

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 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	
4	
5	
6	
7	
8	
<b>TOTAL</b>	



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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]**

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Answer \_\_\_\_\_

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

**[2 marks]**

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Answer \_\_\_\_\_

Turn over ►



2 A hypothesis test is carried out by a student to determine whether there is evidence that the mean  $\mu$  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

6

Turn over ►



**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]**

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Answer \_\_\_\_\_

**3 (b)** The mean of  $T$  is  $\mu$  and the standard deviation of  $T$  is  $\sigma$

**3 (b) (i)** Find the value of  $\mu$

**[2 marks]**

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Answer \_\_\_\_\_



3 (b) (ii) Find the value of  $\sigma$

Give your answer to three significant figures.

[4 marks]

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Answer \_\_\_\_\_

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

Give your answer to three significant figures.

[4 marks]

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Answer \_\_\_\_\_

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  $\lambda$  for this distribution.

[1 mark]

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Answer \_\_\_\_\_

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

Give your answer to three significant figures.

[2 marks]

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Answer \_\_\_\_\_







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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]**

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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]**

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Answer \_\_\_\_\_







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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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