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Centre number	Candidate number	
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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.

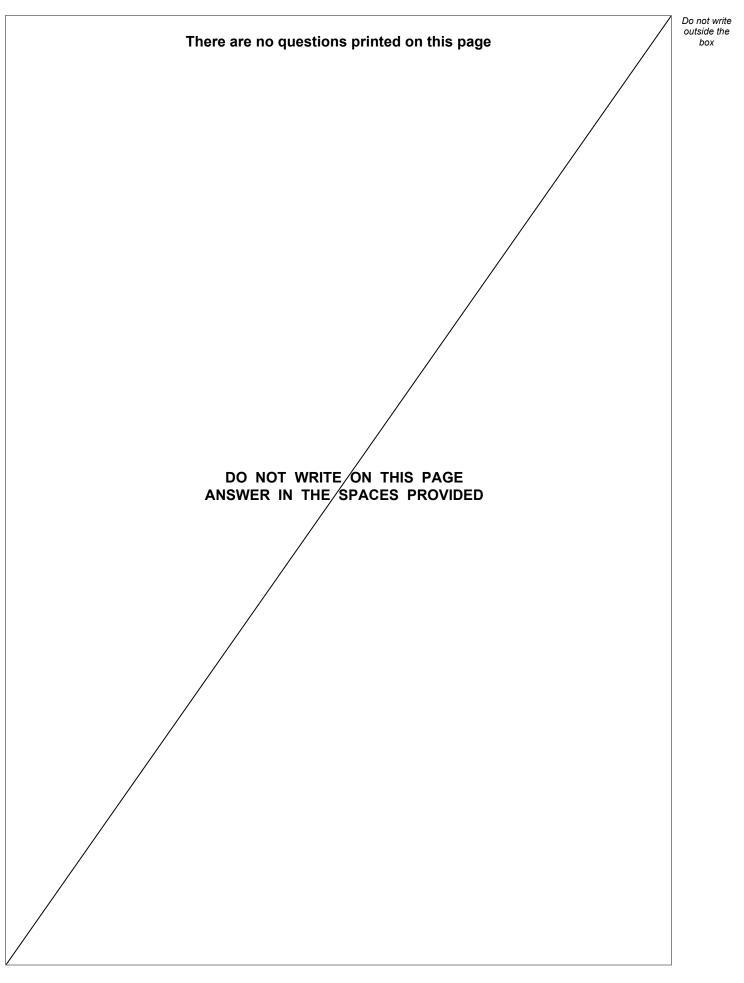
Advice

- 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		
TOTAL		







	Answer all questions in the spaces provided.	Do not write outside the box
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 $Var(3Y-2X)$ [2 marks]	
	Answer	4



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	$H_0: \overline{x} = 18.3$ $H_1: \overline{x} \neq 18.3$	
Stage 2	Under $H_0 X \sim N(18.3, 2.5^2)$	
Stage 3	$n = 16$ $\overline{X} \sim N\left(18.3, \frac{2.5^2}{16}\right)$	
Stage 4	10% level of significance gives $z_{critical} = \pm 1.2816$	
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	$Z \leq Z_{\rm critical}$	
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]

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Error 1 Stage

Correct statement



	Error 2	Stage	Do not wr outside th box
		Correct statement	
	Error 3	Stage	
		Correct statement	
2 (b)	Explain w	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	
		_ is the set of values for the test statistic for which we reject the null hypothesis.	
	Tick (✔) o		
	Tick (✔) o	one box.	
	Tick (✔) (one box. [1 mark]	
	Tick (✔) (A Confidence Interval	
	Tick (✔) (Image: Descent of the system of the syste	
	Tick (✔) (Imark] A Confidence Interval A Critical Region An Unbiased Estimator	6



3	The continuous random variable T has the cumulative distribution function	
	$\int 0 \qquad t < 0$	
	$F(t) = \begin{cases} 0 & t < 0 \\ \frac{t^3}{64} & 0 \le t \le 4 \\ 1 & t > 4 \end{cases}$	
	1 to t > 4	
3 (a)	Find the probability density function of T for all values of t [3 ma	rko]
		IND
	Answer	
3 (b)	Answer The mean of <i>T</i> is μ and the standard deviation of <i>T</i> is σ	
	The mean of T is μ and the standard deviation of T is σ	
		rks]
	The mean of T is μ and the standard deviation of T is σ Find the value of μ	rks]
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Give your answer to three significant figures.	[4 mark
•	
Answer	
Find $P(\mu-2\sigma \le T \le \mu+2\sigma)$	
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Find $P(\mu-2\sigma \le T \le \mu+2\sigma)$	[4 mark



3 (c)

13

3 (b) (ii) Find the value of σ

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A manufacturer makes hand-drying machines which have a mean drying time of 25 seconds.

