

**Paper Reference 9ST0/03**  
**Pearson Edexcel**  
**Level 3 GCE**

Total Marks
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**Statistics**  
**Advanced**  
**PAPER 3: Statistics in Practice**

**Time: 2 hours**

**In the boxes below, write your name,  
centre number and candidate number.**

<b>Surname</b>					
<b>Other names</b>					
<b>Centre Number</b>					
<b>Candidate Number</b>					

**YOU MUST HAVE**

**Statistical formulae and tables booklet,  
calculator**

**YOU WILL BE GIVEN**

**Data Booklet**

**Candidates may use any  
calculator allowed by Pearson  
regulations. Calculators must  
not have retrievable mathematical  
formulae stored in them.**

**Turn over**

## **INSTRUCTIONS**

**Answer ALL questions and ensure that your answers to parts of questions are clearly labelled.**

**Answer the questions in the spaces provided in this Question Paper – 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.**

**Turn over**

## **INFORMATION**

**A booklet ‘Statistical formulae and tables’ is provided.**

**There are 6 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.**

**Turn over**

**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.**

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**Answer ALL questions.**

**Write your answers in the spaces  
provided in this Question Paper.**

- 1. Following an illness, patients might need therapy in order to help improve their balance.**

**The therapy offered is called standard balance training.**

**Giovanni, a physiotherapist, thinks that his patients may be helped further by using a video game designed to improve balance.**

**He designs an experiment to test his theory.**

**(continued on the next page)**

**1. continued.**

**He randomly assigns patients to one of two groups.**

**One group receives a course of therapy including standard balance training and the video game.**

**The other group receives only standard balance training.**

**(a) State which of the two groups described above is the CONTROL group.**

**(1 mark)**

**Answer lines continue on the next page.**



1. (a) continued.

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Turn over

1. continued.

(b) Explain, in context, why Giovanni  
**RANDOMLY** assigns each patient  
to one of the two groups.

(1 mark)

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Turn over

1. continued.

(c) Explain why Giovanni's  
experiment design is not  
double-blind.

(1 mark)

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(continued on the next page)

Turn over

**1. continued.**

**Refer to the diagram for Question 1(d) in the Data Booklet.**

**At the start of the therapy (T0), Giovanni measures the patients' ability to balance using the "Berg balance scale".**

**He repeats this measure at the end of the course of therapy (T1), and at a follow-up appointment one month later (T2).**

**Giovanni displays his results using box and whisker plots, shown in the diagram.**

**(continued on the next page)**

**Turn over**

1. continued.

**A HIGHER SCORE on the  
Berg balance scale indicates  
BETTER balance.**

**(d) Make FOUR distinct comments,  
in context, about Giovanni's  
experiment and on his results  
using the information shown in  
the diagram ONLY.**

**(4 marks)**

**Answer lines continue on the  
next three pages.**

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**Turn over**

1. (d) continued.

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1. (d) continued.

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1. (d) continued.

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(continued on the next page)

Turn over



**1. continued.**

**(e) Highlight ONE advantage and ONE disadvantage of Giovanni's choice of box and whisker plots to display his results.**

**(2 marks)**

**Answer lines continue on the next two pages.**

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**Turn over**

1. (e) continued.

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Turn over

1. (e) continued.

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**(Total for Question 1 is 9 marks)**

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- 2. Refer to the diagram for Question 2(a) in the Data Booklet.**

**Shelly works as a project manager for a clothing design company.**

**She is in charge of a project to produce a new jacket design.**

**A pattern is then made of her design.**

**Shelly sends the pattern to the sample production department to be made into a sample jacket.**

**From past experience, it is known that it should take between 5 and 13 working hours for a sample jacket to be produced from a pattern.**

**(continued on the next page)**

**Turn over**

**2. continued.**

**The uniform distribution is considered a suitable model for the time taken to produce such a sample jacket from a pattern.**

**A diagram of Shelly's modelling distribution is shown in the diagram.**

**(a) Explain why the height of the modelling distribution in the diagram is  $0.125$**

**(1 mark)**

**Answer lines continue on the next page.**

**2. (a) continued.**

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**(continued on the next page)**

**Turn over**

**2. continued.**

**Use Shelly's model and the diagram to answer parts (b) to (e)**

**(b) State the expected time that it will take to produce her sample jacket from the pattern.**

**(1 mark)**

**Answer lines continue on the next page.**

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**Turn over**

**2. (b) continued.**

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**(continued on the next page)**

