Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Thursday 18 June 2020

Afternoon (Time: 2 hours) | Paper Reference **9ST0/02**

Statistics

Advanced

Paper 2: Statistical Inference

You must have:
Statistical formulae and tables booklet
Calculator

Total Marks

Candidates may use any calculator permitted by Pearson regulations.
Calculators must not 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).
- **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.
- Unless otherwise stated, inexact answers should be given to three significant figures.
- Unless otherwise stated, statistical tests should be carried out at the 5% significance level.

Information

- A booklet 'Statistical formulae and tables' is provided.
- There are 7 questions in this question paper. The total mark for this paper is 80.
- 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.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

Turn over ▶

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Pearson

Answer ALL questions. Write your answers in the spaces provided.

1 The weights at 3 months of age, in kg, of baby girls born in the UK are modelled by the normal distribution $N(5.8, 0.74^2)$.

Rose has recently looked up the weights of a sample of 14 baby girls weighed at 3 months of age in her clinic. The mean weight of the baby girls in her sample is 6.3 kg.

(a) Calculate a 95% confidence interval for the mean weight at 3 months of age of baby girls in Rose's clinic.

(3)

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Question 1 continued

(b) Explain whether your answer to part (a) provides significant evidence that the mean weight of baby girls at 3 months of age in Rose's clinic is different from 5.8 kg.

(2)

(c) State **two** assumptions needed for the confidence interval you calculated in part (a) to be valid.

(2)

(Total for Question 1 is 7 marks)

2 A survey investigated whether shoppers prefer to buy cucumbers wrapped in plastic or unwrapped. Of these shoppers, 75% preferred to buy unwrapped cucumbers.

Julia had expected the percentage preferring to buy unwrapped cucumbers to be higher and decided to do a survey of her gardening club. Julia took a random sample of 45 gardeners and found that 36 of them preferred to buy unwrapped cucumbers.

Investigate whether the percentage of gardeners preferring to buy unwrapped cucumbers is higher than 75%.

Make any necessary assumptions.

(7)

(Total for Question 2 is 7 marks)

3 Simon, an educational researcher, wanted to test the effectiveness of a computer program designed to improve the numerical skills of children in Key Stage 1 (KS1).

Simon recorded the marks in two similar numerical tests taken by a random selection of KS1 children. One test was taken before and one was taken after the children used the computer program. For each child, he calculated the value of

test mark after – test mark before

Simon used his calculator to conduct a paired *t*-test. The calculator output is shown in **Figure 1**.

```
1 - Sample tTest

μ       > 0
t       = 2.619047619
p       = 0.007520838
x̄       = 5.5
Sx      = 10.5
n       = 25
```

Figure 1

(a) Use the information given in the calculator output in **Figure 1** to investigate whether there is evidence that children did **better** in the test of numerical skills, on average, after using the computer program.

(4)

Question 3 continued

(b) Explain the meaning of a Type I error in a hypothesis test.

Write down the probability of a Type I error in Simon's test in part (a).

(2)

(c) Make **one** comment on the reliability of your conclusion to Simon's test in part (a).

(1)

(Total for Question 3 is 7 marks)

4 Professional tennis players' prize money is published online.

Martina wanted to do an analysis by nationality of top players (those who earned at least $1 million). She randomly selected a year since 2000 and obtained the data for that year to use in her investigation.

She then aggregated the results for men and women by region of the world, as shown in **Figure 2**.

		Men	**Women**
Region of the world	Australia and South Africa	4	1
	Eastern Europe	11	19
	Far East	2	3
	South America	3	0
	USA and Canada	8	5
	Western Europe	29	10
	Total	**57**	**38**

(Data source: Association of Tennis Professionals and the Women's Tennis Association)

Figure 2

Martina decides to test the hypothesis that, among top players, there is no association between region of the world and sex of player.

Martina combines Australia and South Africa, Far East and South America into a single class called Other Regions of the World.

(a) Explain why Martina needs to combine regions to carry out her test.

You must give numeric justifications.

(3)

Question 4 continued

(b) Complete Martina's hypothesis test.

(9)

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Question 4 continued

(c) Describe, with numerical justification, the nature of any association found between region of the world and sex of player in your conclusion to the test in part (b).

