

**Paper Reference 9MA0/31  
Pearson Edexcel  
Level 3 GCE**

# **Mathematics**

**Advanced**

**PAPER 31: Statistics**

**Time: 2 hours**

**YOU MUST HAVE**

**Mathematical Formulae and Statistical  
Tables (Green), calculator**

**YOU WILL BE GIVEN**

**Data Booklet  
Answer Booklet**

**V72130A**



**Pearson**

**Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.**

## **INSTRUCTIONS**

**In the boxes on the Answer Booklet and on the Data Booklet, write your name, centre number and candidate number.**

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

**(continued on the next page)**

**Turn over**

**Instructions continued.**

**Answer the questions in the Answer Booklet or on the separate data sheets – there may be more space than you need.**

**Do NOT write on the Question Paper.**

**You should show sufficient working to make your methods clear. Answers without working may not gain full credit.**

**Values from statistical tables should be quoted in full. If a calculator is used instead of tables the value should be given to an equivalent degree of accuracy.**

**Inexact answers should be given to three significant figures unless otherwise stated.**

**Turn over**

## **INFORMATION**

**A booklet ‘Mathematical Formulae and Statistical Tables’ is provided.**

**The total mark for this part of the examination is 50**

**There are 6 questions.**

**The marks for EACH question are shown in brackets – use this as a guide as to how much time to spend on each question.**

**There may be spare copies of some data sheets in case you need them.**

**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.**

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1. **George throws a ball at a target  
15 times.**

**Each time George throws the ball,  
the probability of the ball hitting the  
target is 0.48**

**The random variable  $X$  represents  
the number of times George hits the  
target in 15 throws.**

**(continued on the next page)**

**1. continued.**

**(a) Find**

**(i)  $P(X = 3)$**

**(ii)  $P(X \geq 5)$**

**(3 marks)**

**(continued on the next page)**

**Turn over**

**1. continued.**

**George now throws the ball at the target 250 times.**

**(b) Use a normal approximation to calculate the probability that he will hit the target more than 110 times.**

**(3 marks)**

**(Total for Question 1 is 6 marks)**

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**2. A manufacturer uses a machine to make metal rods.**

**The length of a metal rod,  $L$  cm, is normally distributed with**

- a mean of 8 cm**
- a standard deviation of  $x$  cm**

**(continued on the next page)**

**2. continued.**

**Given that the proportion of metal rods less than  $7.902$  cm in length is  $2.5\%$**

**(a) show that  $x = 0.05$  to 2 decimal places.**

**(2 marks)**

**(b) Calculate the proportion of metal rods that are between  $7.94$  cm and  $8.09$  cm in length.**

**(1 mark)**

**(continued on the next page)**

**Turn over**

**2. continued.**

**The COST of producing a single metal rod is 20 pence**

**A metal rod**

- **where  $L < 7.94$  is SOLD for scrap for 5 pence**
- **where  $7.94 \leq L \leq 8.09$  is SOLD for 50 pence**
- **where  $L > 8.09$  is shortened for an extra COST of 10 pence and then SOLD for 50 pence**

**(continued on the next page)**

**Turn over**

**2. continued.**

**(c) Calculate the expected profit per 500 of the metal rods.**

**Give your answer to the nearest pound.**

**(5 marks)**

**(continued on the next page)**

**2. continued.**

**The same manufacturer makes metal hinges in large batches.**

**The hinges each have a probability of  $0.015$  of having a fault.**

**A random sample of  $200$  hinges is taken from each batch and the batch is accepted if fewer than  $6$  hinges are faulty.**

**The manufacturer's aim is for  $95\%$  of batches to be accepted.**

**(continued on the next page)**

**Turn over**

**2. continued.**

**(d) Explain whether the manufacturer is likely to achieve its aim.**

**(4 marks)**

**(Total for Question 2 is 12 marks)**

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3. Dian uses the large data set to investigate the Daily Total Rainfall,  $r$  mm, for Camborne.

(a) Write down how a value of  $0 < r \leq 0.05$  is recorded in the large data set.

