

Write your name here

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Other names

**Pearson Edexcel**  
**Level 3 GCE**

Centre Number

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Candidate Number

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# Further Mathematics

Advanced

Further Mathematics Option 1

Paper 3: Further Statistics 1

Further Mathematics Option 2

Paper 4: Further Statistics 1

Sample Assessment Material for first teaching September 2017

**Time: 1 hour 30 minutes**

Paper Reference

**9FM0/3B****9FM0/4B****You must have:**

Mathematical Formulae and Statistical Tables, calculator

Total Marks

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**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. Bacteria are randomly distributed in a river at a rate of 5 per litre of water. A new factory opens and a scientist claims it is polluting the river with bacteria. He takes a sample of 0.5 litres of water from the river near the factory and finds that it contains 7 bacteria. Stating your hypotheses clearly test, at the 5% level of significance, whether there is evidence that the level of pollution has increased.

(5)

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**Question 1 continued**

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**(Total for Question 1 is 5 marks)**

2. A call centre routes incoming telephone calls to agents who have specialist knowledge to deal with the call. The probability of a caller, chosen at random, being connected to the wrong agent is  $p$ .

The probability of at least 1 call in 5 consecutive calls being connected to the wrong agent is 0.049

The call centre receives 1000 calls each day.

- (a) Find the mean and variance of the number of wrongly connected calls a day. (7)
- (b) Use a Poisson approximation to find, to 3 decimal places, the probability that more than 6 calls each day are connected to the wrong agent. (2)
- (c) Explain why the approximation used in part (b) is valid. (2)

The probability that more than 6 calls each day are connected to the wrong agent using the binomial distribution is 0.8711 to 4 decimal places.

(d) Comment on the accuracy of your answer in part (b). (1)

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**Question 2 continued**

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**(Total for Question 2 is 12 marks)**

3. Bags of £1 coins are paid into a bank. Each bag contains 20 coins.

The bank manager believes that 5% of the £1 coins paid into the bank are fakes. He decides to use the distribution  $X \sim B(20, 0.05)$  to model the random variable  $X$ , the number of fake £1 coins in each bag.

The bank manager checks a random sample of 150 bags of £1 coins and records the number of fake coins found in each bag. His results are summarised in Table 1. He then calculates some of the expected frequencies, correct to 1 decimal place.

<b>Number of fake coins in each bag</b>	0	1	2	3	4 or more
<b>Observed frequency</b>	43	62	26	13	6
<b>Expected frequency</b>	53.8	56.6		8.9	

**Table 1**

- (a) Carry out a hypothesis test, at the 5% significance level, to see if the data supports the bank manager's statistical model. State your hypotheses clearly. (10)

The assistant manager thinks that a binomial distribution is a good model but suggests that the proportion of fake coins is higher than 5%. She calculates the actual proportion of fake coins in the sample and uses this value to carry out a new hypothesis test on the data. Her expected frequencies are shown in Table 2.

<b>Number of fake coins in each bag</b>	0	1	2	3	4 or more
<b>Observed frequency</b>	43	62	26	13	6
<b>Expected frequency</b>	44.5	55.7	33.2	12.5	4.1

**Table 2**

- (b) Explain why there are 2 degrees of freedom in this case. (2)
- (c) Given that she obtains a  $\chi^2$  test statistic of 2.67, test the assistant manager's hypothesis that the binomial distribution is a good model for the number of fake coins in each bag. Use a 5% level of significance and state your hypotheses clearly. (2)

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**Question 3 continued**

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**Question 3 continued**

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**(Total for Question 3 is 14 marks)**

4. A random sample of 100 observations is taken from a Poisson distribution with mean 2.3

Estimate the probability that the mean of the sample is greater than 2.5

(4)

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- 5. The probability of Richard winning a prize in a game at the fair is 0.15

Richard plays a number of games.

- (a) Find the probability of Richard winning his second prize on his 8th game, (2)

- (b) State two assumptions that have to be made, for the model used in part (a) to be valid. (2)

Mary plays the same game, but has a different probability of winning a prize. She plays until she has won  $r$  prizes. The random variable  $G$  represents the total number of games Mary plays.

- (c) Given that the mean and standard deviation of  $G$  are 18 and 6 respectively, determine whether Richard or Mary has the greater probability of winning a prize in a game. (4)

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6. The probability generating function of the discrete random variable  $X$  is given by

$$G_X(t) = k(3 + t + 2t^2)^2$$

(a) Show that  $k = \frac{1}{36}$  (2)

(b) Find  $P(X = 3)$  (2)

(c) Show that  $\text{Var}(X) = \frac{29}{18}$  (8)

(d) Find the probability generating function of  $2X + 1$  (2)

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**Question 6 continued**

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7. Sam and Tessa are testing a spinner to see if the probability,  $p$ , of it landing on red is less than  $\frac{1}{5}$ . They both use a 10% significance level.

Sam decides to spin the spinner 20 times and record the number of times it lands on red.

- (a) Find the critical region for Sam's test. (2)

- (b) Write down the size of Sam's test. (1)

Tessa decides to spin the spinner until it lands on red and she records the number of spins.

- (c) Find the critical region for Tessa's test. (6)

- (d) Find the size of Tessa's test. (1)

- (e) (i) Show that the power function for Sam's test is given by

$$(1 - p)^{19}(1 + 19p)$$

- (ii) Find the power function for Tessa's test. (4)

- (f) With reference to parts (b), (d) and (e), state, giving your reasons, whether you would recommend Sam's test or Tessa's test when  $p = 0.15$  (4)

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