(2)

(Total for Question 4 is 14 marks)

5 GCSE performance at schools in England can be compared using Progress 8. A higher score in Progress 8 means a better performance.

South West London schools are believed to have 'well above average' scores in Progress 8.

Provisional scores for summer 2018 for a random sample of 10 state schools in South West London are given in **Figure 3**, together with the average for all English state schools.

State Schools in South West London	**Progress 8 scores Summer 2018**
A	1.19
B	1.09
C	0.98
D	0.73
E	0.63
F	0.28
G	0.24
H	0.23
I	−0.07
J	−0.09
Average for all English state schools	**−0.02**

(Source: © Crown Copyright)

Figure 3

Davinder has tested a hypothesis. The first two lines of his working are given in **Figure 4.**

$X \sim B(10, 0.5)$

$P(X \leq 2) = 0.0547$

Figure 4

Question 5 continued

(a) Name Davinder's hypothesis test.

State his hypotheses.

Justify why his value for P ($X \leqslant 2$) does not provide sufficient evidence that the average performance of schools in South West London is **better** than the average for all English state schools.

(3)

Davinder wants to use a Wilcoxon signed-rank test to investigate whether the average performance of schools in South West London is **better** than the average for all English state schools.

(b) Using the data given in **Figure 3** and making any necessary assumptions, conduct the Wilcoxon signed-rank test for Davinder.

What can he conclude?

(6)

Question 5 continued

Davinder's test in part (a) could lead to a different conclusion from the Wilcoxon signed-rank test in part (b).

(c) If Davinder obtains different conclusions, how should Davinder choose between the two tests?

(2)

(Total for Question 5 is 11 marks)

6 A formula meal is a calorie controlled drink.

The results of a clinical trial were published in September 2018. The trial compared weight loss of adult patients assigned randomly either to Diet A, based **only** on formula meals, or to Diet B, based only on conventional meals.

(a) Define a double blind trial.

Explain why it was not possible for this clinical trial to be double blind.

(2)

The mean weight loss after one year for each group is shown in **Figure 5**, together with the sample standard deviation of weight loss for each group. Sample sizes for each diet are also given.

	Diet A	**Diet B**
Mean weight loss, $\bar{x}$, kg	10.7	3.1
Sample standard deviation of weight loss, s, kg	9.6	7.0
Sample size, n	104	95

(Source: British Medical Journal)

Figure 5

(b) Conduct a hypothesis test to determine whether the mean weight loss of patients assigned to Diet A is different from that of patients assigned to Diet B.

(7)

Question 6 continued

(c) Explain why it is **not** necessary to make an assumption about the distributions of the mean weight losses to ensure the validity of your test in part (b).

(1)

(d) State **one** necessary assumption you made to ensure the validity of your test in part (b).

(1)

Question 6 continued

To make Diet A medically worthwhile, patients assigned to Diet A would need to lose at least 4 kg more than those assigned to Diet B.

(e) Adapt your hypothesis test to determine whether the mean weight loss of patients assigned to Diet A is at least 4 kg more than that of patients assigned to Diet B.

(6)

(Total for Question 6 is 17 marks)

7 Daniel, a car fleet manager, has collected data about the durability of four brands of car tyre. He recorded the distance, X thousand miles, travelled by each worn out tyre replaced during April 2019. He calls this distance 'tyre life'.

Daniel has calculated summary statistics for tyre life, as given in **Figure 6.**

	Brand A	**Brand B**	**Brand C**	**Brand D**
$\sum x$	190.078	184.401	133.191	146.858
$\sum x^2$	5236.989	4414.446	3068.984	2787.855
n	7	8	6	8

Figure 6

(a) Use ANOVA to investigate whether there is a difference between the mean tyre lives of the four brands, A, B, C and D.

You should make any necessary assumptions.

(11)

Question 7 continued

Question 7 continued

Daniel has also compared tyre lives for brands A, B, C and D by plotting a diagram, as shown in **Figure 7**.