**Turn over**



**2. continued.**

**(c) State the probability that it  
will take less than 4 hours to  
produce her sample jacket from  
the pattern.**

**(1 mark)**

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**(continued on the next page)**

**Turn over**

**2. continued.**

**One week, Shelly sends the pattern to the sample production department on Tuesday, 7 hours before it closes for the day.**

**(d) Calculate the probability that her sample jacket will be produced from the pattern before the sample production department closes on Tuesday.**

**(1 mark)**

**Answer lines continue on the next page.**

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**Turn over**

**2. (d) continued.**

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**(continued on the next page)**

**Turn over**

**2. continued.**

**That same week, Shelly's boss would like the sample jacket to be produced from the pattern by 11 am on Wednesday.**

**The sample production department opens at 8 am**

**(e) Given that the sample jacket was NOT produced from the pattern before the sample production department closed on Tuesday, calculate the probability that it is ready by 11 am on Wednesday.  
(2 marks)**

**Answer lines are on the next two pages.**

**Turn over**

**2. (e) continued.**

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**Turn over**

**2. (e) continued.**

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**(Total for Question 2 is 6 marks)**

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**Turn over**

- 3. Refer to the table for Question 3(a) in the Data Booklet.**

**Klazine is a researcher interested in nutrition.**

**She believes that involving a child in preparing their own meal affects what they choose to eat at that meal.**

**She conducted a study involving 47 children aged 6 to 10 years.**

**25 children ate a meal that they had prepared with their parent.**

**(continued on the next page)**

**Turn over**

**3. continued.**

**The other 22 children ate a meal that their parent had prepared alone.**

**All of the meals contained the same four ingredients: pasta, chicken, cauliflower, and salad.**

**Klazine measured the total weight, in grams, of each ingredient eaten by the children in each group.**

**Her results for SALAD are shown in the table.**

**(continued on the next page)**

**Turn over**



**3. continued.**

- (a) Calculate a 95% confidence interval for the weight of salad eaten by the children whose parent prepared the meal alone.  
(3 marks)**

**Answer lines continue on the next two pages.**

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**Turn over**

3. (a) continued.

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Turn over

**3. (a) continued.**

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**Turn over**

**3. continued.**

**A 95% confidence interval for the weight, in grams, of salad eaten by the children who prepared the meal with their parent is  $(71.0, 121.8)$**

**(b) Give a full explanation of the evidence provided about Klazine's belief by the confidence interval in (a), together with the interval given above.**

**(3 marks)**

**Answer lines continue on the next three pages.**

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**Turn over**

3. (b) continued.

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3. (b) continued.

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Turn over

3. (b) continued.

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Turn over

**3. continued.**

**Refer to the table for Question 3(c) in the Data Booklet.**

**Klazine measured the weight of cauliflower, in grams, eaten by the children in each group.**

**Her results are shown in the table.**

**(continued on the next page)**



**3. continued.**

**(c) Making any necessary assumptions, use a t-test to investigate whether the children who prepared their meal with a parent ate over 10 grams more cauliflower, on average, than the children whose parent prepared the meal alone.**

**(8 marks)**

**Answer lines continue on the next four pages.**

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**Turn over**

3. (c) continued.

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3. (c) continued.

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3. (c) continued.

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3. (c) continued.

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Turn over

**3. continued.**

**There is an assumption about variance that is necessary for the  $t$ -test in (c) to be valid.**

**(d) State the assumption about variance, in context, and comment on its appropriateness, given the data in the table.**

**(2 marks)**

**Answer lines continue on the next two pages.**

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**Turn over**

**3. (d) continued.**

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**Turn over**

**3. (d) continued.**

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**Turn over**



**3. continued.**

**Klazine's colleague, Aurora, is concerned that the sample sizes used in their study are too small to be able to detect a difference between the two groups of children.**

**(continued on the next page)**

**3. continued.**

**(e) Discuss Aurora's concern about  
SAMPLE SIZES.**

**Include ONE reference to the  
statistical techniques applied  
in (a) and in (c) and their  
conclusions and ONE reference  
to the effect of increasing sample  
sizes.**

**(2 marks)**

**Answer lines continue on the  
next two pages.**

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**Turn over**

3. (e) continued.

