

Please write clearly in block capitals.

Centre number

Candidate number

Surname

Forename(s)

Candidate signature

I declare this is my own work.

INTERNATIONAL A-LEVEL

FURTHER MATHEMATICS

(9665/FM04) Unit FS2 Statistics

Wednesday 5 June 2024

07:00 GMT

Time allowed: 1 hour 30 minutes

Materials

- For this paper you must have the OxfordAQA Booklet of Formulae and Statistical Tables (enclosed).
- You may use a graphical calculator.

Instructions

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.

Advice

- Unless stated otherwise, you may quote formulae, without proof, from the booklet.
- Show all necessary working; otherwise marks may be lost.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	



1 The number of days a patient takes to recover from a particular illness after using medicine A has a normal distribution with population standard deviation 2.1 days.

[6 marks]

[illegible]

- 2** The discrete random variables X_1 , X_2 and X_3 follow independent Poisson distributions with the same mean λ

The random variable $R = \frac{X_1 + 2X_2 + 3X_3}{6}$

- 2 (a)** Show that R is an unbiased estimator of λ

[2 marks]

- 2 (b) (i)** Find the efficiency of R relative to X_1

[4 marks]

Answer _____

- 2 (b) (ii)** Hence, explain which of R and X_1 is the more efficient estimator of λ

[1 mark]

Turn over ►



[5 marks]

[illegible]

Do not write
outside the
box

Answer _____

5

Turn over for the next question

Turn over ►



Cordelia is investigating if there is an association between the region a person lives in and their chosen holiday location.

		Holiday location		
		Abroad	Not abroad	Total
Region lived in	North	44	59	103
	South	85	62	147
	Total	129	121	250

Test Cordelia's claim, using the 5% level of significance.

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



This image shows a blank sheet 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.

Turn over for the next question

- 5** Stanley investigates the reaction time in seconds for males and females for the start of a race.

He records the reaction time X of a random sample of 41 males.

He records the reaction time Y of a random sample of 26 females.

His summarised results are

$$\sum (x - \bar{x})^2 = 0.3998 \quad \text{and} \quad \sum (y - \bar{y})^2 = 0.1024$$

Stanley claims that the population standard deviation is equal for both males and females.

- 5 (a)** Stanley wants to carry out a hypothesis test using the F -distribution.

State an assumption that Stanley will need to make.

[1 mark]

- 5 (b)** Test Stanley's claim using the 2% level of significance.

[8 marks]



This image shows a blank sheet 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.

9

- 6 (a) The normal distribution $Z \sim N(0, 1)$ has moment generating function

$$M_Z(t) = e^{\frac{1}{2}t^2}$$

- 6 (a)(i) Find the moment generating function of the random variable

$$X = \mu + \sigma Z$$

where μ and σ are constants.

Give your answer in the form $M_X(t) = e^{f(t)}$ where $f(t)$ is a function of t

[2 marks]

Answer _____



6 (a) (ii) The random variable Y is independent of X and has moment generating function

$$M_Y(t) = e^{\lambda(e^t - 1)}$$

where λ is a constant.

Find the moment generating function of $X + Y$

Give your answer in the form $M_{X+Y}(t) = e^{g(t)}$ where $g(t)$ is a function of t

[2 marks]

Answer _____

Question 6 continues on the next page

Turn over ►



$$f(w) = \begin{cases} \frac{2}{3}e^{2w} & 0 \leq w \leq \ln 2 \\ 0 & \text{otherwise} \end{cases}$$
$$M_W(t) = \frac{2(e^{(t+2)\ln 2} - 1)}{3(t+2)}$$
[illegible]

Give your answer in the form $M'_W(t) = \frac{h(t)}{3(t+2)^2}$ where $h(t)$ is a function of t



Answer _____

6 (b)(iii) Hence find the mean of W

Give your answer to three decimal places.

[2 marks]

Answer _____



This image shows a single sheet 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.



Answer _____

- 7 (b)** The test is repeated using the same random sample but with a smaller level of significance.

Explain how the power of the test is affected.

[1 mark]

7

Turn over for the next question

Turn over ►



The lower limit of a 93% confidence interval calculated using the sample is \$4858.26

[6 marks]

[illegible]

 $\bar{x} =$ _____ $\sigma =$ _____

8 (b) A random sample of size n is taken.

A 96% confidence interval is calculated from the sample and has width \$300 to the nearest dollar.

Find the value of n

[3 marks]

Answer _____

9

Turn over for the next question

Turn over ►



Aeryn models N with the binomial distribution $N \sim B(5, 0.5)$

She observes the game being played 200 times.

Her summarised results are shown in the table.

<i>n</i>	0	1	2	3	4	5
Frequency	11	40	75	48	22	4

[8 marks]

[illegible]

- 9 (b)** State the number of degrees of freedom for the test in **part (a)** if Aeryn's model for N was $N \sim B(5, p)$ where p is unknown.

[1 mark]

Answer _____

9

Turn over for the next question

Turn over ►



The table below shows details of a random sample for town A and a random sample for town B

Town	Size of Random Sample	Sample Mean (thousand dollars)	Unbiased Estimator of Population Standard Deviation (thousand dollars)
A	n	$\bar{x}_A = 39.4$	$s_A = 5.4$
B	$n + 3$	$\bar{x}_B = 43.2$	$s_B = 5.2$

[3 marks]

[illegible]

Answer



A newspaper claims that the mean salary in town B is greater than the mean salary in town A

[6 marks]

[illegible]

9

END OF QUESTIONS



There are no questions printed on this page

*Do not write
outside the
box*

**DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED**



[illegible]