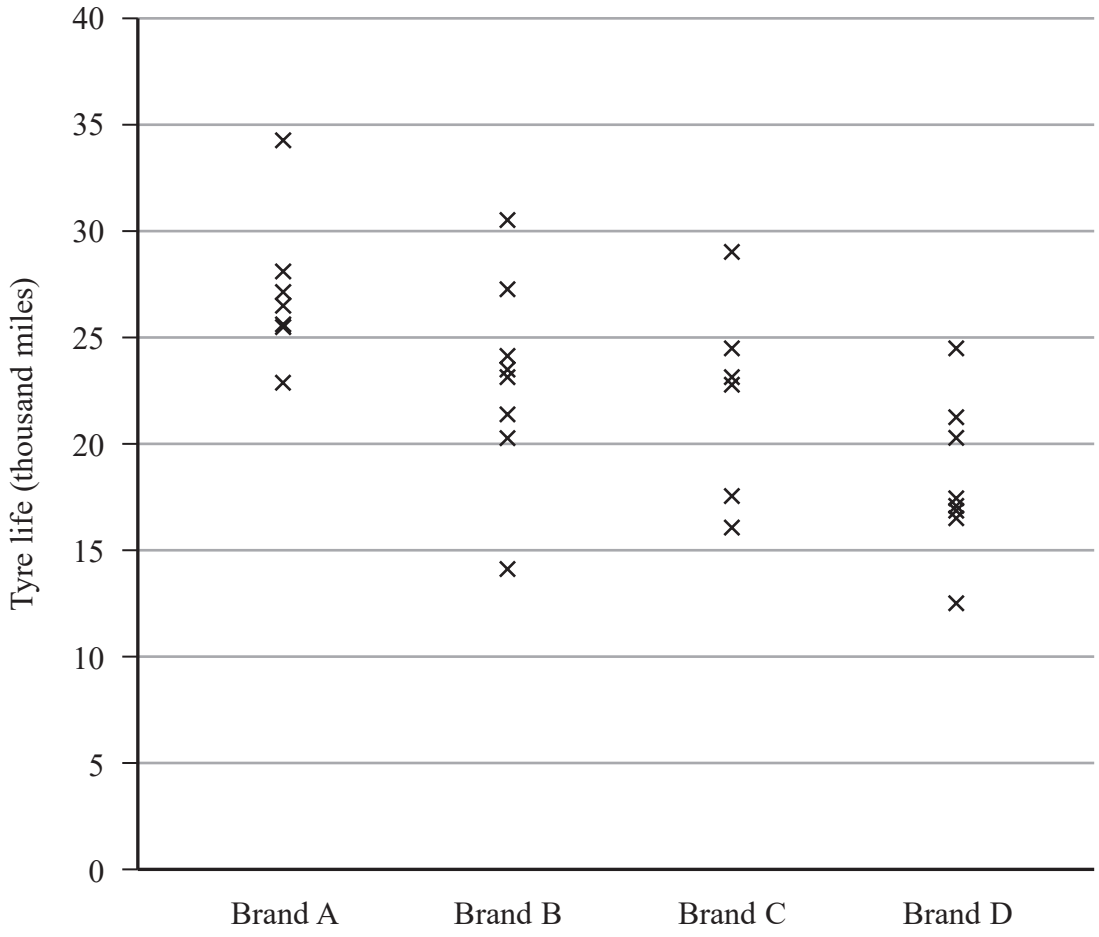

Figure 7

Question 7 continued

(b) Discuss briefly the validity of your test in part (a).

You should consider both the information in **Figure 7** and the method used by Daniel to collect the data.

(3)

Question 7 continues on the next page

Question 7 continued

Daniel's summary statistics and diagram, **Figure 7**, are based on the tyre lives for **front wheel** tyres. He has additional data relating to the tyre lives for **rear wheel** tyres.

Daniel knows that rear wheel tyres can be expected to have longer lives than front wheel tyres.

(c) (i) Explain how Daniel could use a Randomised Block Design to include samples of the four tyre brands and front and rear wheel tyres.

(2)

(ii) Name a hypothesis test that Daniel can use with a Randomised Block Design to investigate whether there is a difference between the mean tyre lives of the four brands, A, B, C and D.

(1)

(Total for Question 7 is 17 marks)

TOTAL FOR PAPER IS 80 MARKS