by Veronica; *(3 marks)*

(v) awarded fewer than three stars by Veronica, given that it is **not** a *comedy*. *(3 marks)*

(c) If three of the 30 films are selected at random without replacement, find the probability that two are *comedies* and one is a *drama*. *(3 marks)*

TURN OVER FOR THE NEXT QUESTION

5 Santos, a newsagent, employs schoolchildren to deliver newspapers. Marilyn is to start delivering morning newspapers. She wishes to complete her delivery round early enough to ensure that she will not be late for school. Santos tells her that the average time taken to complete a delivery round is 40 minutes. Marilyn's friend Lula, who already delivers morning papers for Santos, says that the average time taken to complete a delivery round is 50 minutes.

Before starting her employment, Marilyn checks the times taken by 8 schoolchildren, employed by Santos, to complete their rounds. The times, in minutes, may be regarded as a random sample from a normal distribution with standard deviation 12. The times were as follows:

52 30 41 49 61 33 52 54

(a) (i) By carrying out a hypothesis test, using the 5% significance level, show that the null hypothesis that the mean time to complete a round is equal to 40 minutes is accepted.

(ii) By carrying out a hypothesis test, using the 5% significance level, show that the null hypothesis that the mean time to complete a round is equal to 50 minutes is accepted.

(10 marks)

(b) The following three claims refer to the two tests carried out in part (a).

Claim 1 A Type I error has occurred in at least one of the tests.

Claim 2 A Type II error has occurred in both tests.

Claim 3 A Type II error has occurred in at least one of the tests.

For **each** of the three claims, state whether it is:

A definitely true;

B possibly true;

C definitely not true.

Explain your answers. *(6 marks)*

END OF QUESTIONS

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