



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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9709/61

May/June 2024

1 hour 15 minutes

You will need: List of formulae (MF19)

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
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- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

- The total mark for this paper is 50.
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This document has **16** pages. Any blank pages are indicated.

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- 1 A bus station has exactly four entrances. In the morning the numbers of passengers arriving at these entrances during a 10-second period have the independent distributions $\text{Po}(0.4)$, $\text{Po}(0.1)$, $\text{Po}(0.2)$ and $\text{Po}(0.5)$.

Find the probability that the total number of passengers arriving at the four entrances to the bus station during a randomly chosen 1-minute period in the morning is more than 3. [3]

[illegible]

- 2** The random variable X has the distribution $N(31.2, 10.4^2)$. Two independent random values of X , denoted by X_1 and X_2 , are chosen.

Find $P(X_1 > 3X_2)$.

[5]

[illegible]

- 3 The time taken in minutes for a certain daily train journey has a normal distribution with standard deviation 5.8. For a random sample of 20 days the journey times were noted and the mean journey time was found to be 81.5 minutes.

(a) Calculate a 98% confidence interval for the population mean journey time. [3]

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A student was asked for the meaning of this confidence interval. The student replied as follows.

‘The times for 98% of these journeys are likely to be within the confidence interval.’

(b) Explain briefly whether this statement is true or not. [1]

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Two independent 98% confidence intervals are found.

(c) Given that at least one of these intervals contains the population mean, find the probability that both intervals contain the population mean. [2]

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- 4 (a) A random sample of 8 boxes of cereal from a certain supplier was taken. Each box was weighed and the masses in grams were as follows.

261 249 259 252 255 256 258 254

Find unbiased estimates of the population mean and variance.

[3]

[illegible]

- (b) The supplier claims that the mean mass of boxes of cereal is 253 g. A quality control officer suspects that the mean mass is actually more than 253 g. In order to test this claim, he weighs a random sample of 100 boxes of cereal and finds that the total mass is 25 360 g.
- (i) Given that the population standard deviation of the masses is 3.5 g, test at the 5% significance level whether the population mean mass is more than 253 g. [5]

This image shows a single page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

An employee says, ‘This test is invalid because it uses the normal distribution, but we do not know whether the masses of the boxes are normally distributed.’

- (ii) Explain briefly whether this statement is true or not. [1]

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5 Sales of cell phones at a certain shop occur singly, randomly and independently.

- (a) State one further condition that must be satisfied for the number of sales in a certain time period to be well modelled by a Poisson distribution. [1]

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The average number of sales per hour is 1.2 .

Assume now that a Poisson distribution is a suitable model.

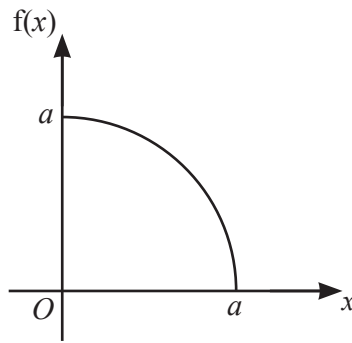
- (b)** Find the probability that the number of sales during a randomly chosen 12-hour period will be more than 12 and less than 16. [3]

[illegible]

- (c) Use a suitable approximating distribution to find the probability that the number of sales during a randomly chosen 1-month period (140 hours) will be less than 150. [4]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school handwriting practice paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

6



The diagram shows the graph of the probability density function, f , of a random variable X . The graph is a quarter circle entirely in the first quadrant with centre $(0,0)$ and radius a , where a is a positive constant. Elsewhere $f(x) = 0$.

- (a) Show that $a = \frac{2}{\sqrt{\pi}}$. [2]

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- (b) Show that $f(x) = \sqrt{\frac{4}{\pi} - x^2}$. [2]

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(c) Show that $E(X) = \frac{8}{3\sqrt{\pi^3}}$.

[4]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 7 Every July, as part of a research project, Rita collects data about sightings of a particular kind of bird. Each day in July she notes whether she sees this kind of bird or not, and she records the number X of days on which she sees it. She models the distribution of X by $B(31, p)$, where p is the probability of seeing this kind of bird on a randomly chosen day in July.

Data from previous years suggests that $p = 0.3$, but in 2022 Rita suspected that the value of p had been reduced. She decided to carry out a hypothesis test.

In July 2022, she saw this kind of bird on 4 days.

- (a) Use the binomial distribution to test at the 5% significance level whether Rita's suspicion is justified. [5]

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In July 2023, she noted the value of X and carried out another test at the 5% significance level using the same hypotheses.

- (b) Calculate the probability of a Type I error. [2]

- [illegible]

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This image shows a full page of a handwriting practice worksheet. It consists of multiple rows of horizontal dashed lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

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9709/62

May/June 2024

1 hour 15 minutes

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This document has **12** pages.

1 A random variable X has the distribution $\text{Po}(145)$.

(a) Use a suitable approximating distribution to calculate $P(X \leq 150)$.

[4]

[illegible]

(b) Justify the use of your approximating distribution in this case.

[1]

This image shows a blank sheet of white paper with ten horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and extend across the width of the page. There is no handwriting or other markings on the paper.

- 2 Henri wants to choose a random sample from the 804 students at his college. He numbers the students from 1 to 804 and then uses random numbers generated by his calculator. The first 20 random digits produced by his calculator are as follows.

