General Certificate of Education
January 2008
Advanced Level Examination

STATISTICS   **SS04**
Unit Statistics 4

Tuesday 22 January 2008   1.30 pm to 3.00 pm

Time allowed: 1 hour 30 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 SS04.
- Answer **all** questions.
- Show all necessary working; 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 75.
- The marks for questions are shown in brackets.

Advice
- Unless stated otherwise, you may quote formulae, without proof, from the booklet.

SS04

Answer **all** questions.

1 Sunita grows daffodils and cuts some of them to arrange in vases. She always cuts daffodils when the buds are just showing colour. She has observed that her daffodils last an average of seven days until the petals begin to droop.

A friend tells Sunita that the flowers will last longer if she uses cold, weak tea in her vases. She cuts 12 daffodils and puts them into a vase containing cold, weak tea. For each flower, she records the time, x days, until its petals begin to droop, and calculates the following statistics:

$$\overline{x} = 7.5 \qquad s = 1.15$$

(a) Carry out a test, using the t-distribution and the 5% level of significance, to investigate whether, on average, cut daffodils put into cold, weak tea will last longer than seven days until their petals begin to droop. *(8 marks)*

(b) State two necessary assumptions for the test carried out in part (a) to be valid. *(2 marks)*

2 Andy runs a farm shop where he accepts payments from customers by cash or cheque. For each of a random sample of 90 customers, Andy records the method of payment and the time taken to deal with the payment.

(a) Of the 90 customers in the sample, 10 paid by cheque. Construct an approximate 99% confidence interval for the proportion of Andy's customers who pay by cheque.

(6 marks)

(b) The times, x seconds, taken to deal with the 10 cheque payments are listed below.

$$57 \quad 64 \quad 68 \quad 53 \quad 71 \quad 55 \quad 63 \quad 69 \quad 51 \quad 72$$

Assuming that times to deal with cheque payments are normally distributed, construct a 99% confidence interval for the mean time taken to deal with a cheque payment.

(7 marks)

(c) The times, y seconds, taken to deal with the 80 cash payments are summarised below.

$$\bar{y} = 16.6 \qquad s = 3.02$$

Construct a 99% confidence interval for the mean time taken to deal with a cash payment. *(3 marks)*

(d) Some of Andy's cash customers have complained that delays are caused by the time taken to deal with cheque payments. Andy considers changing to cash-only payments, but is concerned that he may lose custom from people who prefer to pay by cheque. He decides to make the change only if he is **very** confident that **both** the following conditions are satisfied:

A   The proportion of customers who currently pay by cheque is less than 25%;

B   The mean time taken to deal with a cheque payment is more than three times that taken to deal with a cash payment.

Advise Andy as to whether he should change to cash-only payments. You should refer to your answers to parts (a), (b) and (c) and to the confidence level used.   *(5 marks)*

Turn over for the next question

3 Sam owns a car ferry which operates during the tourist season between the mainland and an island. The ferry operates eight times a day in each direction. Records over several seasons show that the number of cars booked for a departure of the ferry from the mainland may be modelled by a Poisson distribution with mean 4.5.

Early in a new tourist season, the island is featured in a television programme. Sam carries out two surveys after the programme has been shown and obtains the following results:

Survey 1: On the first Monday after the programme was shown, the number of cars booked for the 10.00 am departure from the mainland was 9.

Survey 2: On the fifth Monday after the programme was shown, the total number of cars booked for the eight departures from the mainland was 43.

Sam examines the results and concludes that the television programme has caused an increase in demand for the ferry.

(a) Assuming that a Poisson model is still appropriate, carry out a hypothesis test, at the 5% significance level, to investigate whether the mean number of cars booked for a departure of the ferry from the mainland is greater than 4.5:

   (i)   using the result of Survey 1 and an exact probability distribution;   *(6 marks)*

   (ii) using the result of Survey 2 and a distributional approximation.   *(6 marks)*

(b) By considering your findings in part (a), comment on Sam's conclusion that the television programme has caused an increase in demand for the ferry.   *(2 marks)*

4 The medical staff at a health centre includes three doctors and one nurse. The duration of a consultation between a doctor and a patient is X minutes, where X may be modelled by a normal distribution with mean 7.7 and standard deviation 2.2. The duration of a consultation between the nurse and a patient is Y minutes, where Y may be modelled by a normal distribution with mean 4.1 and standard deviation 0.6. The durations of any two consultations are independent of each other.

Amy and Samir both attend the health centre one morning. Amy has a consultation with a doctor, immediately followed by a consultation with the nurse. Samir has a consultation with the nurse.

(a) Find the probability that the total duration of Amy's two consultations is less than 15 minutes. *(4 marks)*

(b) (i) Find the distribution of the variable $X - 2Y$.

  (ii) Find the probability that the duration of Amy's consultation with the doctor is more than twice that of her consultation with the nurse. *(6 marks)*

(c) Write down the probability that Amy's consultation with the nurse is of longer duration than Samir's. *(1 mark)*

(d) (i) Explain why the duration of the consultation between a doctor and a patient and the time taken by the doctor to update the patient's record after the consultation are unlikely to be independent variables. *(1 mark)*

  (ii) State, with a reason, whether or not the duration of the nurse's first consultation of the day and the time spent in the waiting room by the nurse's third patient of the day are likely to be independent variables. *(1 mark)*

Turn over for the next question

5 Applicants for a vocational training course are tested for colour blindness, and the proportion of applicants who fail this test is 3.8%. The random variable A denotes the number who fail the test out of a total of n applicants.

(a) (i) Specify fully a possible distribution for A. *(2 marks)*

(ii) State one assumption necessary for this distribution to be valid. *(1 mark)*

(b) (i) Use a distributional approximation to find the probability that exactly 5 out of 85 applicants fail the test for colour blindness. *(5 marks)*

(ii) Explain why the approximate distribution that you used in part (b)(i) is appropriate. *(2 marks)*

(c) From a random sample of 96 applicants offered places on one of these training courses, 67 accepted the place. Carry out a test, at the 5% significance level, to investigate whether the proportion of applicants who accept a place when it is offered is 75%.

(7 marks)

END OF QUESTIONS

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