

**Paper Reference 8FM0/23  
Pearson Edexcel  
Level 3 GCE**

**Further Mathematics  
Advanced Subsidiary  
Further Mathematics options  
23: Further Statistics 1  
(Part of options B, E, F and G)**

**YOU MUST HAVE**

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

**YOU WILL BE GIVEN**

**Data Booklet  
Answer Booklet**

**X71967A**

**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 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 the statistical tables should be quoted in full. If a calculator is used instead of the 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 40  
There are 4 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 table for Question 1 in the Data Booklet. Stuart is investigating a treatment for a disease that affects fruit trees.

He has **400** fruit trees and applies the treatment to a random sample of these trees.

The remainder of the trees have no treatment.

He records the number of years,  $y$ , that each fruit tree remains free from this disease.

The results are summarised in the table in the Data Booklet.

The data are to be used to determine whether or not there is an association between the application of the treatment and the number of years that a fruit tree remains free from this disease.

(continued on the next page)

1. continued.

(a) Calculate the expected frequencies for

(i) Applied and  $y < 1$

(ii) Not applied and  $1 \leq y < 2$

(2 marks)

The value of  $\sum \frac{(O - E)^2}{E}$  for the OTHER FOUR classes is 2.642 to 3 decimal places.

(b) Test, at the 5% level of significance, whether or not there is an association between the application of the treatment and the number of years a fruit tree remains free from this disease.

You should state your hypotheses, test statistic, critical value and conclusion clearly.

(5 marks)

(Total for Question 1 is 7 marks)

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2. Xena catches fish at random, at a constant rate of  $0.6$  per hour.

(a) Find the probability that Xena catches exactly 4 fish in a 5-hour period.

(2 marks)

The probability of Xena catching no fish in a period of  $t$  hours is less than  $0.16$

(b) Find the minimum value of  $t$ , giving your answer to one decimal place.

(3 marks)

(continued on the next page)

2. continued.

Independently of Xena, Zion catches fish at random with a mean rate of  $0.8$  per hour.

Xena and Zion try using new bait to catch fish.

The number of fish caught in total by Xena and Zion after using the new bait, in a randomly selected 4-hour period, is 12

(c) Use a suitable test to determine, at the 5% level of significance, whether or not there is evidence that the rate at which fish are caught has increased after using the new bait. State your hypotheses clearly and the  $p$ -value used in your test.

(5 marks)

(Total for Question 2 is 10 marks)

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3. Refer to Table 1 and Table 2 for Question 3 in the Data Booklet.

In a game, a coin is spun **5** times and the number of heads obtained is recorded.

Tao suggests playing the game **20** times and carrying out a chi-squared test to investigate whether the coin might be biased.

- (a) Explain why playing the game only **20** times may cause problems when carrying out the test.

(1 mark)

(continued on the next page)

**3. continued.**

**Chris decides to play the game 500 times.**

**The results are shown in Table 1 in the Data Booklet.**

**Chris decides to test whether or not the data can be modelled by a binomial distribution, with the probability of a head on each spin being 0.6**

**She calculates the expected frequencies, to 2 decimal places, as shown in Table 2 in the Data Booklet.**

**(b) State the number of degrees of freedom in Chris' test, giving a reason for your answer.  
(1 mark)**

**(continued on the next page)**

3. continued.

(c) Carry out the test at the 5% level of significance.

You should state your hypotheses, test statistic, critical value and conclusion clearly.

(5 marks)

(d) Showing your working, find an alternative model which would better fit Chris' data.

(2 marks)

(Total for Question 3 is 9 marks)

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4. Refer to the table for Question 4 in the Data Booklet. The discrete random variable  $X$  has the probability distribution shown in the table in the Data Booklet.

(a) Find in terms of  $q$

(i)  $E(X)$

(ii)  $E(X^2)$

(2 marks)

Given that  $\text{Var}(X) = 3.66$

(b) show that  $q = 0.3$

(3 marks)

(continued on the next page)

4. continued.

In a game, the score is given by the discrete random variable  $X$

Given that games are independent,

- (c) calculate the probability that after the 4th game has been played, the total score is exactly 20  
(3 marks)

(continued on the next page)

4. continued.

A round consists of **4** games plus **2** bonus games.

The bonus games are only played if after the **4th** game has been played the total score is exactly **20**

A prize of **£10** is awarded if **6** games are played in a round **AND** the total score for the round is at least **27**

Bobby plays **3** rounds.

- (d) Find the probability that Bobby wins at least **£10**  
(6 marks)

(Total for Question 4 is 14 marks)

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**TOTAL FOR FURTHER STATISTICS 1 IS 40 MARKS**  
**END OF PAPER**

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