An engineer redesigns the hand-drying machine and a random sample of 500 redesigned machines are tested.

The drying time, X seconds, is measured for each of the redesigned machines and the results are summarised as

 $\sum x = 12430$ and $\sum x^2 = 310000$

The engineer now claims that the mean drying time has been reduced.

Test the engineer's claim at the 1% level of significance.

[10 marks]

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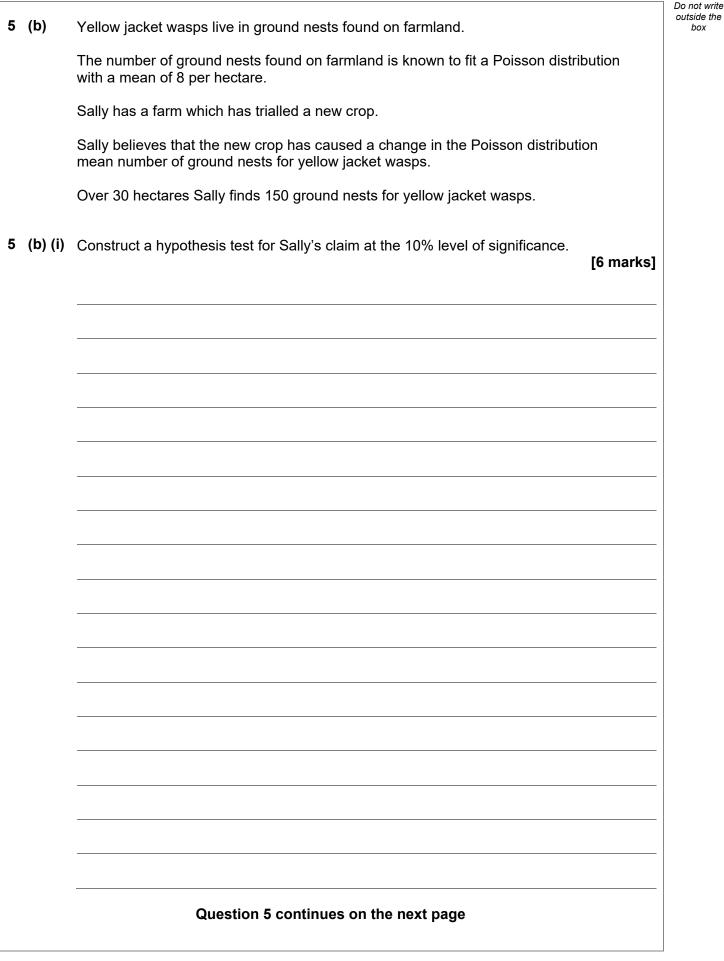
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5	(a) (i)	State two conditions required for using a Poisson distribution as an approximation binomial distribution $B(n, p)$		
			[1	mark]
		Condition 1		
		Condition 2		
5	(a) (ii)	It is given that $X \sim B(500, 0.02)$		
		Use a Poisson approximation 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 r	narks]
			-	-
		Answer		



