

Please check the examination details below before entering your candidate information

Candidate surname					Other names									
Pearson Edexcel Level 3 GCE					Centre Number					Candidate Number				
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Time 1 hour 30 minutes					Paper reference					9FM0/3B				
Further Mathematics Advanced PAPER 3B: Further Statistics 1 October 2021 Shadow Set 1														
You must have: Mathematical Formulae and Statistical Tables (Green), calculator										Total Marks <input type="text"/>				

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

- 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.
- 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.*

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.
- Good luck with your examination.

Turn over ►

1. Kelly throws a tetrahedral die n times and records the number on which it lands for each throw.

She calculates the expected frequency for each number to be 43 if the die was unbiased.

The table below shows three of the frequencies Kelly records but the fourth one is missing.

Number	1	2	3	4
Frequency	46	33	38	x

- (a) Show that $x = 55$

(1)

Kelly wishes to test, at the 5% level of significance, whether or not there is evidence that the tetrahedral die is unbiased.

- (b) Explain why there are 3 degrees of freedom for this test.

(1)

- (c) Stating your hypotheses clearly and the critical value used, carry out the test.

(5)

(Total for Question 1 is 7 marks)

2. On a weekday, a factory monitors the randomly produced faulty items, at a mean rate of 1.2 per 15 minutes.

(a) Show that the probability that on a weekday at least 3 faults produced by the Machine in a 60 minute slot is 0.857 to 3 decimal places. (2)

(b) Calculate the probability that at least 3 faults are recorded in fewer than 4 out of 7 randomly selected, non-overlapping 60-minute periods on a weekday. (2)

The manager of the factory randomly selects 120 non-overlapping 60-minute periods on weekdays.

She records the number of faults produced in each of these 60-minute periods.

(c) Using a Poisson approximation show that the probability of the manager finding at least 4 of these 60-minute periods when exactly 10 faults are found is 0.103 to 3 significant figures. (4)

(d) Explain why the Poisson approximation may be reasonable in this case. (1)

The manager of the factory decided to investigate if the number of faults produced is different on a Saturday to a weekday. She selects a Saturday at random and records the number faults produced in the first 3.5 hours.

(e) Write down the hypotheses for this test. (1)

The manager found that there had been 23 faults in the first 3.5 hours

(f) Carry out the test using a 5% level of significance. (4)

(Total for Question 2 is 14 marks)

3. A food delivery company delivers takeaway food. A random variable X represents the number of food deliveries made each day by the company where $X \sim B(300, 0.72)$

A random sample X_1, X_2, \dots, X_{100} is taken.

Estimate the probability that the mean number of food deliveries delivered each day by the company is greater than 217

(4)

(Total for Question 3 is 4 marks)

4. A spinner with numbers 0 to 5 is used to play at a games club has the following probability distribution:.

n	0	1	2	3	4	5
$P(N = n)$	0.1	a	0.25	b	c	0.2

Given that $E(2N + 5) = 9.6$ and $P(N = 1|N < 3) = \frac{6}{13}$

The probability of landing on a 3 is twice the probability of landing on a 4.

(a) show that $\text{Var}(N) = 2.71$

(6)

The games club pay 20p if you land on 3, 4 or 5 otherwise you win 10p.

(b) calculate the expected winnings per player.

(3)

Bai suggests that, as the mean and variance are close, a Poisson distribution could be used to model the amount won by a player.

(c) State a limitation of the Poisson distribution in this case.

(1)

(Total for Question 4 is 10 marks)

5. Three bags labelled **A**, **B** and **C** respectively contain a large number of marbles coloured either yellow or green.

A Marble is drawn from a bag one at a time, the colour is noted and returned to the bag.

The probability of drawing a yellow marble in one go from bag **A** is 0.04

- (a) Find the probability of drawing at least 3 green marbles before getting a red from bag **A** (2)
- (b) Find the probability of drawing a second yellow marble from bag **A** on the 10th draw. (2)

The probability of getting a yellow marble on any one draw from bag **B** is p .

A marble is drawn and replaced from bag **B** until n yellow marbles are drawn. The random variable D is the number of marbles drawn.

Given that the mean and the standard deviation of D are 22500 and 300 respectively,

- (c) find the value of p . (4)

Tom believe bag **C** has a smaller proportion of yellow marbles than bag **A**. To test this Tom draws marbles from bag **C** until he gets a yellow. Tom defines the random variable J to be the number of marbles drawn up to and including the first yellow counter.

- (d) Stating your hypotheses clearly and using a 5% level of significance, find the critical region for this test. (5)

Tom gets a yellow marble for the first time on his 24th draw.

- (e) Giving a reason for your answer, state whether or not there is evidence that bag **C** contains a smaller proportion of yellow marbles than bag **A**. (2)

Given that the probability of getting a yellow from bag **C** on any one draw is 0.013

- (f) show that the power of the test is 0.380 to 3 significant figures. (3)

(Total for Question 5 is 18 marks)

6. The probability generating function of the random variable X is

$$G_X(t) = k(2 + t)^4$$

where k is a constant.

(a) Show that $k = \frac{1}{81}$ (2)

(b) Find $P(X = 2)$ (2)

(c) Find the probability generating function of $W = 3X + 2$ (2)

The probability generating function of the random variable Y is

$$G_Y(t) = \frac{t(2+t)^2}{9}$$

Given that X and Y are independent,

(d) find the probability generating function of $U = X + Y$ in its simplest form. (2)

(e) Use calculus to find the value of $\text{Var}(U)$ (6)

(Total for Question 6 is 14 marks)

7. A manufacturer has a machine that produces jars of jam.
The volume of jam produced by the machine is normally distributed with unknown mean μ and standard deviation 0.15

Andrew believes that the machine is not working properly and the mean volume of the jars of jam has decreased.

He takes a random sample of size n to test, at the 1% level of significance, the hypotheses

$$H_0: \mu = 22 \quad H_1: \mu < 22$$

- (a) Write down the size of this test.

(1)

Given that the actual value of μ is 21.8

- (b) (i) calculate the minimum value of n such that the probability of a Type II error is less than 0.05

Show your working clearly.

(6)

- (ii) Andrew uses the same sample size, n , but now carries out the test at a 5% level of significance. Without doing any further calculations, state how this would affect the probability of a Type II error.

(1)

(Total for Question 7 is 8 marks)

TOTAL FOR PAPER IS 75 MARKS