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Turn over

**3. (e) continued.**

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**(continued on the next page)**

**Turn over**

**3. continued.**

**(f) If Klazine uses a much larger sample of children in her study, what effect would you expect this to have on the confidence intervals in (a) and in (b)?**

**(1 mark)**

**Answer lines continue on the next page.**

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**Turn over**

**3. (f) continued.**

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**(Total for Question 3 is 19 marks)**

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**Turn over**

- 4. Petra is an engineer who works on an offshore wind farm.**

**Petra organises the repairs of wind turbines that fail.**

**The wind farm contract states that wind turbines must be repaired on the same day that they fail.**

**Failures appear to happen at random, and at a fairly consistent rate over the year.**

**(continued on the next page)**

**4. continued.**

**In order to organise repairs, Petra uses a Poisson model with  $\lambda = 2 \cdot 8$  for the number of failures per year for each wind turbine.**

**Use Petra's model to answer (a) to (f)**

**(a) Calculate the standard deviation of the number of failures per year for a wind turbine at the wind farm.**

**(1 mark)**

**Answer lines continue on the next page.**

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**Turn over**



4. (a) continued.

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4. continued.

(b) Find the probability that a wind turbine at the wind farm fails exactly three times in a given year.

(1 mark)

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Turn over

**4. continued.**

**(c) Find the probability that a wind turbine at the wind farm fails more than seven times over a three-year period.**

**(2 marks)**

**Answer lines continue on the next page.**

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**Turn over**

4. (c) continued.

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**4. continued.**

**(d) State fully the distribution of the time, in years, between successive failures of a wind turbine at the wind farm.**

**(2 marks)**

**Answer lines continue on the next page.**

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**Turn over**

4. (d) continued.

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(continued on the next page)

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4. continued.

(e) Calculate the expected time,  
in years, between successive  
failures of a wind turbine at the  
wind farm.

(1 mark)

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(continued on the next page)

Turn over

**4. continued.**

- (f) Given that a particular wind turbine at the wind farm has not failed for two consecutive years, calculate the probability that it fails within the next six months.**

**(3 marks)**

**Answer lines continue on the next page.**

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**Turn over**



4. (f) continued.

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Turn over

**4. continued.**

**The wind farm has six wind turbines.**

**During the past five years, there have been 84 wind turbine failures at the wind farm.**

**(g) Show how Petra used this information to calculate the value of  $\lambda$**

**(1 mark)**

**Answer lines continue on the next page.**

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**Turn over**

4. (g) continued.

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(continued on the next page)

Turn over

**4. continued.**

**(h) Make THREE criticisms, in context, of Petra's use of a Poisson model with  $\lambda = 2.8$  for the number of failures per year for each wind turbine.**

**You may consider both the use of a Poisson model and the value of  $\lambda$**

**(3 marks)**

**Answer lines continue on the next three pages.**

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**Turn over**

4. (h) continued.

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4. (h) continued.

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Turn over

**4. (h) continued.**

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**(Total for Question 4 is 14 marks)**

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**Turn over**

- 5. Refer to the diagram for Question 5(a) in the Data Booklet.**

**Dennis and Viola are doing a course in film studies.**

**They want to conduct a study into the factors affecting film running times.**

**They start by investigating the distribution of film running times.**

**Dennis and Viola extract a random sample of 250 films from a database containing the names and dates of all films ever made and look up the running time of each film in their sample on the internet.**

**(continued on the next page)**

**Turn over**



**5. continued.**

**They use graphing software to produce a histogram of their results, shown in the diagram.**

**Viola believes that a normal distribution might be a suitable model for film running times.**

**(a) Explain ONE feature of the diagram that supports Viola's belief.**

**(1 mark)**

**Answer lines continue on the next page.**

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**Turn over**

**5. (a) continued.**

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**(continued on the next page)**

**Turn over**

**5. continued.**

**(b) Explain ONE feature of the  
diagram that does not support  
Viola's belief.**

**(1 mark)**

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**(continued on the next page)**

**Turn over**

**5. continued.**

**Refer to the table for Question 5(c) in the Data Booklet.**

**Dennis and Viola agree that they should perform a goodness-of-fit test to investigate whether a normal distribution would be a suitable model for film running times.**

**For their sample of 250 films, the mean running time is 105·26 minutes and the standard deviation of the running times is 22·18 minutes.**

