# GCE Examinations

# Statistics
# Module S3

Advanced Subsidiary / Advanced Level

Paper C

Time: 1 hour 30 minutes

*Instructions and Information*

Candidates may use any calculator except those with a facility for symbolic algebra and / or calculus.

Full marks may be obtained for answers to ALL questions.

Mathematical and statistical formulae and tables are available.

This paper has 8 questions.

*Advice to Candidates*

You must show sufficient working to make your methods clear to an examiner. Answers without working will gain no credit.

*Written by Shaun Armstrong & Chris Huffer*

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**1.** A researcher wishes to take a sample of size 9, without replacement, from a list of 72 people involved in the trial of a new computer keyboard. She numbers the people from 01 to 72 and uses the table of random numbers given in the formula book. She starts with the left-hand side of the sixth row of the table and works across the row. The first two numbers she writes down are 56 and 32.

*(a)* Find the other six numbers in the sample. **(3 marks)**

*(b)* Give one advantage and one disadvantage of using random numbers when taking a sample.

**(2 marks)**

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**2.** The length of time that registered customers spend on each visit to a supermarket's website is normally distributed with a mean of 28.5 minutes and a standard deviation of 7.2 minutes.

Eight visitors to the site are selected at random and the length of time, $T$ minutes, that each stays is recorded.

*(a)* Write down the distribution of $\overline{T}$, the mean time spent at the site by these eight visitors.

**(2 marks)**

*(b)* Find $P(25 < \overline{T} < 30)$. **(4 marks)**

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**3.** The discrete random variable $X$ has the probability distribution given below.

| $x$ | 2 | 4 | 7 | $k$ |
|---|---|---|---|---|
| $P(X = x)$ | 0.05 | 0.15 | 0.3 | 0.5 |

*(a)* Find the mean of $X$ in terms of $k$. **(2 marks)**

*(b)* Find the bias in using $(2\overline{X} - 5)$ as an estimator of $k$. **(3 marks)**

Fifty observations of $X$ were made giving a sample mean of 8.34 correct to 3 significant figures.

*(c)* Calculate an unbiased estimate of $k$. **(2 marks)**

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**4.** The mass of waste in filled large dustbin bags is normally distributed with a mean of 6.8 kg and a standard deviation of 1.5 kg. The mass of waste in filled small dustbin bags is normally distributed with a mean of 3.2 kg and a standard deviation of 0.6 kg.

One week there are 8 large and 3 small dustbin bags left for collection outside a block of flats. Find the probability that this waste has a total mass of more than 70 kg.

**(7 marks)**

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**5.** For a project, a student is investigating whether more athletic individuals have better hand-eye coordination. He records the time it takes a number of students to complete a task testing coordination skills and notes whether or not they play for a school sports team. His results are as follows:

| | Number of Students | Mean | Standard Deviation |
|---|---|---|---|
| In a School Team | 50 | 32.8 s | 4.6 s |
| Not in a Team | 190 | 35.1 s | 8.0 s |

Stating your hypotheses clearly, test at the 5% level of significance whether or not there is evidence that those who play in a school team complete the task more quickly on average.

**(8 marks)**

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**6.** Two schools in the same town advertise at the same time for new heads of English and History departments. The number of applicants for each post are shown in the table below.

| | English | History |
|---|---|---|
| *Highfield School* | 32 | 14 |
| *Rowntree School* | 48 | 26 |

Stating your hypotheses clearly, test at the 10% level of significance whether or not there is evidence of the proportion of applicants for each job being different in the two schools.

**(11 marks)**

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***Turn over***

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**7.** A sports scientist wishes to examine the link between resting pulse and fitness. He records the resting pulse, $p$, of 20 volunteers and the length of time, $t$ minutes, that each one can run comfortably at 4 metres per second on a treadmill. The results are summarised by

$$\Sigma p = 1176, \quad \Sigma t = 511, \quad \Sigma p^2 = 70\,932, \quad \Sigma t^2 = 19\,213, \quad \Sigma pt = 27\,188.$$

*(a)* Calculate the product moment correlation coefficient for these data. **(5 marks)**

*(b)* Stating your hypotheses clearly, test at the 1% level of significance whether there is evidence of people with a lower resting pulse having a higher level of fitness as measured by the test.

**(4 marks)**

*(c)* State an assumption necessary to carry out the test in part *(b)* and comment on its validity in this case.

**(2 marks)**

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**8.** A physicist believes that the number of particles emitted by a radioactive source with a long half-life can be modelled by a Poisson distribution. She records the number of particles emitted in 80 successive 5-minute periods and her results are shown in the table below.

| No. of Particles | 0 | 1 | 2 | 3 | 4 | 5 or more |
|---|---|---|---|---|---|---|
| No. of Intervals | 23 | 32 | 14 | 8 | 3 | 0 |

*(a)* Comment on the suitability of a Poisson distribution for this situation. **(3 marks)**

*(b)* Show that an unbiased estimate of the mean number of particles emitted in a 5-minute period is 1.2 and find an unbiased estimate of the variance.

**(5 marks)**

*(c)* Explain how your answers to part *(b)* support the fitting of a Poisson distribution.

**(1 mark)**

*(d)* Stating your hypotheses clearly and using a 5% level of significance, test whether or not these data can be modelled by a Poisson distribution.

**(11 marks)**

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**END**

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