General Certificate of Education
January 2009
Advanced Level Examination

AQA⟋

STATISTICS **SS04**
Unit Statistics 4

Wednesday 21 January 2009   1.30 pm to 3.00 pm

For this paper you must have:
- an 8-page answer book
- 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.
- 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 The number of complaints received by a restaurant about the quality of service follows a Poisson distribution.

Over recent months, the mean number of complaints had been 2.2 per day. As a result, the restaurant manager organised a training session for all serving staff. During a five-day period after this training session, a total of 7 complaints were received about the quality of service.

Carry out a hypothesis test to investigate whether there has been a reduction in the mean number of complaints per day. Use an exact Poisson distribution and the 10% significance level. *(6 marks)*

2 *Question: What is red and four metres high with wheels on top?*
Answer: A sleeping bus.

(a) In a random sample of 55 eight-year-old children, 36 thought that the above joke was funny.

In a random sample of 60 eleven-year-old children, 32 thought that the joke was funny.

Construct an approximate 95% confidence interval for:

(i) the proportion of eight-year-old children who think that the joke is funny;

(ii) the proportion of eleven-year-old children who think that the joke is funny. *(7 marks)*

(b) Use the confidence intervals that you found in part (a) to comment on **each** of the following statements:

(i) a majority of eight-year-old children think that the joke is funny; *(2 marks)*

(ii) eight-year-old children are more likely to think that the joke is funny than eleven-year-old children. *(2 marks)*

3 Roadworks on a dual carriageway require the closure of one lane so that all traffic must travel along the other lane, with a 50 mph speed limit. Queues develop on the approach to the roadworks section. A survey shows that the mean queuing time for vehicles from joining the queue to reaching the start of the roadworks section is 17 minutes.

In an attempt to reduce the mean queuing time, the speed limit on the roadworks section is changed to 30 mph. Another survey is now conducted. The queuing times, x minutes, recorded for a random sample of 14 vehicles may be summarised as

$$\bar{x} = 13.2 \qquad s = 2.4$$

(a) (i) Carry out a hypothesis test, at the 1% significance level, to investigate whether the mean queuing time is now less than **15 minutes**. Assume that queuing times are normally distributed. *(7 marks)*

(ii) Comment on the claim that the mean queuing time for vehicles has been reduced by more than 10 per cent following the change in the speed limit from 50 mph to 30 mph. *(2 marks)*

(b) State, with a reason, whether or not it can be claimed that the total time taken by a vehicle, from joining the queue to reaching the **end** of the roadworks section, has been reduced following the change in the speed limit. *(2 marks)*

4 Every morning, Duncan bakes 30 scones to sell in his café. If any scones are unsold at the end of the day, Duncan throws them away.

The number of scones requested during a day may be modelled by a Poisson distribution with mean 27.

(a) Use a distributional approximation to find the probability that no more than 20 scones are requested during a particular day. *(5 marks)*

(b) Estimate the probability that Duncan does not have enough scones to satisfy all the requests on a particular day. *(3 marks)*

(c) Explain why a Poisson distribution is **not** an appropriate model for the number of scones **sold** during a day in Duncan's café. *(2 marks)*

Turn over ▶

5 Hitesh is investigating estimation skills among students. For one experiment, he chooses a random sample of 11 students and gives each of them a one-metre length of string. The students must cut the string into two pieces, aiming for lengths of 75 cm and 25 cm, judging by eye where to make the cut.

The lengths, in centimetres, of the longer pieces of string cut by the students are

$$71.8 \quad 73.1 \quad 75.1 \quad 74.9 \quad 73.8 \quad 71.7 \quad 74.8 \quad 71.4 \quad 79.4 \quad 73.0 \quad 77.9$$

(a) Assuming that these data are from a normal population with mean μ_L, construct a 98% confidence interval for μ_L. *(6 marks)*

(b) The mean of the distribution of the shorter lengths of string cut by students is denoted by μ_S. Deduce a 98% confidence interval for μ_S. Justify your answer. *(2 marks)*

(c) Before conducting the experiment, Hitesh made two predictions.

Prediction 1: All students will be accurate to within 2.5 cm in judging where to cut the string.

Prediction 2: On average, the length of the longer piece of string cut by students will exceed 74 cm.

Comment on **each** of these predictions. *(4 marks)*

6 Selina runs a country store which has two pumps for selling fuel to motorists.

The amount of petrol she sells in a day is X litres, where X is normally distributed with mean 550 and standard deviation 72.

The amount of diesel she sells in a day is Y litres, where Y is normally distributed with mean 305 and standard deviation 36.

Assume that X and Y are independent.

(a) Find the probability that, on a particular day, the **total** amount of fuel that Selina sells is less than 1000 litres. *(4 marks)*

(b) (i) Find the mean and variance of the variable $X - 2Y$. *(3 marks)*

(ii) Hence find the probability that, on a particular day, Selina sells more than twice as much petrol as diesel. *(4 marks)*

7 The management team of a chocolate company is considering changing the recipe for the powder that it produces for making hot chocolate drinks. The team agrees to conduct a two-stage trial to investigate whether there is a clear preference for the new recipe. If the preliminary trial indicates that more than 50 per cent of customers prefer the new recipe, the main trial will take place.

(a) In the preliminary trial, the company statistician invites customers in the factory cafeteria to sample hot chocolate drinks made with powder from each of the two recipes. Each customer is asked to state which drink they prefer.

From a random sample of 30 customers, 21 prefer the new recipe. Carry out a hypothesis test to show that there is enough evidence for the main trial to take place. Use an exact probability distribution and the 5% significance level. *(5 marks)*

(b) In the main trial, tasting sessions are arranged in the cafeterias of 10 supermarkets in different parts of the country. The company statistician visits each cafeteria to organise the sessions. If results indicate that more than 60 per cent of all customers prefer the new recipe, the management team will adopt it as the company's standard product.

From a total random sample of 320 customers, 208 prefer the new recipe. Carry out a hypothesis test to investigate whether the new recipe should be adopted. Use a distributional approximation and the 5% significance level. *(7 marks)*

(c) Suggest a reason why the management team used a two-stage trial rather than just carrying out the main trial described in part (b). *(2 marks)*

END OF QUESTIONS

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