# Paper Reference 9MA0–31
# Pearson Edexcel
# Level 3 GCE

# Mathematics
## Advanced
## Paper 31: Statistics

**Friday 14 June 2019 – Afternoon**

**MATERIALS REQUIRED FOR EXAMINATION**
**Mathematical Formulae and Statistical Tables, calculator**

**ITEMS INCLUDED WITH QUESTION PAPER**
**Diagram Book**
**Answer Book**

**V63358A**

Pearson

**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.**

**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.**

**Answer ALL questions.**

**Write your answers in the Answer Book.**

1. Three bags, A, B and C, each contain 1 red marble and some green marbles.

Bag A contains 1 red marble and 9 green marbles only

Bag B contains 1 red marble and 4 green marbles only

Bag C contains 1 red marble and 2 green marbles only

(continued on the next page)

1. continued.

Sasha selects at random one marble from bag **A**

If he selects a red marble, he stops selecting.

If the marble is green, he continues by selecting at random one marble from bag **B**

If he selects a red marble, he stops selecting.

If the marble is green, he continues by selecting at random one marble from bag **C**

(continued on the next page)

1. continued.

(a) Draw a tree diagram to represent this information.

(2 marks)

(b) Find the probability that Sasha selects 3 green marbles.

(2 marks)

(c) Find the probability that Sasha selects at least 1 marble of each colour.

(2 marks)

(continued on the next page)

1. continued.

(d) Given that Sasha selects a red marble, find the probability that he selects it from bag **B**

(2 marks)

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

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

The partially completed box plot in Diagram 1 shows the distribution of daily mean air temperatures using the data from the large data set for Beijing in 2015

Diagram 2 shows the same partially completed box plot.

An outlier is defined as a value more than $1 \cdot 5 \times IQR$ below $Q_1$ or more than $1 \cdot 5 \times IQR$ above $Q_3$

(continued on the next page)

2. continued.

The three lowest air temperatures in the data set are 7·6 °C, 8·1 °C and 9·1 °C

The highest air temperature in the data set is 32·5 °C

(a) Complete the box plot in Diagram 1 showing clearly any outliers.
(4 marks)

(b) Using your knowledge of the large data set, suggest from which month the two outliers are likely to have come.
(1 mark)

(continued on the next page)

2. continued.

Using the data from the large data set, Simon produced the following summary statistics for the daily mean air temperature, $x\,^{\circ}C$, for Beijing in 2015

$n = 184$

$\sum x = 4153 \cdot 6$

$S_{xx} = 4952 \cdot 906$

(c) Show that, to 3 significant figures, the standard deviation is $5 \cdot 19\,^{\circ}C$

(1 mark)

(continued on the next page)

2. continued.

Simon decides to model the air temperatures with the random variable

$$T \sim N(22 \cdot 6, 5 \cdot 19^2)$$

(d) Using Simon's model, calculate the 10th to 90th interpercentile range.

(3 marks)

(continued on the next page)

2. continued.

Simon wants to model another variable from the large data set for Beijing using a normal distribution.

(e) State two variables from the large data set for Beijing that are NOT suitable to be modelled by a normal distribution.
Give a reason for each answer.
(2 marks)

**(Total for Question 2 is 11 marks)**

3. Barbara is investigating the relationship between average income (GDP per capita), $x$ US dollars, and average annual carbon dioxide ($CO_2$) emissions, $y$ tonnes, for different countries.

She takes a random sample of 24 countries and finds the product moment correlation coefficient between average annual $CO_2$ emissions and average income to be $0{\cdot}446$

(continued on the next page)

3. continued.

(a) Stating your hypotheses clearly, test, at the 5% level of significance, whether or not the product moment correlation coefficient for all countries is greater than zero.
(3 marks)

(continued on the next page)

3. continued.

Barbara believes that a non–linear model would be a better fit to the data. She codes the data using the coding $m = \log_{10} x$ and $c = \log_{10} y$ and obtains the model

$$c = -1 \cdot 82 + 0 \cdot 89m$$

The product moment correlation coefficient between $c$ and $m$ is found to be $0 \cdot 882$

(b) Explain how this value supports Barbara's belief.

(1 mark)

(continued on the next page)

3. continued.

(c) Show that the relationship between $y$ and $x$ can be written in the form $y = ax^n$ where $a$ and $n$ are constants to be found.

(5 marks)

**(Total for Question 3 is 9 marks)**

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

Magali is studying the mean total cloud cover, in oktas, for Leuchars in 1987 using data from the large data set.

The daily mean total cloud cover for all 184 days from the large data set is summarised in the table.

(continued on the next page)

4. continued.

One of the 184 days is selected at random.

(a) Find the probability that it has a daily mean total cloud cover of 6 or greater.

(1 mark)

(continued on the next page)

4. continued.

Magali is investigating whether the daily mean total cloud cover can be modelled using a binomial distribution.

She uses the random variable $X$ to denote the daily mean total cloud cover and believes that

$X \sim B(8, 0{\cdot}76)$

(continued on the next page)

4. continued.

Using Magali's model,

(b) (i) find $P(X \geq 6)$

(2 marks)

(ii) find, to 1 decimal place, the expected number of days in a sample of 184 days with a daily mean total cloud cover of 7

(2 marks)

(continued on the next page)

4. continued.

(c) Explain whether or not your answers to part (b) support the use of Magali's model.

(1 mark)

(continued on the next page)

4. continued.

Refer to the table for Question 4(c) in the Diagram Book.

There were 28 days that had a daily mean total cloud cover of 8 For these 28 days the daily mean total cloud cover for the FOLLOWING day is shown in the table.

(d) Find the proportion of these days when the daily mean total cloud cover was 6 or greater.

(1 mark)

(continued on the next page)

4. continued.

(e) Comment on Magali's model in light of your answer to part (d)

(2 marks)

**(Total for Question 4 is 9 marks)**

5. A machine puts liquid into bottles of perfume.

The amount of liquid put into each bottle, $D$ ml, follows a normal distribution with mean $25$ ml

Given that $15\%$ of bottles contain less than $24 \cdot 63$ ml

(a) find, to $2$ decimal places, the value of $k$ such that

$$P(24 \cdot 63 < D < k) = 0 \cdot 45$$

(5 marks)

(continued on the next page)

5. continued.

(b) Using a normal approximation, find the probability that fewer than half of these bottles contain between $24 \cdot 63$ ml and $k$ ml
(3 marks)

The machine is adjusted so that the standard deviation of the liquid put in the bottles is now $0 \cdot 16$ ml

(continued on the next page)

5. continued.

Following the adjustments, Hannah believes that the mean amount of liquid put in each bottle is less than 25 ml

She takes a random sample of 20 bottles and finds the mean amount of liquid to be 24·94 ml

(c) Test Hannah's belief at the 5% level of significance.

You should state your hypotheses clearly.

(5 marks)

**(Total for Question 5 is 13 marks)**

**TOTAL FOR STATISTICS IS 50 MARKS**

**END OF PAPER**