**(continued on the next page)**

**Turn over**

**5. continued.**

**Part of their working is shown in the table.**

**(c) Find the values of  $S$ ,  $t$ ,  $u$  and  $v$  missing from the table.**

**(4 marks)**

**Answer lines continue on the next two pages.**

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**Turn over**

**5. (c) continued.**

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**Turn over**

**5. (c) continued.**

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**(continued on the next page)**

**Turn over**

**5. continued.**

**(d) Explain, with a reason, what adjustment Viola and Dennis must make to the data in the table before they can carry out the  $\chi^2$  goodness-of-fit test.**

**(1 mark)**

**Answer lines continue on the next page.**

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**Turn over**



**5. (d) continued.**

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**(continued on the next page)**

**Turn over**

**5. continued.**

**Viola and Dennis make the necessary adjustment to their data.**

**They calculate the  $\chi^2$  test statistic to be  $13.04$  (to 2 d.p.)**

**(e) Use this information to complete their  $\chi^2$  goodness-of-fit test.**

**You must state appropriate hypotheses.**

**(4 marks)**

**Answer lines continue on the next three pages.**

5. (e) continued.

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Turn over

**5. (e) continued.**

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**Turn over**

**5. (e) continued.**

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**(Total for Question 5 is 11 marks)**

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**Turn over**

**6. Russell and Robert are interested in sport.**

**They believe that wearing red may affect the success of a person or team in a sporting competition.**

**Russell finds the following information about the 2004 Olympic games.**

- Male combatants in combat sports were randomly assigned either a red or a blue outfit.**
- There was a total of 21 rounds of fighting for these combat sports.**

**(continued on the next page)**

**Turn over**

**6. continued.**

- **One round had an equal number of red and blue winners.**
- **Four rounds had MORE BLUE than red winners**
- **Sixteen rounds had MORE RED than blue winners.**

**(continued on the next page)**

**Turn over**

**6. continued.**

**(a) Making any necessary assumptions, use Russell's data to investigate their belief.**

**Make a full conclusion, in context, about any effect seen, or otherwise.**

**(7 marks)**

**Answer lines continue on the next seven pages.**

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**Turn over**



**6. (a) continued.**

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**Turn over**

6. (a) continued.

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6. (a) continued.

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6. (a) continued.

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6. (a) continued.

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**6. (a) continued.**

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**Turn over**

6. (a) continued.

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Turn over

**6. continued.**

**Refer to the table for Question 6(b) in the Data Booklet.**

**Robert collected data about the performance of five teams that sometimes wore a red kit at the Euro 2004 men's football competition.**

**He awarded one point for a win, zero for a draw and minus one point for a loss (disregarding penalty shoot-outs).**

**He then found the average points scored when each team wore red and when they did not wear red.**

**(continued on the next page)**

**Turn over**



**6. continued.**

**Opposing football teams never wear the same colour kit as each other.**

**Robert's results are shown in the table.**

**(continued on the next page)**

**6. continued.**

**(b) Making any necessary assumptions, use the AVERAGE POINTS data in the table and a PAIRED t-test to investigate Russell and Robert's belief that wearing red may affect the success of a team.**

**Make a full conclusion, in context, about any effect seen, or otherwise.**

**(8 marks)**

**Answer lines are on the next six pages.**

**Turn over**

**6. (b) continued.**

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**Turn over**

6. (b) continued.

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6. (b) continued.

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6. (b) continued.

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6. (b) continued.

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Turn over

**6. (b) continued.**

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**(continued on the next page)**

**Turn over**



**6. continued.**

**(c) Considering the data and tests used in (a) and (b), make FOUR distinct criticisms.**

**In your answer you might consider**

- **the size of sample provided,**
- **the sampling design,**
- **the test used and its assumptions.**

**(4 marks)**

**Answer lines are on the next four pages.**

**Turn over**

6. (c) continued.

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6. (c) continued.

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6. (c) continued.

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Turn over

**6. (c) continued.**

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**(continued on the next page)**

**Turn over**

**6. continued.**

**Charlotte reads Russell and Robert's research and tells her women's netball team that they should change to wearing red to improve their results.**

**(d) Make TWO comments about Charlotte's statement in light of the data given and the conclusions to the tests in (a) and (b)**  
**(2 marks)**

**Answer lines continue on the next two pages.**

6. (d) continued.

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Turn over

**6. (d) continued.**

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**(Total for Question 6 is 21 marks)**

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**TOTAL FOR PAPER IS 80 MARKS**

**END OF PAPER**

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