5 6 7 1 0 9 8 4 3 1 0 9 6 6 5 0 2 1 7 6

Henri's first two student numbers are 567 and 109.

- (a) Use Henri's digits to find the numbers of the next two students in the sample. [2]

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There were 30 students in Henri's sample. He asked each of them how much time, X hours, they spent on social media each week, on average. He summarised the results as follows.

$$n = 30 \qquad \Sigma x = 610 \qquad \Sigma x^2 = 12405$$

- (b)** Use this information to calculate an unbiased estimate of the mean of X and show that an unbiased estimate of the variance of X is less than 0.1 . [3]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school handwriting practice paper. The lines are evenly spaced and run across the entire width of the page. There are no margins, text, or other markings present.

- (c) Henri's friend claims that Henri has probably made a mistake in his calculation of Σx or Σx^2 .

Use your answer to part (b) to comment on this claim. [1]

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- 3 A student wishes to estimate the proportion, p , of students at her college who have exactly one brother. She surveys a random sample of 50 students at her college and finds that 18 of them have exactly one brother. She calculates an approximate $\alpha\%$ confidence interval for p and finds that the lower limit of the confidence interval is 0.244 correct to 3 significant figures.

Find α correct to the nearest integer.

[4]

This image shows a full page of a worksheet designed for handwriting practice. It consists of approximately 20 evenly spaced, horizontal dotted lines extending across the entire width of the page. The background is plain white, providing a clear guide for letter formation and alignment. There are no margins, text, or other markings present.

- 4 A random variable X has the distribution $N(10, 12)$. Two independent values of X , denoted by X_1 and X_2 , are chosen at random.

(a) Write down the value of $P(X_1 > X_2)$. [1]

(b) Find $P(X_1 > 2X_2 - 3)$. [5]

This image shows a full page of a handwriting practice worksheet. It consists of multiple rows of horizontal dotted lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

- 5** The number of goals scored by a sports team in the first half of any match has the distribution $X \sim \text{Po}(3.1)$. The number of goals scored by the same team in the second half of any match has the distribution $Y \sim \text{Po}(2.4)$. You may assume that the distributions of X and Y are independent.

(a) Find $P(X < 4)$.

[2]

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(b) Find the probability that, in a randomly chosen match, the team scores at least 5 goals.

[3]

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- (c) Given that the team scores a total of 5 goals in a randomly chosen match, find the probability that they score exactly 3 goals in the first half. [4]

[illegible]

- 6 The masses of cereal boxes filled by a certain machine have mean 510 grams. An adjustment is made to the machine and an inspector wishes to test whether the mean mass of cereal boxes filled by the machine has decreased.

After the adjustment is made, he chooses a random sample of 120 cereal boxes. The mean mass of these boxes is found to be 508 grams.

Assume that the standard deviation of the masses is 10 grams.

- (a) Test at the 2.5% significance level whether the mean mass of cereal boxes filled by the machine has decreased. [5]

[illegible]

Later the inspector carries out a similar test at the 2.5% significance level, using the same hypotheses and another 120 randomly chosen cereal boxes.

- (b)** Given that the mean mass is now actually 506 grams, find the probability of a Type II error. [5]

[illegible]

9709/62/M/J/24

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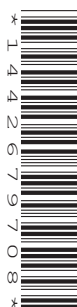
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MATHEMATICS
9709/63

Paper 6 Probability & Statistics 2

May/June 2024
1 hour 15 minutes

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INSTRUCTIONS

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(a) Use a suitable approximating distribution to find $P(2 \leq X < 5)$. [3]

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(b) Justify your approximating distribution in this case. [1]

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- (a) Calculate an estimate of the population standard deviation. [3]

[illegible]

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[illegible]



Test at the 5% significance level whether support for the Today Party has decreased. [5]

[illegible]



5 A random variable X has probability density function f given by

$$f(x) = \begin{cases} ax - x^3 & 0 \leq x \leq \sqrt{2}, \\ 0 & \text{otherwise,} \end{cases}$$

where a is a constant.

(a) Show that $a = 2$.

[3]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school handwriting practice paper. The lines are evenly spaced and run across the entire width of the page. There are no margins, text, or other markings on the paper.

(b) Find the median of X .

[4]

[illegible]



[3]



6 The numbers of green sweets in 200 randomly chosen packets of Frutos are summarised in the table.

Number of green sweets	0	1	2	3	> 3
Number of packets	32	50	97	21	0

- (a) Calculate an unbiased estimate for the population mean of the number of green sweets in a packet of Frutos, and show that an unbiased estimate of the population variance is 0.783 correct to 3 significant figures. [3]

[illegible]

The manufacturers of Frutos claim that the mean number of green sweets in a packet is 1.65 .

Anji believes that the true value of the mean, μ , is less than 1.65 . She uses the results from the 200 randomly chosen packets to test the manufacturers' claim.

- (b) State suitable null and alternative hypotheses for the test. [1]

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- Explain how this shows that the significance level that Anji used in her test was not 1%. [1]

[illegible]



7 The independent random variables X and Y have the distributions $\text{Po}(1.9)$ and $\text{Po}(2.2)$ respectively.

(a) Find $P(X + Y < 4)$. [3]

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(b) Find the probability that $X = 2$ given that $X + Y < 4$. [4]

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- Find the probability that the sample mean of $X+Y$ is less than 4.0 . [6]

[illegible]

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