AQA

General Certificate of Education
Advanced Level Examination
January 2011

Statistics   **SS04**

Unit Statistics 4

Wednesday 26 January 2011   1.30 pm to 3.00 pm

For this paper you must have:
• the blue AQA booklet of formulae and statistical tables.
You may use a graphics calculator.

Time allowed
• 1 hour 30 minutes

Instructions
• Use black ink or black ball-point pen. Pencil should only be used for drawing.
• Fill in the boxes at the top of this page.
• Answer **all** questions.
• Write the question part reference (eg (a), (b)(i) etc) in the left-hand margin.
• You must answer the questions in the spaces provided. Do not write outside the box around each page.
• Show all necessary working; otherwise marks for method may be lost.
• Do all rough work in this book. Cross through any work that you do not want to be marked.
• The **final** answer to questions requiring the use of tables or calculators should normally be given to three significant figures.

Information
• The marks for questions are shown in brackets.
• The maximum mark for this paper is 75.

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

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Answer **all** questions in the spaces provided.

1 A power company is investigating a site for a new wind farm. The company claims that more than half the residents of the surrounding area are in favour of the wind farm.

In an independent survey, a random sample of 250 residents is interviewed and 114 of them say that they are in favour of the wind farm.

(a) Construct an approximate 90% confidence interval for the proportion of residents who are in favour of the wind farm.
(5 marks)

(b) Use your confidence interval to comment on the claim made by the company.
(2 marks)

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2 A species of rodent is found in mainland locations and on a remote island.

(a) The weights, x grams, of a random sample of 10 adult males of this species found on the island are recorded as follows.

20.4 23.4 22.7 25.9 20.3 25.0 19.7 23.2 22.4 21.5

Construct a 95% confidence interval for the mean weight of adult males of this species of rodent in the island location. Assume that weights are normally distributed. *(6 marks)*

(b) The weights, y grams, of a random sample of 55 adult males of this species found on the mainland are summarised as follows.

$$\bar{y} = 18.27 \qquad s = 1.638$$

Construct a 95% confidence interval for the mean weight of adult males of this species of rodent in mainland locations. *(3 marks)*

(c) Olivia, a zoology student, states that animals living on remote islands are always heavier, on average, than those of the same species living in mainland locations.

Use your confidence intervals to comment on her statement. *(3 marks)*

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3 A newspaper article claimed that fewer than 30 per cent of cyclists stop at zebra crossings when a pedestrian is waiting to use the crossing.

Sabrina collects data at several zebra crossings. She records 20 occasions at random when a cyclist approaches a crossing whilst a pedestrian is waiting to use it. On 4 of these occasions, the cyclist stops.

(a) Carry out a hypothesis test to investigate the claim made in the newspaper article. Use an exact binomial distribution and the 10% significance level. *(6 marks)*

(b) Give one reason why a binomial distribution may not be an appropriate model in this situation. *(1 mark)*

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4 Rory keeps a flock of a rare breed of sheep. Each year, he shears the sheep using hand shears. He advertises the woollen-wear that he produces as

'*Made from the fleeces of our own sheep. We use only traditional hand shears.*'

Rory takes a mean time of 13.5 minutes to shear a sheep. The mean weight of fleece that he obtains is 1.85 kg.

Rory's daughter, Davina, advises him to change to using electric shears as this would increase the weight of fleece obtained and save time. Rory has training and practice at using electric shears, which are powered from the battery of a vehicle. He then shears 8 of his own sheep and records, for each sheep, the weight, x kg, of fleece obtained and the shearing time, y minutes. His results may be summarised as

$$\bar{x} = 1.915 \qquad s_X = 0.182$$
$$\bar{y} = 12.090 \qquad s_Y = 1.240$$

Both sets of data may be treated as random samples from normal populations.

(a) Carry out a hypothesis test, using the 10% significance level, to investigate whether the mean weight of fleece obtained using electric shears is greater than 1.85 kg.

(6 marks)

(b) Carry out a hypothesis test, using the 1% significance level, to investigate whether the mean shearing time using electric shears is less than 13.5 minutes. *(4 marks)*

(c) (i) Use the results of your hypothesis tests to comment on Davina's advice. *(2 marks)*

(ii) Suggest **two** factors, other than weight of fleece and shearing time, that Rory should consider when deciding whether or not to change to using electric shears. *(2 marks)*

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5   A charity recruits large numbers of volunteers.

  (a)   Past experience suggests that 62 per cent of people who apply to be volunteers complete the induction process.

   (i)   Assuming that any necessary conditions are satisfied, specify the binomial distribution that might be used to model the number of people who complete the induction process out of 85 applicants.   *(1 mark)*

   (ii)   In a 3-month period, 85 people apply to be volunteers.

Use a distributional approximation to find the probability that more than 50 of them complete the induction process.   *(5 marks)*

  (b)   Records over several years show that the number of applications per week from people wanting to become volunteers may be modelled by a Poisson distribution with mean 7.

Mervin, the volunteer coordinator, believes that there has recently been a decrease in the mean number of applications per week.

   (i)   During the following week, there are 3 applications from people wanting to become volunteers.

Carry out a hypothesis test to show that there is evidence to support Mervin's belief. Use the 10% significance level and an exact Poisson distribution.   *(4 marks)*

   (ii)   Mervin suggests that recruitment advertisements should be placed in local newspapers. Carmen, the finance manager, says that the evidence for a decrease in the mean number of applications is not convincing. She requires **very** strong evidence of a decrease, based on a period of 6 weeks, before she will authorise the advertisements.

During the next 6 weeks, there are 33 applications from people wanting to become volunteers.

Carry out a hypothesis test to determine whether or not Carmen should authorise the advertisements. Use a distributional approximation and an appropriate significance level.   *(8 marks)*

   (iii)   Explain, in the context of this question, the meaning of a Type I error.   *(2 marks)*

   (iv)   Justify, in context, your choice of significance level in part **(b)(ii)**.   *(2 marks)*

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6 Manesh works in a café where he serves coffee by pouring it from a coffee pot into mugs of a standard size. The volume of coffee that he pours into a mug is X litres, where X is normally distributed with mean 0.25 and standard deviation 0.02.

The volumes of coffee that Manesh pours into separate mugs are independent of each other.

The total volume of coffee used when Manesh pours coffee into 2 mugs is T_2 litres. The total volume of coffee used when Manesh pours coffee into 5 mugs is T_5 litres.

(a) (i) Find the mean of T_2. *(1 mark)*

(ii) Show that the variance of T_2 is 0.0008. *(1 mark)*

(iii) Find the distribution of T_5. *(2 marks)*

(b) The volume of coffee in a freshly made pot is Y litres, where Y is normally distributed with mean 2.4 and standard deviation 0.15.

Manesh pours coffee from a freshly made pot into 5 mugs.

(i) Find the probability that the total volume of coffee used is less than 1.2 litres. *(2 marks)*

(ii) By obtaining the distribution of the variable $T_5 - \frac{1}{2}Y$, find the probability that Manesh uses less than half of the coffee in the pot. *(7 marks)*

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