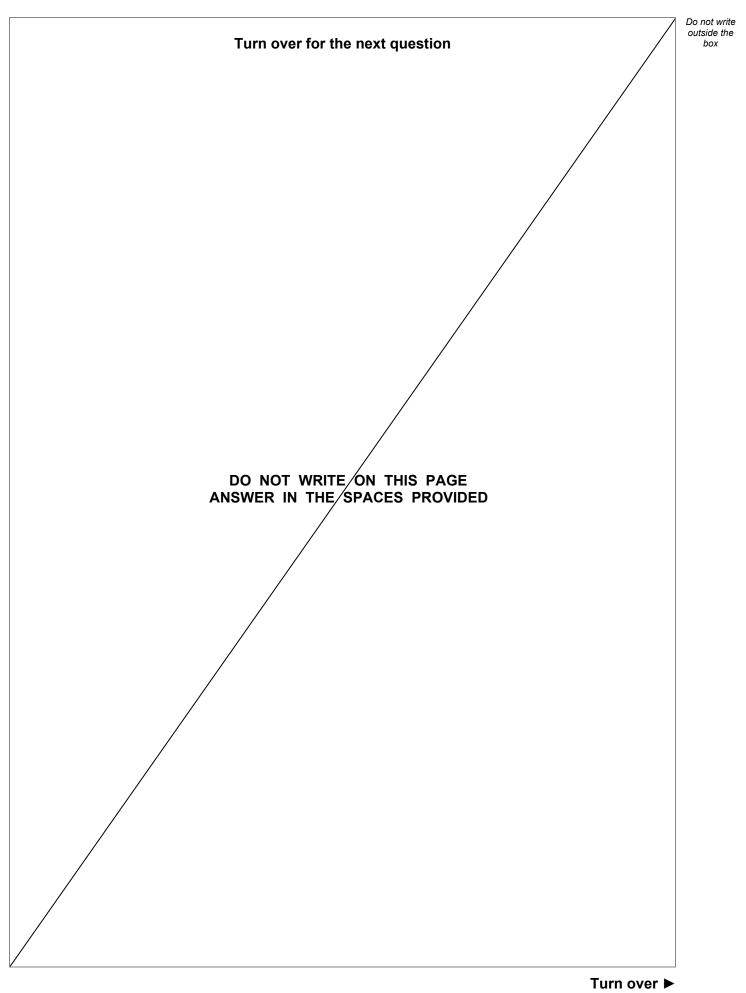
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5	(b) (ii)	Find the critical region for the hypothesis test in part (b)(i) at the 10% level of significance.	
			[3 marks]
		Answer	
5	(c) (i)	Describe in the context of the test in part (b)(i) a Type I error.	
J	(0) (1)	Describe in the context of the test in part (b)(i) a Type 1 enor.	[1 mark]
5	(c) (ii)	Calculate the probability of a Type I error for the test in part (b)(i) .	
			[1 mark]
		Answer	







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	Answer_		
Give your answer to three significant figures.			
6 (b)	Find the queue time exceeded by 10%	of people for the High Swings.	
	Answer_		
	Give your answer to three significant fig	gures. [2 marks]	
6 (a)		for the Vertical Slide is less than 10 minutes.	
	Jump Drop	$X_5 \sim N(\mu, \sigma^2)$	
	Roller Coaster	$X_4 \sim N(14, 2^2)$	
	Gravity Wheel	$X_2 \sim N(0, 0.0^{\circ})$ $X_3 \sim N(7, 1^2)$	
	High Swings	$X_1 \sim N(12, 1.3)$ $X_2 \sim N(8, 0.8^2)$	
	Vertical Slide $X_1 \sim N(12, 1.5^2)$		
6	A theme park has five rides. The queue times in minutes for each ride are modelled as independent normal distributions as shown below.		



(c)	For the Jump Drop it is given that
	$P(X_5 < 16) = 0.82$ and $P(X_5 > 10) = 0.53$
	Find the value of μ and the value of σ
	Give your answers to three significant figures.
	[6 marks]
	$\mu = _ \sigma = _$
	Question 6 continues on the next page



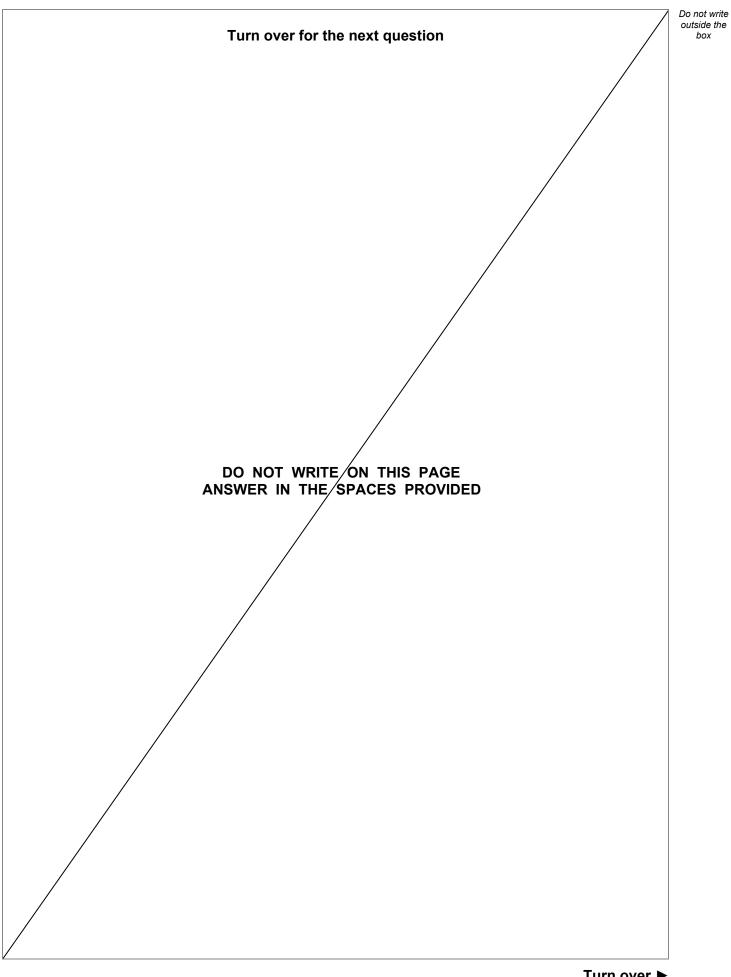
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[1 mark]

