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| Please check the examination details below before entering your candidate information     |  |                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                     |
| Candidate surname                                                                         |  | Other names                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                     |
| <b>Pearson Edexcel</b><br><b>Level 3 GCE</b>                                              |  | Centre Number                                                                                                                                                                                                                                                                                                                                                                                                        | Candidate Number                                                                                                                                                                                                                                                                                                                    |
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| <b>Monday 19 October 2020</b>                                                             |  |                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                     |
| Afternoon                                                                                 |  | Paper Reference <b>9MA0/31</b>                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                     |
| <b>Mathematics</b><br><br><b>Advanced</b><br><br><b>Paper 31: Statistics</b>              |  |                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                     |
| <b>You must have:</b><br>Mathematical Formulae and Statistical Tables (Green), calculator |  |                                                                                                                                                                                                                                                                                                                                                                                                                      | Total Marks                                                                                                                                                                                                                                                                                                                         |

**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

- 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.
- 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.

### 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.

**Turn over** ►

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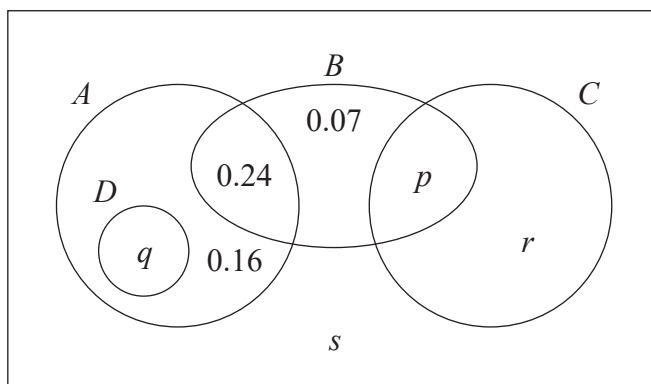


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1. The Venn diagram shows the probabilities associated with four events,  $A$ ,  $B$ ,  $C$  and  $D$



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

Given that  $P(B) = 0.4$

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

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

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

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

- (d) find
- (i) the value of  $r$
  - (ii) the value of  $s$
- (4)**



**Question 1 continued**

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**(Total for Question 1 is 8 marks)**



2. A random sample of 15 days is taken from the large data set for Perth in June and July 1987. The scatter diagram in Figure 1 displays the values of two of the variables for these 15 days.

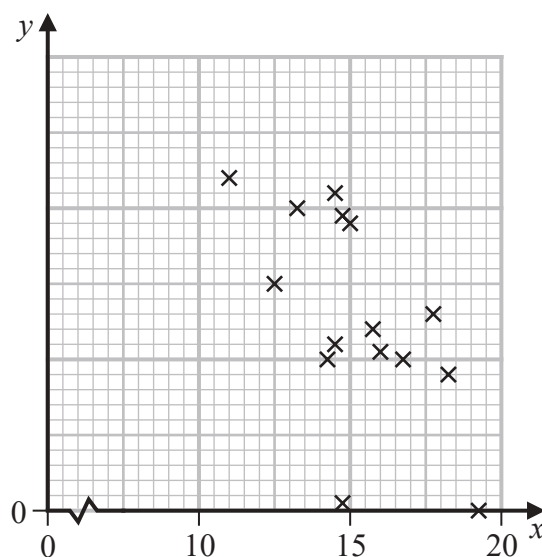


Figure 1

- (a) Describe the correlation.

(1)

The variable on the  $x$ -axis is Daily Mean Temperature measured in  $^{\circ}\text{C}$ .

- (b) Using your knowledge of the large data set,

- suggest which variable is on the  $y$ -axis,
- state the units that are used in the large data set for this variable.

(2)

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)

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)

**Question 2 continued**

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Question 2 continued

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**Question 2 continued**

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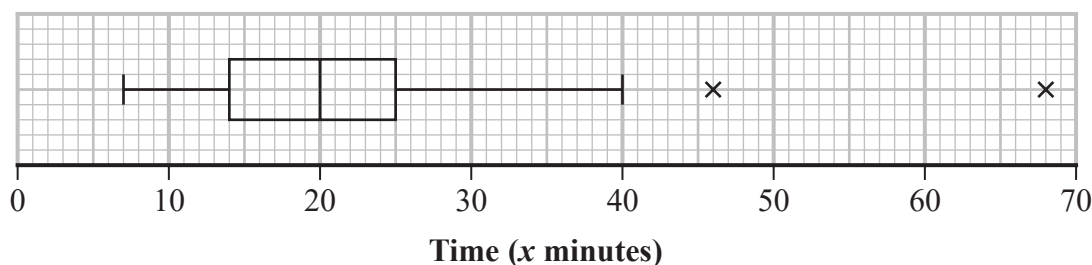
**(Total for Question 2 is 7 marks)**



3. 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 following box and whisker plot.



- (a) Find the range of the times. (1)

- (b) Find the interquartile range of the times. (1)

For these 27 people  $\sum x = 607.5$  and  $\sum x^2 = 17\,623.25$

- (c) calculate the mean time taken to complete the puzzle, (1)

- (d) calculate the standard deviation of the times taken to complete the puzzle. (2)

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)

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)
- (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)





**Question 3 continued**

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Question 3 continued

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**Question 3 continued**

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



4. The discrete random variable  $D$  has the following probability distribution

|            |                |                |                |                |                |
|------------|----------------|----------------|----------------|----------------|----------------|
| $d$        | 10             | 20             | 30             | 40             | 50             |
| $P(D = d)$ | $\frac{k}{10}$ | $\frac{k}{20}$ | $\frac{k}{30}$ | $\frac{k}{40}$ | $\frac{k}{50}$ |

where  $k$  is a constant.

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

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)**

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)



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Question 4 continued

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**Question 4 continued**

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**(Total for Question 4 is 10 marks)**



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)

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)

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  $T \sim N(5, 3.5^2)$

- (c) Using this model,

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

(1)

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

(3)

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

(1)

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)

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**Question 5 continued**

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

**TOTAL FOR STATISTICS IS 50 MARKS**

