Centre No.						Paper Reference	Surname	Initial(s)
Candidate No.						6 6 8 6 / 0 1 R	Signature	

Paper Reference(s)

6686/01R

Edexcel GCE

Statistics S4

Advanced/Advanced Subsidiary

Friday 21 June 2013 – Morning

Time: 1 hour 30 minutes

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
7	
8	
Total	

Materials required for examination	**Items included with question papers**
Mathematical Formulae (Pink)	Nil

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 or symbolic differentiation/integration, or have retrievable mathematical formulae stored in them.

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initials and signature.
Check that you have the correct question paper.
Answer ALL the questions.
You must write your answer to each question in the space following the question.
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 for Candidates

A booklet 'Mathematical Formulae and Statistical Tables' is provided.
Full marks may be obtained for answers to ALL questions.
The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
There are 8 questions in this question paper. The total mark for this paper is 75.
There are 24 pages in this question paper. Any blank pages are indicated.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You should show sufficient working to make your methods clear to the Examiner.
Answers without working may not gain full credit.

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P 4 2 9 6 0 A 0 1 2 4

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PEARSON

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1. (a) Find the value of the constant a such that

$$P(1.690 < \chi^2_7 < a) = 0.95$$

(2)

The random variable Y follows an F-distribution with 6 and 4 degrees of freedom.

(b) (i) Find the upper 1% critical value for Y.

(ii) Find the lower 1% critical value for Y.

(2)

Q1

(Total 4 marks)

Leave blank

2. The time, t hours, that a typist can sit before incurring back pain is modelled by $N(\mu, \sigma^2)$. A random sample of 30 typists gave unbiased estimates for μ and σ^2 as shown below.

$$\hat{\mu} = 2.5 \quad s^2 = 0.36$$

(a) Find a 95% confidence interval for σ^2

(5)

(b) State with a reason whether or not the confidence interval supports the assertion that $\sigma^2 = 0.495$

(2)

Q2

(Total 7 marks)

Leave blank

3. The number of houses sold per week by a firm of estate agents follows a Poisson distribution with mean 2. The firm believes that the appointment of a new salesman will increase the number of houses sold. The firm tests its belief by recording the number of houses sold, x, in the week following the appointment. The firm sets up the hypotheses $H_0 : \lambda = 2$ and $H_1 : \lambda > 2$, where λ is the mean number of houses sold per week, and rejects the null hypothesis if $x \geqslant 3$

(a) Find the size of the test.

(2)

(b) Show that the power function for this test is

$$1 - \frac{1}{2}e^{-\lambda}(2 + 2\lambda + \lambda^2)$$

(3)

The table below gives the values of the power function to 2 decimal places.

λ	2.5	3.0	3.5	4.0	5.0	7.0
Power	0.46	r	0.68	s	0.88	0.97

Table 1

(c) Calculate the values of r and s.

(2)

(d) Draw a graph of the power function on the graph paper provided on page 6

(2)

(e) Find the range of values of λ for which the power of this test is greater than 0.6

(1)

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Question 3 continued

Turn over

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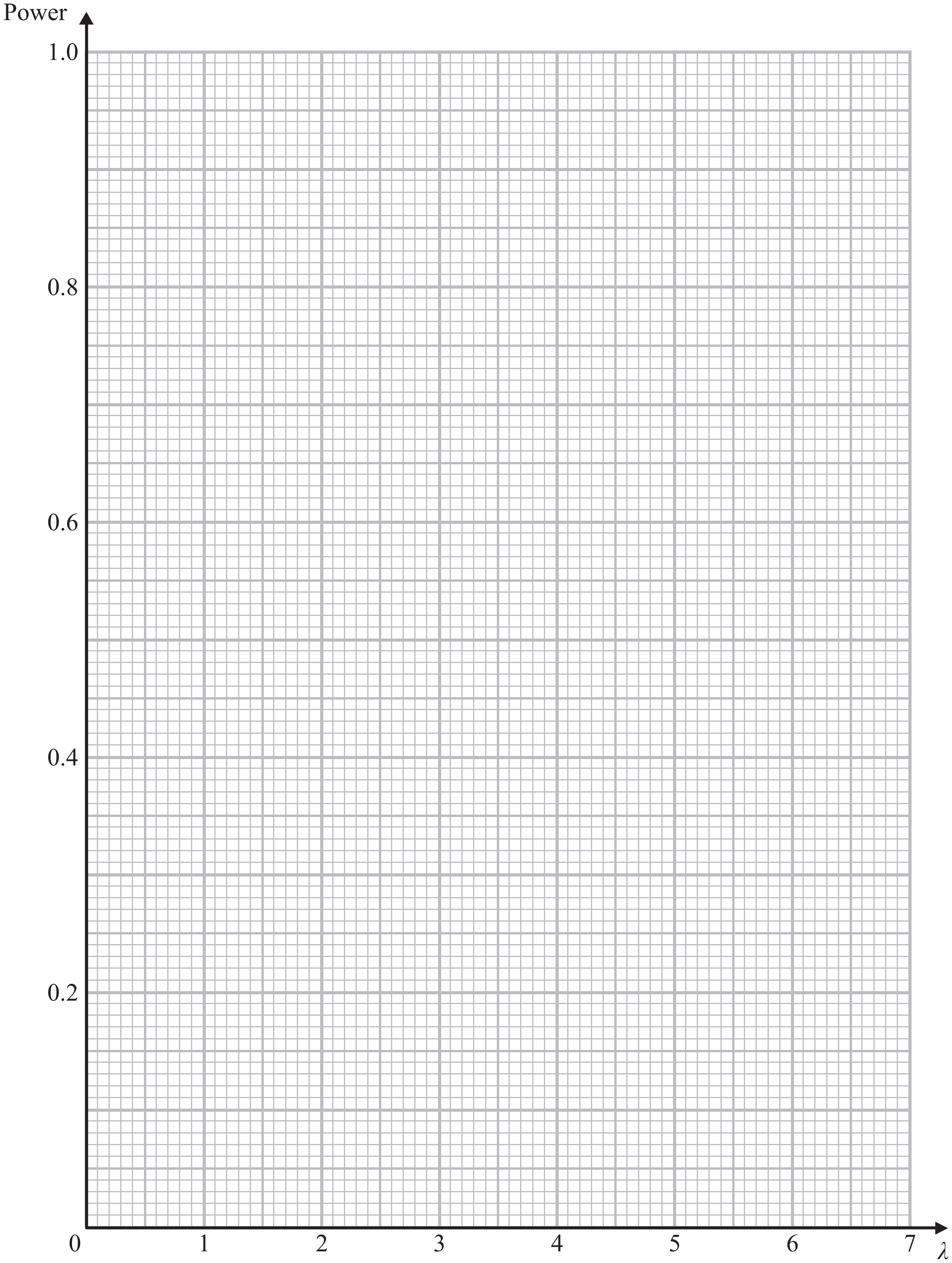
Question 3 continued