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



6 (d)





7		Don runs a business where people make appointments to ride ponies.	Do not wr outside th box
		The number of appointments made by customers for rides each week can be modelled by a Poisson distribution with $\lambda = 2.5$	
7	(a)	Find the probability that there are exactly four appointments in a given week.	
		Give your answer to four significant figures. [2 marks]	
		Answer	
7	(b)	The summer holiday period lasts 6 weeks.	
		Find the probability that there are more than 18 appointments over the summer holiday period.	
		Give your answer to four significant figures. [3 marks]	
		Answer	



7	(c)	The time, T weeks, between appointments can be modelled by an exponential distribution.	Do not write outside the box
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 <i>c</i> such that $P(T < c) = 0.9$	
		Give your answer to the nearest day. [3 marks]	
		Answer	10



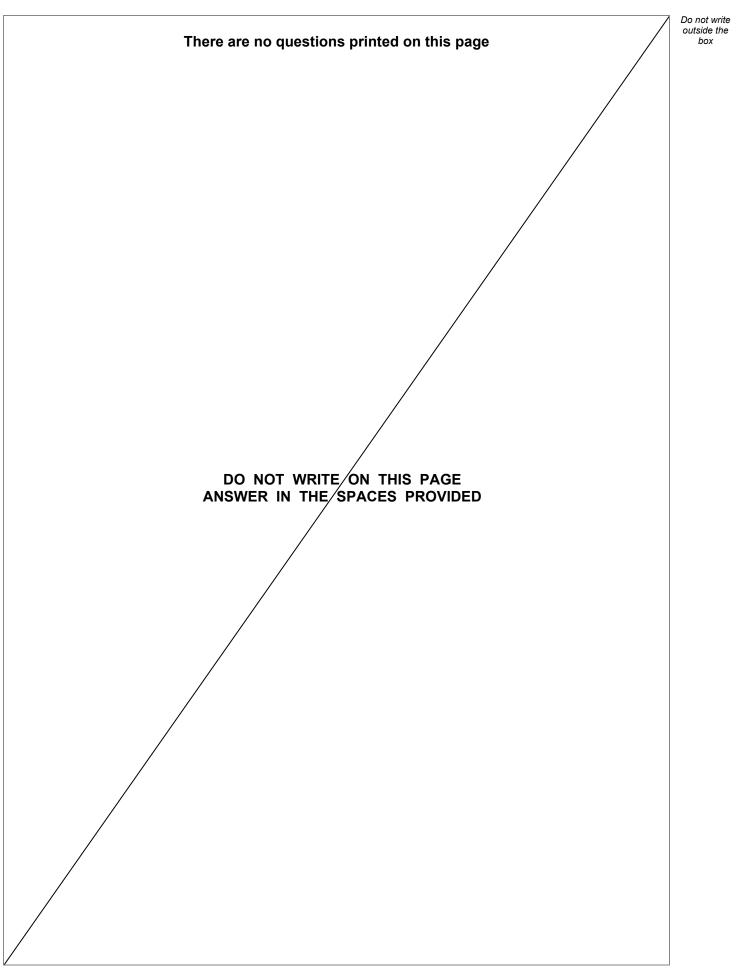


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8 (b)	It is given that $F(4.4) = 0.8$	
. ,		
	Find the value of k	
		[3 marks]
		· · · · · · · · · · · · · · · · · · ·
		· · · · · · · · · · · · · · · · · · ·
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	Answer	
	END OF QUESTIONS	







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