



Cambridge International AS & A Level

CANDIDATE
NAME

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

FURTHER MATHEMATICS

9231/43

Paper 4 Further Probability & Statistics

October/November 2021

1 hour 30 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- 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.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- 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.

INFORMATION

- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [].

This document has **16** pages. Any blank pages are indicated.

BLANK PAGE

- 1 The times taken for students at a college to run 200 m have a normal distribution with mean μ s. The times, x s, are recorded for a random sample of 10 students from the college. The results are summarised as follows, where $\bar{x}$ is the sample mean.

$\bar{x} = 25.6 \qquad \sum(x - \bar{x})^2 = 78.5$

- (a) Find a 90% confidence interval for μ . [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

A test of the null hypothesis $\mu = k$ is carried out on this sample, using a 10% significance level. The test does not support the alternative hypothesis $\mu < k$.

- (b) Find the greatest possible value of k . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

2 The continuous random variable X has cumulative distribution function F given by

$$F(x) = \begin{cases} 0 & x < -1, \\ \frac{1}{2}(1+x)^2 & -1 \leq x \leq 0, \\ 1 - \frac{1}{2}(1-x)^2 & 0 < x \leq 1, \\ 1 & x > 1. \end{cases}$$

(a) Find the probability density function of X . [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Find $P\left(-\frac{1}{2} \leq X \leq \frac{1}{2}\right)$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Find $E(X^2)$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(d) Find $\text{Var}(X^2)$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 3 A supermarket sells pears in packs of 8. Some of the pears in a pack may not be ripe, and the supermarket manager claims that the number of unripe pears in a pack can be modelled by the distribution $B(8, 0.15)$.

A random sample of 150 packs was selected and the number of unripe pears in each pack was recorded. The following table shows the observed frequencies together with some of the expected frequencies using the manager’s binomial distribution.

Number of unripe pears per pack	0	1	2	3	4	5	≥ 6
Observed frequency	35	48	43	15	6	3	0
Expected frequency	40.874	p	35.641	12.579	2.775	0.392	q

- (a) Find the values of p and q . [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b) Carry out a goodness of fit test, at the 5% significance level, to test whether the manager’s claim is justified. [6]

.....

.....

.....

.....

.....

.....

.....

.....

.....

Use a t -test, at the 5% significance level, to test whether Manet's claim is justified, stating any assumption that you make. [8]

[illegible]

5 Nine balls labelled 1, 2, 3, 4, 5, 6, 7, 8, 9 are placed in a bag. Kai selects three balls at random from the bag, without replacement. The random variable X is the number of balls selected by Kai that are labelled with a multiple of 3.

(a) Find the probability generating function $G_X(t)$ of X . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The balls are replaced in the bag.

Jacob now selects two balls at random from the bag, without replacement. The random variable Y is the number of balls selected by Jacob that are labelled with an even number.

(b) Find the probability generating function $G_Y(t)$ of Y . [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The random variable Z is the sum of the number of balls that are labelled with a multiple of 3 selected by Kai and the number of balls that are labelled with an even number selected by Jacob.

(c) Find the probability generating function of Z , expressing your answer as a polynomial. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(d) Use the probability generating function of Z to find $E(Z)$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 6 The blood cholesterol levels, measured in suitable units, of a random sample of 11 women and a random sample of 12 men are shown below.

Women	51	55	242	167	152	256	75	137	98	238	235	
Men	311	262	170	302	175	320	220	260	72	351	86	333

Carry out a Wilcoxon rank-sum test, at the 5% significance level, to test whether, on average, there is a difference in cholesterol levels between women and men. [9]

This image shows a full page of a worksheet designed for handwriting practice. It consists of approximately 20 horizontal rows. Each row is defined by two parallel dashed lines, creating a series of uniform gaps for letter height. The lines are evenly spaced across the entire page, providing a guide for consistent letter formation. There is no text or other markings on the page.

[illegible]

[illegible]

BLANK PAGE

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.