For your convenience Table 1 is repeated here.

λ	2.5	3.0	3.5	4.0	5.0	7.0
Power	0.46	r	0.68	s	0.88	0.97

Table 1



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Question 3 continued

Q3

(Total 10 marks)

P 4 2 9 6 0 A 0 7 2 4

Turn over

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4. A company carries out an investigation into the strengths of rods from two different suppliers, Ardo and Bards. Independent random samples of rods were taken from each supplier and the force, x kN, needed to break each rod was recorded. The company wrote the results on a piece of paper but unfortunately spilt ink on it so some of the results can not be seen.
The paper with the results on is shown below.

Ardo: 13.1 13.6 13.2 13.8 12.8 13.5 13.8

Bards: 15.3 15.5 14.1 15.4 14.2 15.4

Ardo $n_A = 7$ $\bar{x}_A = 13.4$ s

Bards $n_B = 9$ $\bar{x}_B = 14.8$ s

Pooled estimate of variance = 0.261

(a) (i) Use the data from Ardo to calculate an unbiased estimate, s_A^2, of the variance.

(ii) Hence find an unbiased estimate, s_B^2, of the variance for the sample of 9 values from Bards.

(4)

(b) Stating your hypotheses clearly, test at the 10% level of significance whether or not there is a difference in variability of strength between the rods from Ardo and the rods from Bards.
(You may assume the two samples come from independent normal distributions.)

(5)

(c) Use a 5% level of significance to test whether the mean strength of rods from Bards is more than 0.9 kN greater than the mean strength of rods from Ardo.

(6)

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Question 4 continued

Turn over

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Question 4 continued

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Question 4 continued

Q4

(Total 15 marks)

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5. Students studying for their Mathematics GCSE are assessed by two examination papers. A teacher believes that on average the score on paper I is more than 1 mark higher than the score on paper II. To test this belief the scores of 8 randomly selected students are recorded. The results are given in the table below.

Student	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*
Score on paper I	57	63	68	81	43	65	52	31
Score on paper II	53	62	61	78	44	64	43	29

Assuming that the scores are normally distributed and stating your hypotheses clearly, test at the 5% level of significance whether or not there is evidence to support the teacher's belief.

(8)

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Question 5 continued

Q5

(Total 8 marks)

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6. A machine fills bottles with water. The amount of water in each bottle is normally distributed. To check the machine is working properly, a random sample of 12 bottles is selected and the amount of water, in ml, in each bottle is recorded. Unbiased estimates for the mean and variance are

$$\hat{\mu} = 502 \qquad s^2 = 5.6$$

Stating your hypotheses clearly, test at the 1% level of significance

(a) whether or not the mean amount of water in a bottle is more than 500 ml,

(5)

(b) whether or not the standard deviation of the amount of water in a bottle is less than 3 ml.

(5)

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Question 6 continued

Q6

(Total 10 marks)

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7. A machine produces bricks. The lengths, x mm, of the bricks are distributed $N(\mu, 2^2)$. At the start of each week a random sample of n bricks is taken to check the machine is working correctly.
A test is then carried out at the 1% level of significance with

$$H_0 : \mu = 202 \text{ and } H_1 : \mu < 202$$

(a) Find, in terms of n, the critical region of the test.

(3)

The probability of a type II error, when $\mu = 200$, is less than 0.05

(b) Find the minimum value of n.

(6)

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Question 7 continued

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Question 7 continued

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Question 7 continued

Q7

(Total 9 marks)

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8. A random sample $W_1, W_2 \ldots, W_n$ is taken from a distribution with mean μ and variance σ^2

(a) Write down $\mathrm{E}\left(\sum_{i=1}^{n} W_i\right)$ and show that $\mathrm{E}\left(\sum_{i=1}^{n} W_i^2\right) = n(\sigma^2 + \mu^2)$

(4)

An estimator for μ is

$$\bar{X} = \frac{1}{n}\sum_{i=1}^{n} W_i$$

(b) Show that $\bar{X}$ is a consistent estimator for μ.

(3)

An estimator of σ^2 is

$$U = \frac{1}{n}\sum_{i=1}^{n} W_i^2 - \left(\frac{1}{n}\sum_{i=1}^{n} W_i\right)^2$$

(c) Find the bias of U.

(4)

(d) Write down an unbiased estimator of σ^2 in the form kU, where k is in terms of n.

(1)

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Question 8 continued

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Question 8 continued

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Question 8 continued

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Question 8 continued

Q8

(Total 12 marks)

TOTAL FOR PAPER: 75 MARKS

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