General Certificate of Education
January 2005
Advanced Subsidiary Examination

MATHEMATICS AND STATISTICS   MBS1
(SPECIFICATION B)
Unit Statistics 1

Wednesday 12 January 2005   Afternoon Session

In addition to this paper you will require:
- a 12-page answer book;
- two sheets of graph paper for use in Questions 3 and 7;
- a ruler;
- 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 MBS1.
- 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.

MBS1

Answer **all** questions.

1 Estimate, **without undertaking any calculation**, the value of the product moment correlation coefficient between the variables x and y in **each** of the scatter diagrams below.

(a)

(b)

(c)
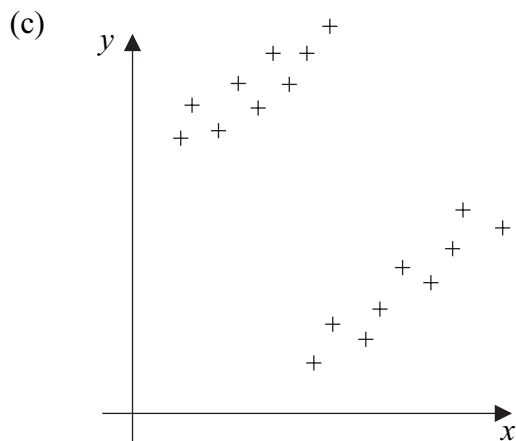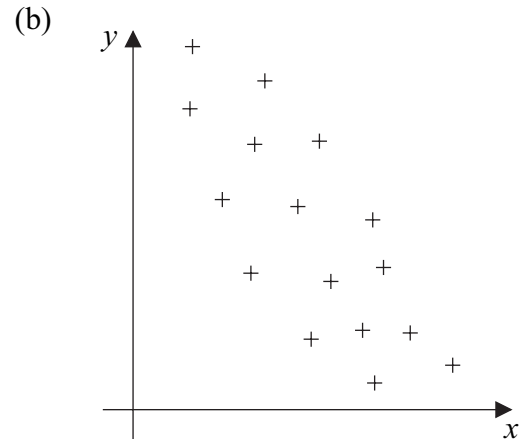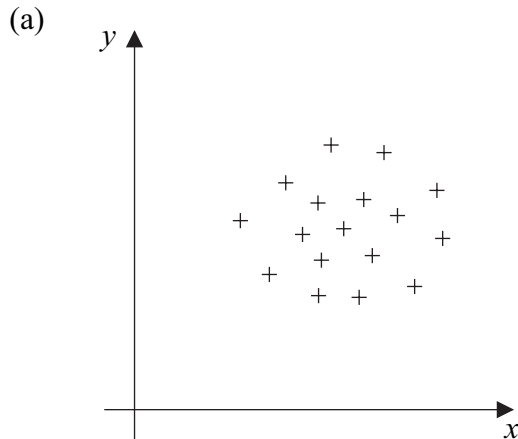
(5 marks)

2 At a petrol station the number of 'drive-outs' (motorists who obtain petrol and then drive away without paying) may be modelled by a Poisson distribution with mean 0.8 per day.

(a) Find the probability that, on a particular day, the number of 'drive-outs' is:

(i)   2 or fewer;

(ii) more than 1 but fewer than 3.   *(4 marks)*

(b) (i)   Evaluate the mean and the standard deviation of the number of 'drive-outs' during a 5-day period.   *(3 marks)*

(ii) Find the probability that there are fewer than 3 'drive-outs' during a 5-day period.
                                                                              (1 mark)

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

(a) The following table summarises the shell lengths of a sample of blue-rayed limpets collected from seaweed on a rocky shore.

Length (mm)	**Frequency**
4.00 –	9
5.00 –	14
6.00 –	20
8.00 –	15
10.00 –	11
12.00 – 16.00	11

   (i) Draw a cumulative frequency curve of the data. *(4 marks)*

   (ii) Hence, or otherwise, estimate the median and the interquartile range. *(3 marks)*

(b) The shells of a sample of blue-rayed limpets collected at a second site had a median length of 6.35 mm and an interquartile range of 3.88 mm. Compare the distributions of length for the two samples. *(2 marks)*

(c) Explain why the data given in this question may not provide a fair comparison of the shell lengths of blue-rayed limpets at the two sites. *(1 mark)*

TURN OVER FOR THE NEXT QUESTION

4 A school employs 75 teachers. The following table summarises their length of service at the school, classified by gender.

