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Candidate number

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Candidate signature

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I declare this is my own work.

INTERNATIONAL A-LEVEL MATHEMATICS

(9660/MA04) Unit S2 Statistics

Friday 13 January 2023 07:00 GMT Time allowed: 1 hour 30 minutes

Materials

- For this paper you must have the Oxford International AQA 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 | |
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| TOTAL | |



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ANSWER IN THE SPACES PROVIDED**



Answer **all** questions in the spaces provided.

- 1** The continuous random variable X has mean 12 and variance 5
 The continuous random variable Y has mean 15 and variance 2.5
 The random variables X and Y are independent.

- 1 (a)** Find the value of $E(3Y - 2X)$

[2 marks]

Answer _____

- 1 (b)** Find the value of $\text{Var}(3Y - 2X)$

[2 marks]

Answer _____

Turn over ►



- 2** A hypothesis test is carried out by a student to determine whether there is evidence that the mean μ of a normally distributed random variable X has changed from 18.3

A random sample of size 16 has a sample mean of 19

The standard deviation of X is known to be 2.5

A 10% level of significance is used.

There are errors in **three** stages of the student's attempt at the hypothesis test below.

| | Statement |
|----------------|--|
| Stage 1 | $H_0: \bar{x} = 18.3$ $H_1: \bar{x} \neq 18.3$ |
| Stage 2 | Under H_0 $X \sim N(18.3, 2.5^2)$ |
| Stage 3 | $n = 16$ $\bar{X} \sim N\left(18.3, \frac{2.5^2}{16}\right)$ |
| Stage 4 | 10% level of significance gives $z_{\text{critical}} = \pm 1.2816$ |
| Stage 5 | Using sample mean = 19 $z = \frac{19 - 18.3}{\left(\frac{2.5}{4}\right)}$ |
| Stage 6 | Test statistic $z = 1.12$ |
| Stage 7 | $z < z_{\text{critical}}$ |
| Stage 8 | As we have evidence to suggest a change in mean occurred at the 10% level of significance, we reject H_0 |

- 2 (a)** Identify the **three** stages with errors and write down the correct statements for each of the stages.

[4 marks]

Error 1 Stage _____

Correct statement _____



Error 2 Stage _____

Correct statement _____

Error 3 Stage _____

Correct statement _____

2 (b) Explain why the Central Limit Theorem is not needed in the student's hypothesis test.**[1 mark]**

2 (c) Which of the five options below correctly completes the following sentence?

_____ is the set of values for the test statistic for which we reject the null hypothesis.

Tick (✓) **one** box.**[1 mark]**

| | |
|--------------------------|-----------------------|
| <input type="checkbox"/> | A Confidence Interval |
| <input type="checkbox"/> | A Critical Region |
| <input type="checkbox"/> | An Unbiased Estimator |
| <input type="checkbox"/> | A Critical Value |
| <input type="checkbox"/> | A Significance Test |



- 3** The continuous random variable T has the cumulative distribution function

$$F(t) = \begin{cases} 0 & t < 0 \\ \frac{t^3}{64} & 0 \leq t \leq 4 \\ 1 & t > 4 \end{cases}$$

- 3 (a)** Find the probability density function of T for all values of t

[3 marks]

Answer _____

- 3 (b)** The mean of T is μ and the standard deviation of T is σ

- 3 (b) (i)** Find the value of μ

[2 marks]

Answer _____



3 (b) (ii) Find the value of σ

Give your answer to three significant figures.

[4 marks]

Answer _____

3 (c) Find $P(\mu - 2\sigma \leq T \leq \mu + 2\sigma)$

Give your answer to three significant figures.

[4 marks]

Answer _____

Turn over ►



[illegible]

[illegible]

Turn over ►



- 5 (a) (i)** State **two** conditions required for using a Poisson distribution as an approximation to a binomial distribution $B(n, p)$

[1 mark]

Condition 1 _____

Condition 2 _____

- 5 (a) (ii)** It is given that $X \sim B(500, 0.02)$

Use a Poisson approximation to find the parameter λ for this distribution.

[1 mark]

Answer _____

- 5 (a) (iii)** Using your Poisson approximation for X find $P(X < 10)$

Give your answer to three significant figures.

[2 marks]

Answer _____



Over 30 hectares Sally finds 150 ground nests for yellow jacket wasps.

[6 marks]

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Turn over ►



[3 marks]

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[1 mark]

[1 mark]

15



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- 6** A theme park has five rides. The queue times in minutes for each ride are modelled as independent normal distributions as shown below.

Vertical Slide $X_1 \sim N(12, 1.5^2)$

High Swings $X_2 \sim N(8, 0.8^2)$

Gravity Wheel $X_3 \sim N(7, 1^2)$

Roller Coaster $X_4 \sim N(14, 2^2)$

Jump Drop $X_5 \sim N(\mu, \sigma^2)$

- 6 (a)** Find the probability that the queue time for the Vertical Slide is less than 10 minutes.
Give your answer to three significant figures.

[2 marks]

Answer _____

- 6 (b)** Find the queue time exceeded by 10% of people for the High Swings.
Give your answer to three significant figures.

[3 marks]

Answer _____



6 (c)

$$P(X_5 < 16) = 0.82 \quad \text{and} \quad P(X_5 > 10) = 0.53$$

Find the value of μ and the value of σ

Give your answers to three significant figures.

[6 marks]

[illegible]

$$\mu = \quad \sigma =$$

Question 6 continues on the next page

Turn over ►



- 6 (d)** Use your answers to **part (c)** to suggest why modelling the Jump Drop queue time as this normal distribution might not be appropriate in this context.

[1 mark]

- 6 (e)** A person queues once for each of the Vertical Slide, High Swings, Gravity Wheel and Roller Coaster.

The total queue time is T minutes.

Find $P(T < 35)$

Give your answer to three significant figures.

[3 marks]

Answer _____

15



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The number of appointments made by customers for rides each week can be modelled by a Poisson distribution with $\lambda = 2.5$

Give your answer to four significant figures.

Find the probability that there are more than 18 appointments over the summer holiday period.

Give your answer to four significant figures.

[illegible]

Answer



7 (c) The time, T weeks, between appointments can be modelled by an exponential distribution.

7 (c) (i) Find the mean of T

[1 mark]

Answer _____

7 (c) (ii) Find the variance of T

[1 mark]

Answer _____

7 (d) A week lasts 7 days.

Find the value of c such that $P(T < c) = 0.9$

Give your answer to the nearest day.

[3 marks]

Answer _____



8

$$f(x) = \begin{cases} \frac{96}{(5x+k)^2} & 2 \leq x \leq d \\ 0 & \text{otherwise} \end{cases}$$

where k and d are constants, $k > 0$ and $d > 2$

8 (a)

$$F(x) = \begin{cases} 0 & x < 2 \\ \frac{96(x-2)}{(10+k)(5x+k)} & 2 \leq x \leq d \\ 1 & x > d \end{cases}$$

[4 marks]

[illegible]

8 (b) It is given that $F(4.4) = 0.8$

Find the value of k

[3 marks]

Answer _____

END OF QUESTIONS



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| Question number | <p style="text-align: center;">Additional page, if required. Write the question numbers in the left-hand margin.</p> |
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