Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Mock Examination

(Time: 1 hour 30 minutes) | Paper Reference **9FM0/3B**

Further Mathematics

Advanced

Paper 3B: Further Statistics 1

You must have:
Mathematical Formulae and Statistical Tables, calculator

Total Marks

Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for algebraic 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.
- 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.*

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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Answer ALL questions. Write your answers in the spaces provided.

1. In a survey, a large number of people were asked whether or not they recycle plastics. In each case the distance, in metres, from their home to the nearest plastic recycling point was measured and recorded. The results are shown in Table 1

Observed frequencies		**Recycle plastics**	
		Yes	**No**
Distance to nearest plastic recycling point	**Less than 500 m**	64	42
	500–1000 m	32	22
	More than 1000 m	14	26

Table 1

The Council's Environment Officer, Barbara, believes that whether or not people recycle plastics is independent of the distance to the nearest recycling point.

Barbara decides to test if the data from the survey supports her belief. Her expected frequencies are shown in Table 2

Expected frequencies		**Recycle plastics**	
		Yes	**No**
Distance to nearest plastic recycling point	**Less than 500 m**	58.3	47.7
	500–1000 m	29.7	24.3
	More than 1000 m	22	18

Table 2

(a) Carry out a hypothesis test, at the 5% significance level, to see if the data from the survey support Barbara's belief. State your hypotheses and the critical value used in this test.

(5)

Barbara explains her results to her assistant, Bill. The data were collected by Bill, who now confesses to Barbara that he actually only collected data from 100 people and then doubled all his results.

(b) With reference to the test statistic and critical value, explain whether or not Barbara's conclusions are still valid.

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Question 1 continued

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Question 1 continued

(Total for Question 1 is 7 marks)

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2. A bag contains 10 tokens, 3 are red and 7 are green. Tokens are removed, one at a time, without replacement until a red token is removed or until 4 tokens have been removed, whichever occurs first.

The discrete random variable X represents the number of tokens removed.

(a) Show that $P(X = 4) = \frac{7}{24}$

(2)

The probability distribution of X is given in the table below

x	1	2	3	4
$P(X = x)$	$\frac{3}{10}$	$\frac{7}{30}$	$\frac{7}{40}$	$\frac{7}{24}$

(b) Showing your working clearly, find $\text{Var}(X)$

(4)

The same bag of 10 tokens is now used again. This time a token is removed, the colour is noted and the token is replaced. This procedure is repeated until a red token is removed.

The discrete random variable Y represents the number of green tokens removed.

(c) Showing your working clearly, find $\text{Var}(Y)$

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Question 2 continued

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3. The discrete random variable X has distribution $X \sim \text{Po}(10.8)$

(a) (i) Find the probability that $X = 9$

(ii) Find the probability that X is at least 9

(3)

Charlie has a mobile phone. His parents claim that on average he looks at his mobile phone no more than 3 times every 30 minutes. Charlie's teacher suspects that this may not be true and that Charlie looks at his mobile phone more frequently than 3 times every 30 minutes. She decides to carry out a hypothesis test of her belief, at a 5% significance level.

She observes Charlie during a 1-hour revision class and notes the number of times that he looks at his mobile phone.

If Charlie actually looks at his mobile phone at an average rate of 5 times every 30 minutes,

(b) find the power of the teacher's hypothesis test, stating her hypotheses.

(6)

(c) State an assumption the teacher needs to make in order for this test to be valid.

(1)

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Question 3 continued

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Question 3 continued

(Total for Question 3 is 10 marks)

4. Desmond believes that a particular six-sided die is biased. He decides to count the number of rolls required until he first rolls a 5 or a 6. He carries out this experiment 100 times. His results are summarised in the table below

Number of rolls to 1st 5 or 6	1	2	3	4	5	6	7 or more
Observed frequency	39	17	17	10	3	3	11

(a) Stating your hypotheses clearly, test, at the 5% significance level, whether or not these results provide evidence that the die is biased. You should show your working clearly, including the expected frequencies and the critical value used.

(10)

Mai suggests recording the results of rolling the die 100 times and using a goodness of fit test for a discrete uniform distribution.

(b) (i) Give 2 reasons why Mai might think that her test is better than Desmond's test.

(ii) Give a reason why Desmond might think that his test is better than Mai's test.

(3)

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Question 4 continued

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Question 4 continued

(Total for Question 4 is 13 marks)

5. A laboratory checks soil samples for evidence of lead contamination. Past records suggest that 0.5% of samples test positive for lead contamination.

As part of a new contract the laboratory receives batches of 1000 independent soil samples. The random variable X represents the number of soil samples that test positive for lead contamination out of a batch of 1000 independent soil samples.

Ushma wants to calculate the probability that at least 10 soil samples will test positive for lead contamination out of a batch of 1000 independent soil samples.

(a) (i) State the distribution of X.

(ii) Calculate the percentage error if Ushma uses a Poisson distribution to estimate this probability.

(6)

Ushma decides to use $X \geqslant 9$ as the critical region to test the hypotheses

$$H_0 : p = 0.005 \quad \text{against} \quad H_1 : p > 0.005$$

where p is the probability that a randomly selected soil sample tests positive for lead contamination.

Ushma's colleague Javed suggests an alternative test of size 8%. Their manager Chris wants to minimise the probability of a Type I error. Given no further information about Javed's test,

(b) explain which of these tests you would advise Chris to use. Give a reason for your answer.

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Question 5 continued

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Question 5 continued

(Total for Question 5 is 10 marks)

6. Malik is a circus clown. As a part of his act he throws darts at a modified dartboard whilst blindfolded. He knows that there is a probability of 0.8 that each dart misses the bullseye.

In rehearsals, Malik throws darts at the dartboard whilst blindfolded until his assistant tells him he has hit the bullseye 3 times.

(a) (i) Calculate how many darts Malik should expect to throw in order to hit the bullseye 3 times.

(3)

(ii) State two assumptions that need to be made about Malik's throws of the darts in order for this calculation to be valid.

(2)

Malik rehearses once a day for each of 100 days.

Given that the assumptions in part (a) are true,

(b) calculate an estimate of the probability that the mean number of throws required is at least 16

(5)

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Question 6 continued

(Total for Question 6 is 10 marks)

7. A discrete random variable X has probability generating function $G_X(t) = e^{\lambda(t-1)}$ where λ is a positive constant.

(a) Use calculus to show that $E(X) = \lambda$

(3)

A discrete random variable Y has probability generating function $G_Y(t) = \left(\frac{t^2}{a} + b\right)^n$

where a and b are both positive and n is a positive integer.

(b) Show that

$$b = 1 - \frac{1}{a}$$

(2)

(c) Hence find the range of possible values of a

(2)

(d) In the case where $n = 4$, use calculus to show that $\text{Var}(Y) = \frac{16}{a^2}(a - 1)$

(8)

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Question 7 continued

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TOTAL FOR PAPER IS 75 MARKS

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