

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

**Mathematics**  
**Advanced**  
**PAPER 31: Statistics**

**Tuesday 20 June 2023 – Afternoon**

**Time for 9MA0/31 and 9MA0/32: 2 hours**

**YOU MUST HAVE**

**Mathematical Formulae and Statistical Tables (Green),  
calculator, 9MA0/32**

**YOU WILL BE GIVEN**

**Data Booklet  
Answer Booklet**

**X72819A**

**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 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.**

**Answer the questions in the Answer Booklet – 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.**

## **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.**

## **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.**

---

1. Refer to the diagram for Question 1 in the Data Booklet.

It is a Venn Diagram.

The Venn diagram, where  $p$  and  $q$  are probabilities, shows the three events **A**, **B** and **C** and their associated probabilities.

- (a) Find  $P(A)$

(1 mark)

The events **B** and **C** are independent.

- (b) Find the value of  $p$  and the value of  $q$

(3 marks)

- (c) Find  $P(A|B')$

(2 marks)

(Total for Question 1 is 6 marks)

---

2. A machine fills packets with sweets and  $\frac{1}{7}$  of the packets also contain a prize.

The packets of sweets are placed in boxes before being delivered to shops.

There are 40 packets of sweets in each box.

The random variable  $T$  represents the number of packets of sweets that contain a prize in each box.

- (a) State a condition needed for  $T$  to be modelled by  $B(40, \frac{1}{7})$   
(1 mark)

(continued on the next page)

**2. continued.**

**A box is selected at random.**

**(b) Using  $T \sim B(40, \frac{1}{7})$  find**

**(i) the probability that the box has exactly  
6 packets containing a prize,**

**(ii) the probability that the box has fewer than  
3 packets containing a prize.**

**(2 marks)**

**Kamil's sweet shop buys 5 boxes of these sweets.**

**(c) Find the probability that exactly 2 of these  
5 boxes have fewer than 3 packets containing a  
prize.**

**(2 marks)**

**(continued on the next page)**

**2. continued.**

**Kamil claims that the proportion of packets containing a prize is less than  $\frac{1}{7}$**

**A random sample of 110 packets is taken and 9 packets contain a prize.**

**(d) Use a suitable test to assess Kamil's claim.**

**You should**

- **state your hypotheses clearly**
- **use a 5% level of significance**

**(4 marks)**

**(Total for Question 2 is 9 marks)**

---

- 3. Refer to the table for Question 3 in the Data Booklet. Ben is studying the Daily Total Rainfall,  $x$  mm, in Leeming for 1987**

**He used all the data from the large data set and summarised the information in the table in the Data Booklet.**

- (a) Explain how the data will need to be cleaned before Ben can start to calculate statistics such as the mean and standard deviation.**  
**(2 marks)**

**(continued on the next page)**



3. continued.

Using all 184 of these values, Ben estimates

$$\sum x = 390 \quad \text{and} \quad \sum x^2 = 4336$$

(b) Calculate estimates for

(i) the mean Daily Total Rainfall,

(ii) the standard deviation of the Daily Total Rainfall.

(3 marks)

(continued on the next page)

**3. continued.**

**Ben suggests using the statistic calculated in part (b)(i) to estimate the annual mean Daily Total Rainfall in Leeming for 1987**

**(c) Using your knowledge of the large data set,**

**(i) give a reason why these data would not be suitable,**

**(ii) state, giving a reason, how you would expect the estimate in part (b)(i) to differ from the actual annual mean Daily Total Rainfall in Leeming for 1987**

**(2 marks)**

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

---

4. A study was made of adult men from region **A** of a country.

It was found that their heights were normally distributed with a mean of **175·4 cm** and standard deviation **6·8 cm**

- (a) Find the proportion of these men that are taller than **180 cm**  
(1 mark)

(continued on the next page)

**4. continued.**

**A student claimed that the mean height of adult men from region B of this country was different from the mean height of adult men from region A**

**A random sample of 52 adult men from region B had a mean height of 177.2 cm**

**The student assumed that the standard deviation of heights of adult men was 6.8 cm both for region A and region B**

**(b) Use a suitable test to assess the student's claim.**

**You should**

- state your hypotheses clearly**
- use a 5% level of significance**

**(4 marks)**

**(continued on the next page)**

4. continued.

- (c) Find the  $p$ -value for the test in part (b)  
(1 mark)

(Total for Question 4 is 6 marks)

---

5. Refer to the table for Question 5 in the Data Booklet.
- Tisam is playing a game.
- She uses a ball, a cup and a spinner.

The random variable  $X$  represents the number the spinner lands on when it is spun.

The probability distribution of  $X$  is given in the table in the Data Booklet where  $a$ ,  $b$ ,  $c$  and  $d$  are probabilities.

To play the game

- the spinner is spun to obtain a value of  $X$
- Tisam then stands  $X$  cm from the cup and tries to throw the ball into the cup

(continued on the next page)

5. continued.

The event **S** represents the event that Tisam successfully throws the ball into the cup.

To model this game Tisam assumes that

- $P(S | \{X = x\}) = \frac{k}{x}$  where  $k$  is a constant
- $P(S \cap \{X = x\})$  should be the same whatever value of  $x$  is obtained from the spinner

Using Tisam's model,

(a) show that

$$c = \frac{8}{5}b$$

(2 marks)

(b) find the probability distribution of  $X$

(5 marks)

(continued on the next page)

**5. continued.**

**Nav tries, a large number of times, to throw the ball into the cup from a distance of 100 cm**

**He successfully gets the ball in the cup 30% of the time.**

- (c) State, giving a reason, why Tisam's model of this game is not suitable to describe Nav playing the game for all values of  $X$**   
**(1 mark)**

**(Total for Question 5 is 8 marks)**

---



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

It is a histogram.

A medical researcher is studying the number of hours,  $T$ , a patient stays in hospital following a particular operation.

The histogram in the Data Booklet summarises the results for a random sample of 90 patients.

- (a) Use the histogram to estimate  
 $P(10 < T < 30)$   
(2 marks)

(continued on the next page)

6. continued.

For these 90 patients the time spent in hospital following the operation had

- a mean of 14.9 hours
- a standard deviation of 9.3 hours

Tomas suggests that  $T$  can be modelled by  $N(14.9, 9.3^2)$

(b) With reference to the histogram, state, giving a reason, whether or not Tomas' model could be suitable.

(1 mark)

(continued on the next page)

6. continued.

Xiang suggests that the frequency polygon based on this histogram could be modelled by a curve with equation

$$y = kxe^{-x} \quad 0 \leq x \leq 4$$

where

- $x$  is measured in tens of hours
- $k$  is a constant

(c) Use algebraic integration to show that

$$\int_0^n xe^{-x} dx = 1 - (n + 1)e^{-n}$$

(4 marks)

(continued on the next page)

6. continued.

(d) Show that, for Xiang's model,  $k = 99$  to the nearest integer.

(3 marks)

(e) Estimate

$P(10 < T < 30)$  using

(i) Tomas' model of

$$T \sim N(14.9, 9.3^2)$$

(1 mark)

(ii) Xiang's curve with equation

$$y = 99xe^{-x} \text{ and the answer to part (c)}$$

(2 marks)

(continued on the next page)

**6. continued.**

**The researcher decides to use Xiang's curve to model**

$$\mathbf{P(a < T < b)}$$

**(f) State one limitation of Xiang's model.**

**(1 mark)**

**(Total for Question 6 is 14 marks)**

---

**TOTAL FOR STATISTICS IS 50 MARKS**

**END OF PAPER**

---