

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

**Mathematics**  
**Advanced**  
**Paper 31: Statistics**

**Monday 19 October 2020 – Afternoon**

**MATERIALS REQUIRED FOR EXAMINATION**

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

**ITEMS INCLUDED WITH QUESTION PAPER**

**Answer Book**  
**Diagram Book**

**X66788A**

**Candidates may use any calculator allowed 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 Book and on the Diagram Book, write 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 Answer Book or on the separate diagrams – 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 5 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.**

## **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. Refer to the diagram for Question 1 in the Diagram Book.

It is a Venn diagram which shows the probabilities associated with four events, **A**, **B**, **C** and **D**

- (a) Write down any pair of mutually exclusive events from **A**, **B**, **C** and **D**  
(1 mark)

Given that  $P(B) = 0.4$

- (b) find the value of  $p$   
(1 mark)

Given also that **A** and **B** are independent

- (c) find the value of  $q$   
(2 marks)

(continued on the next page)

1. continued.

Given further that  $P(B' | C) = 0.64$

(d) find

(i) the value of  $r$

(ii) the value of  $s$

(4 marks)

(Total for Question 1 is 8 marks)

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2. Refer to the diagram for Question 2 in the Diagram Book.

A random sample of **15** days is taken from the large data set for Perth in June and July **1987**

The scatter diagram in the Diagram Book displays the values of two of the variables for these **15** days.

- (a) Describe the correlation.  
(1 mark)

The variable on the **X**-axis is  
Daily Mean Temperature measured in **°C**

- (b) Using your knowledge of the large data set,
- (i) suggest which variable is on the **y**-axis,
  - (ii) state the units that are used in the large data set for this variable.

(2 marks)

(continued on the next page)

Turn over

**2. continued.**

**Stav believes that there is a correlation between  
Daily Total Sunshine and  
Daily Maximum Relative Humidity at Heathrow.**

**He calculates the product moment correlation  
coefficient between these two variables for a  
random sample of 30 days and obtains  
 $r = -0.377$**

**(c) Carry out a suitable test to investigate Stav's  
belief at a 5% level of significance.  
State clearly**

- your hypotheses**
- your critical value**

**(3 marks)**

**(continued on the next page)**

**2. continued.**

**On a random day at Heathrow the Daily Maximum Relative Humidity was 97%**

**(d) Comment on the number of hours of sunshine you would expect on that day, giving a reason for your answer.**

**(1 mark)**

**(Total for Question 2 is 7 marks)**

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- 3. Refer to the diagram for Question 3 in the Diagram Book.**

**Each member of a group of 27 people was timed when completing a puzzle.**

**The time taken,  $x$  minutes, for each member of the group was recorded.**

**These times are summarised in the box and whisker plot in the Diagram Book.**

- (a) Find the range of the times.**

**(1 mark)**

- (b) Find the interquartile range of the times.**

**(1 mark)**

**(continued on the next page)**

**3. continued.**

**For these 27 people**

$$\sum x = 607 \cdot 5 \text{ and}$$

$$\sum x^2 = 17\,623 \cdot 25$$

**(c) calculate the mean time taken to complete the puzzle,**

**(1 mark)**

**(d) calculate the standard deviation of the times taken to complete the puzzle.**

**(2 marks)**

**Taruni defines an outlier as a value more than 3 standard deviations above the mean.**

**(e) State how many outliers Taruni would say there are in these data, giving a reason for your answer.**

**(1 mark)**

**(continued on the next page)**

**Turn over**

**3. continued.**

**Adam and Beth also completed the puzzle in  $a$  minutes and  $b$  minutes respectively, where  $a > b$**

**When their times are included with the data of the other 27 people**

- **the median time increases**
- **the mean time does not change**

**(f) Suggest a possible value for  $a$  and a possible value for  $b$ , explaining how your values satisfy the above conditions.**

**(3 marks)**

**(g) Without carrying out any further calculations, explain why the standard deviation of all 29 times will be lower than your answer to part (d)**

**(1 mark)**

**(Total for Question 3 is 10 marks)**

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4. Refer to the table for Question 4 in the Diagram Book.

The discrete random variable  $D$  has the probability distribution shown in the Diagram Book where  $k$  is a constant.

- (a) Show that the value of  $k$  is  $\frac{600}{137}$   
(2 marks)

The random variables  $D_1$  and  $D_2$  are independent and each have the same distribution as  $D$

- (b) Find

$$P(D_1 + D_2 = 80)$$

Give your answer to 3 significant figures.

(3 marks)

(continued on the next page)

4. continued.

A single observation of  $D$  is made.

The value obtained,  $d$ , is the common difference of an arithmetic sequence.

The first 4 terms of this arithmetic sequence are the angles, measured in degrees, of quadrilateral  $Q$

- (c) Find the exact probability that the smallest angle of  $Q$  is more than  $50^\circ$   
(5 marks)

(Total for Question 4 is 10 marks)

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5. A health centre claims that the time a doctor spends with a patient can be modelled by a normal distribution with a mean of **10** minutes and a standard deviation of **4** minutes.

- (a) Using this model, find the probability that the time spent with a randomly selected patient is more than **15** minutes.

(1 mark)

Some patients complain that the mean time the doctor spends with a patient is more than **10** minutes.

The receptionist takes a random sample of **20** patients and finds that the mean time the doctor spends with a patient is **11.5** minutes.

- (b) Stating your hypotheses clearly and using a **5%** significance level, test whether or not there is evidence to support the patients' complaint.

(4 marks)

(continued on the next page)

Turn over

5. continued.

The health centre also claims that the time a dentist spends with a patient during a routine appointment,  $T$  minutes, can be modelled by the normal distribution where  $T \sim N(5, 3 \cdot 5^2)$

(c) Using this model,

(i) find the probability that a routine appointment with the dentist takes less than 2 minutes

(1 mark)

(ii) find  $P(T < 2 \mid T > 0)$

(3 marks)

(iii) hence explain why this normal distribution may not be a good model for  $T$

(1 mark)

(continued on the next page)

**5. continued.**

**The dentist believes that she cannot complete a routine appointment in less than 2 minutes.**

**She suggests that the health centre should use a refined model only including values of  $T > 2$**

- (d) Find the median time for a routine appointment using this new model, giving your answer correct to one decimal place.  
(5 marks)**

**(Total for Question 5 is 15 marks)**

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**TOTAL FOR STATISTICS IS 50 MARKS**

**END OF PAPER**

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