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Pearson
Edexcel GCE

Centre Number

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Candidate Number

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Statistics S4

Advanced/Advanced Subsidiary

Tuesday 26 June 2018 – Morning
Time: 1 hour 30 minutes

Paper Reference
6686/01

You must have:
Mathematical Formulae and Statistical Tables (Pink)

Total Marks

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B). Coloured pencils and highlighter pens must not be used.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Values from the statistical tables should be quoted in full. When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information

- The total mark for this paper is 75.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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4. A glue supplier claims that *Goglue* is stronger than *Tackfast*. A company is presently using *Tackfast* but agrees to change to *Goglue* if, at the 5% significance level,

- the standard deviation of the force required for *Goglue* to fail is not greater than the standard deviation of the force required for *Tackfast* to fail and
- the mean force required for *Goglue* to fail is more than 4 newtons greater than the mean force for *Tackfast* to fail.

A series of trials is carried out, using *Goglue* and *Tackfast*, and the glues are tested to destruction. The force, x newtons, at which each glue fails is recorded.

| | Sample size (n) | Sample mean (\bar{x}) | Standard deviation (s) |
|-------------------------|---------------------|---------------------------|----------------------------|
| <i>Tackfast</i> (T) | 6 | 5.27 | 0.31 |
| <i>Goglue</i> (G) | 5 | 10.12 | 0.66 |

It can be assumed that the force at which each glue fails is normally distributed.

- (a) Test, at the 5% level of significance, whether or not there is evidence that the standard deviation of the force required for *Goglue* to fail is greater than the standard deviation of the force required for the *Tackfast* to fail. State your hypotheses clearly. (5)

The supplier claims that the mean force required for its *Goglue* to fail is more than 4 newtons greater than the mean force required for *Tackfast* to fail.

- (b) Stating your hypotheses clearly and using a 5% level of significance, test the supplier's claim. (7)
- (c) Show that, at the 5% level of significance, the supplier's claim will be accepted if $\bar{X}_G - \bar{X}_T > 4.55$, where \bar{X}_G and \bar{X}_T are the mean forces required for *Goglue* to fail and *Tackfast* to fail respectively. (2)

Later, it was found that an error had been made when recording the results for *Goglue*. This resulted in all the forces recorded for *Goglue* being 0.5 newtons more than they should have been. The results for *Tackfast* were correct.

- (d) Explain whether or not this information affects the decision about which glue the supplier decides to use. (3)

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6. The continuous random variable X has probability density function $f(x)$

$$f(x) = \begin{cases} \frac{x}{2\theta^2} & 0 \leq x \leq 2\theta \\ 0 & \text{otherwise} \end{cases}$$

where θ is a constant.

(a) Use integration to show that $E(X^N) = \frac{2^{N+1}}{N+2}\theta^N$ (3)

(b) Hence

(i) write down an expression for $E(X)$ in terms of θ

(ii) find $\text{Var}(X)$ in terms of θ (3)

A random sample X_1, X_2, \dots, X_n where $n \geq 2$ is taken to estimate the value of θ

The random variable $S_1 = q\bar{X}$ is an unbiased estimator of θ

(c) Write down the value of q and show that S_1 is a consistent estimator of θ (3)

The continuous random variable Y is independent of X and is uniformly distributed over the interval $[0, \frac{2\theta}{3}]$, where θ is the same unknown constant as in $f(x)$.

The random variable $S_2 = aX + bY$ is an unbiased estimator of θ and is based on one observation of X and one observation of Y .

(d) Find the value of a and the value of b for which S_2 has minimum variance. (7)

(e) Show that the minimum variance of S_2 is $\frac{\theta^2}{11}$ (1)

(f) Explain which of S_1 or S_2 is the better estimator for θ (2)

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