

Paper Reference 9FM0/3B

Pearson Edexcel

Level 3 GCE

Further Mathematics

Advanced

PAPER 3B: Further Statistics 1

Friday 13 June 2025 – Afternoon

Time: 1 hour 30 minutes

Question Paper

**THIS DOCUMENT MUST BE RETURNED TO
PEARSON AT THE END OF THE EXAMINATION.**

In the boxes below, write your name, centre number and candidate number.

Surname					
Other names					
Centre Number					
Candidate Number					

YOU MUST HAVE

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

YOU WILL BE GIVEN

Diagram Booklet

Answer Booklet

Candidates may use any calculator permitted 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

Answer ALL questions and ensure that your answers to parts of questions are clearly labelled.

Answer the questions in the spaces provided in the Answer Booklet or in the separate Diagram Booklet – 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 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.

INFORMATION

A booklet 'Mathematical Formulae and Statistical Tables' is provided.

There are **7** questions in this Question Paper.

The total mark for this paper is **75**

The marks for EACH question are shown in brackets – use this as a guide as to how much time to spend on each question.

There may be spare copies of some diagrams.

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. Irina is practising her serves in badminton and counts the number of her serves that are faults. She finds that **15%** of her serves are faults.

Assuming that each serve is independent,

(a) find the probability that

(i) Irina's **4th** fault comes on her **20th** serve,
(2 marks)

(ii) in **18** serves, Irina has **4** faults.
(2 marks)

With practice, Irina reduces her proportion of faults, p , so that the mean number of serves until her **4th** fault is at least **32**

(b) Find the maximum value of p
(3 marks)

(Total for Question 1 is 7 marks)

2. Refer to the table for Question 2 in the Diagram Booklet.

The discrete random variable X has the probability distribution shown in the table, where a and b are positive constants.

- (a) Find an expression for $E(X)$ in terms of a and b
(2 marks)

The discrete random variable Y is defined as $Y = a + bX$

Given that

$$\text{Var}(Y) = \frac{1}{4} \text{Var}(X) \text{ and}$$

$$E(Y) = \frac{5}{16}$$

- (b) find the value of $E(X)$
(7 marks)

(Total for Question 2 is 9 marks)

- 3. Refer to Table 1, Table 2 and Table 3 for Question 3 in the Diagram Booklet.**

A journalist uses a gender equality test on some randomly chosen films.

She believes that whether or not a film passes the test is associated with the period in which the film is first released.

Her data is summarised in Table 1 in the Diagram Booklet.

The journalist decides to test whether the data supports her belief.

Some of the expected frequencies she calculates are shown in Table 2 in the Diagram Booklet.

- (a) Complete Table 2 showing expected frequencies.**

**There are four spaces to fill
(2 marks)**

(continued on the next page)

3. continued.

(b) Write down hypotheses for a suitable test to assess the journalist's belief.

(1 mark)

(c) Showing your working clearly, test the journalist's belief using a 5% level of significance.

You should state your critical value and conclusion clearly.

(6 marks)

(continued on the next page)

3. continued.

The journalist wants to publish her data and findings.

She decides to publish the data as **PERCENTAGES** of pass and fail for each period, as shown in Table 3 in the Diagram Booklet, rather than as **FREQUENCIES**.

The editor suggests carrying out the hypothesis test of the journalist's belief using the percentages in Table 3.

(d) (i) Describe the effect this would have on the test statistic, justifying your answer.

(ii) Explain whether or not the journalist should follow her editor's suggestion.

(3 marks)

(Total for Question 3 is 12 marks)

4. The discrete random variable X has probability generating function

$$G_X(t) = \frac{1}{\left(1 - \frac{2t}{5}\right)} - k$$

where k is a constant.

- (a) Find the exact value of k
(2 marks)

- (b) Find the exact value of $E(X)$
(3 marks)

- (c) Find $P(X = 2)$
(3 marks)

(continued on the next page)

4. continued.

The random variable Y is defined as

$$Y = 4X - 1$$

- (d) Find the probability generating function of Y
(2 marks)

(Total for Question 4 is 10 marks)

5. A football team scores goals at an average rate of 1.8 goals per match.

- (a) Give two assumptions that would be necessary to use a Poisson distribution to model the number of goals scored in a match by the team.
(2 marks)

Given that in their next match the team scores exactly 3 goals,

- (b) find the exact probability that 2 of these goals were scored in the first half of the match.
(4 marks)

(continued on the next page)

5. continued.

A hockey team plays **2** games each week during a **40**–week season.

Each game consists of **2** periods.

The probability that the team concedes no goals in a period is **0.55**

The random variable **X** represents the number of **PERIODS** in a week in which the team concedes no goals.

(c) (i) Write down a suitable distribution for **X**

(ii) For this **40**–week season, use the Central Limit Theorem to estimate

$$P(\bar{X} > 2)$$

(4 marks)

(Total for Question 5 is 10 marks)

6. A biased coin and a fair coin are thrown repeatedly.

The probability that the biased coin shows heads is $\frac{1}{3}$

Let **B** represent the number of throws of the biased coin until it shows heads for the first time.

Let **F** represent the number of throws of the fair coin until it shows heads for the first time.

(a) Find

(i) $P(B = 3)$
(2 marks)

(ii) $P(2 \leq F \leq 8)$
(3 marks)

(iii) $P(\{B = 3\} \cup \{F = 3\})$
(3 marks)

(continued on the next page)

6. continued.

Each day Chris invites his friend Shivani to play a game with these coins.

One player's score will be X and the other player's score will be Y , where

$$X = 4F \quad \text{and} \quad Y = \frac{B^2}{2}$$

Chris and Shivani will play a large number of games and the winner will be the player with the higher TOTAL score.

Before their first game, Chris allows Shivani to choose whether her score for every game will be X or her score for every game will be Y

(b) State, explaining your reasoning and showing any calculations you have made, which choice Shivani should make.

(5 marks)

(Total for Question 6 is 13 marks)

7. A software company develops computer programs. Its **Lovelace** program is found to glitch **7** times on average when it is run.

The company makes some alterations to improve the program.

It then tests to see if it has been successful in reducing the average number of glitches per run.

The glitches can be assumed to occur independently.

(a) (i) State suitable hypotheses for the test.

(ii) Find the critical region for the test at a **10%** level of significance.

(iii) State the size of the test.

(4 marks)

(continued on the next page)

7. continued.

The altered program is actually found to glitch 5 times on average when run.

(b) Find the probability of a Type II error for the company's test.

(3 marks)

Due to the high value of the probability of a Type II error in part (b), the company makes an entirely new version of the program.

The new version of the program is designed to have an average of fewer than k glitches per run.

The random variable T represents the number of RUNS of the program until a run with no glitches occurs.

(c) Write down the name of a suitable distribution for T

(1 mark)

(continued on the next page)

7. continued.

If the new version has an average of λ glitches per run, this new version of the program will be tested using the hypotheses

$$H_0 : \lambda = k$$

$$H_1 : \lambda < k$$

The company will reject H_0 if the first run without any glitches of the new version occurs within n runs.

(d) Show that the power function of the test is given by

$$1 - (1 - e^{-\lambda})^n$$

(2 marks)

(continued on the next page)

7. continued.

The company requires

$$P(\text{Type II error}) < 0.2$$

Assuming that the new version of the program has an average of 2.75 glitches per run,

- (e) find the minimum value of n
(4 marks)

(Total for Question 7 is 14 marks)

TOTAL FOR PAPER IS 75 MARKS

END OF PAPER