	Less than 3 years	3 years to 8 years	More than 8 years
Female	12	20	13
Male	8	15	7

(a) Find the probability that a randomly selected teacher:

  (i) is female;

  (ii) is female, given that the teacher has more than 8 years service;

  (iii) is female, given that the teacher has less than 3 years service. *(4 marks)*

(b) State, giving a reason, whether or not the event of selecting a female teacher is independent of the event of selecting a teacher with less than 3 years service. *(2 marks)*

(c) Define an event which is mutually exclusive to the event of selecting a female teacher. *(2 marks)*

(d) Three teachers are selected at random without replacement. Find the probability that all three are:

  (i) females with less than 3 years service;

  (ii) of the same gender. *(5 marks)*

5 A chemist sells two types of bath cube. One type is relaxing and the other type is invigorating. The owner of a small hotel buys 50 cubes from the chemist. For each cube there is independently a probability of 0.40 that it will be relaxing.

  (a) Find the probability that the 50 cubes will include:

   (i) 20 or fewer relaxing cubes; *(3 marks)*

   (ii) 20 or fewer invigorating cubes; *(3 marks)*

   (iii) more relaxing cubes than invigorating cubes. *(2 marks)*

  (b) The 50 cubes included 22 relaxing cubes. State, giving a reason, whether or not a binomial distribution will provide an appropriate model for the random variable, R, in **each** of the following cases.

   (i) A guest at the hotel randomly selects one of the 50 cubes. If it is not a relaxing cube, he replaces it and again selects a cube at random. He continues this procedure until he obtains a relaxing cube. The random variable R denotes the number of cubes he selects until he obtains a relaxing cube.

   (ii) The owner randomly selects 20 of the 50 cubes and places them in a bowl. The random variable R denotes the number of relaxing cubes placed in the bowl.
   (4 marks)

6 The distance, in kilometres, travelled to work by the employees of a city council may be modelled by a normal distribution with mean 7.5 and standard deviation 2.5.

  (a) Find the probability that the distance travelled to work by a randomly selected employee of the city council is:

   (i) less than 11.0 km; *(3 marks)*

   (ii) between 5.5 km and 10.5 km. *(4 marks)*

  (b) Find d such that 10% of the council's employees travel less than d kilometres to work.
   (4 marks)

  (c) Find the probability that the mean distance travelled to work by a random sample of 6 of the council's employees is less than 5.0 km. *(4 marks)*

  (d) **Without further calculation**, comment on the fact that the mean distance travelled to work by the 6 people employed to clean the council's offices is 4.4 km. *(2 marks)*

Turn over ▶

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

Carina obtains cash from an ATM (cash machine). She suspects that the rate at which she spends cash is affected by the amount of cash she withdrew at her previous visit to an ATM. To investigate this she deliberately varies the amounts she withdraws. She records, for each visit to an ATM, the amount, £x, withdrawn, and the number of hours, y, until her next visit to an ATM.

Withdrawal	1	2	3	4	5	6	7	8	9	10
x	40	10	100	110	120	150	20	90	80	130
y	56	62	195	330	94	270	48	196	214	286

(a) Draw a scatter diagram of the data. *(2 marks)*

(b) Calculate the equation of the regression line of y on x and draw it on your scatter diagram. *(6 marks)*

(c) (i) Carina made one withdrawal immediately before going on a weekend visit to Edinburgh. Identify the most likely withdrawal, giving a reason. *(2 marks)*

(ii) Following another withdrawal, Carina was confined to bed for several days with a heavy cold. Identify the most likely withdrawal, giving a reason. *(2 marks)*

(d) (i) Interpret, in context, the gradient of the regression line.

(ii) Comment on the evidence, if any, that Carina's rate of spending cash is affected by the amount she withdraws. *(3 marks)*

END OF QUESTIONS

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