(1 mark)

(continued on the next page)

**3. continued.**

**Dian uses the data for the 31 days of August 2015 for Camborne and calculates the following statistics**

$$n = 31$$

$$\sum r = 174.9$$

$$\sum r^2 = 3523.283$$

**(continued on the next page)**

**3. continued.**

**(b) Use these statistics to calculate**

**(i) the mean of the Daily Total Rainfall in Camborne for August 2015,**

**(ii) the standard deviation of the Daily Total Rainfall in Camborne for August 2015**

**(3 marks)**

**(continued on the next page)**

**Turn over**

**3. continued.**

**Dian believes that the mean Daily Total Rainfall in August is less in the South of the UK than in the North of the UK.**

**The mean Daily Total Rainfall in Leuchars for August 2015 is 1.72 mm to 2 decimal places.**

**(c) State, giving a reason, whether this provides evidence to support Dian's belief.**

**(2 marks)**

**(continued on the next page)**

**Turn over**

**3. continued.**

**Dian uses the large data set to estimate the proportion of days with no rain in Camborne for 1987 to be 0.27 to 2 decimal places.**

**(d) Explain why the distribution  $B(14, 0.27)$  might NOT be a reasonable model for the number of days without rain for a 14-day summer event.**

**(1 mark)**

**(Total for Question 3 is 7 marks)**

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**Turn over**

- 4. A dentist knows from past records that 10% of customers arrive late for their appointment.**

**A new manager believes that there has been a change in the proportion of customers who arrive late for their appointment.**

**A random sample of 50 of the dentist's customers is taken.**

**(continued on the next page)**

**4. continued.**

**(a) Write down**

- **a null hypothesis  
corresponding to no change  
in the proportion of customers  
who arrive late**
- **an alternative hypothesis  
corresponding to the  
manager's belief**

**(1 mark)**

**(continued on the next page)**

**Turn over**

**4. continued.**

**(b) Using a 5% level of significance, find the critical region for a two-tailed test of the null hypothesis in (a)**

**You should state the probability of rejection in each tail, which should be less than 0.025**

**(3 marks)**

**(c) Find the actual level of significance of the test based on your critical region from part (b)**

**(1 mark)**

**(continued on the next page)**

**Turn over**

**4. continued.**

**The manager observes that 15 of the 50 customers arrived late for their appointment.**

**(d) With reference to part (b),  
comment on the manager's  
belief.**

**(1 mark)**

**(Total for Question 4 is 6 marks)**

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

**A company has 1825 employees.**

**The employees are classified as professional, skilled or elementary.**

**The table in the Data Booklet shows**

- the number of employees in each classification**
- the two areas, A or B, where the employees live**

**(continued on the next page)**

**5. continued.**

**An employee is chosen at random.**

**Find the probability that this employee**

**(a) is skilled,**

**(1 mark)**

**(b) lives in area B and is not a professional.**

**(1 mark)**

**(continued on the next page)**

**5. continued.**

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

**It shows an incomplete Venn diagram.**

**Some classifications of employees  
are more likely to work from home.**

**(continued on the next page)**

**5. continued.**

- **65% of professional employees in both area A and area B work from home**
- **40% of skilled employees in both area A and area B work from home**
- **5% of elementary employees in both area A and area B work from home**
- **Event F is that the employee is a professional**
- **Event H is that the employee works from home**
- **Event R is that the employee is from area A**

**(continued on the next page)**

**Turn over**

**5. continued.**

**(c) Using this information, complete the Venn diagram in the Data Booklet.**

**(4 marks)**

**(d) Find  $P(R' \cap F)$**

**(1 mark)**

**(e) Find  $P([H \cup R]')$**

**(1 mark)**

**(f) Find  $P(F | H)$**

**(2 marks)**

**(Total for Question 5 is 10 marks)**

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**Turn over**

**6. Refer to the diagram for Question 6 in the Data Booklet.**

**It shows a scatter diagram.**

**Anna is investigating the relationship between exercise and resting heart rate.**

**She takes a random sample of 19 people in her year at school and records for each person**

- their resting heart rate,  $h$  beats per minute**
- the number of minutes,  $m$ , spent exercising each week**

**(continued on the next page)**

**Turn over**

**6. continued.**

**Her results are shown on the scatter diagram in the Data Booklet.**

**(a) Interpret the nature of the relationship between  $h$  and  $m$   
(1 mark)**

**(continued on the next page)**

**6. continued.**

**Anna codes the data using the formulae**

$$\mathbf{x = \log_{10} m}$$

$$\mathbf{y = \log_{10} h}$$

**The product moment correlation coefficient between X and y is**  
**-0.897**

**(continued on the next page)**

**6. continued.**

**(b) Test whether or not there is significant evidence of a negative correlation between  $X$  and  $y$**

**You should**

- state your hypotheses clearly**
- use a 5% level of significance**
- state the critical value used**

**(3 marks)**

**(continued on the next page)**

**Turn over**

6. continued.

The equation of the line of best fit of  $y$  on  $X$  is

$$y = -0.05x + 1.92$$

(c) Use the equation of the line of best fit of  $y$  on  $X$  to find a model for  $h$  on  $m$  in the form

$$h = am^k$$

where  $a$  and  $k$  are constants to be found.

(5 marks)

(Total for Question 6 is 9 marks)

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Turn over

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**TOTAL FOR STATISTICS IS 50 MARKS**

**END OF PAPER**

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