

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

I declare this is my own work.

INTERNATIONAL A-LEVEL MATHEMATICS

(9660/MA04) Unit S2 Statistics

Thursday 5 June 2025

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	
TOTAL	



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

1 The random variable X has

$$E(X) = a \quad \text{and} \quad E(X^2) = b$$

where a and b are constants.

1 (a) (i) Find in terms of a an expression for $E(3X + 5)$

[1 mark]

Answer _____

1 (a) (ii) Find in terms of a and b an expression for $\text{Var}(X)$

[1 mark]

Answer _____



- 1 (b) The random variable Y has

$$E(Y) = 4a \quad \text{and} \quad \text{Var}(Y) = 5b + a^2$$

The random variables X and Y are independent.

- 1 (b) (i) Find in terms of a an expression for $E(2X - 3Y)$

[2 marks]

Answer _____

- 1 (b) (ii) It is given that $\text{Var}(2X - 3Y) = 50b + a^2$

Find b in terms of a

[3 marks]

Answer _____

Turn over ►



- 2** The continuous random variable W has probability density function

$$f(w) = \begin{cases} kw(8-w) & 0 \leq w \leq 8 \\ 0 & \text{otherwise} \end{cases}$$

where k is a positive constant.

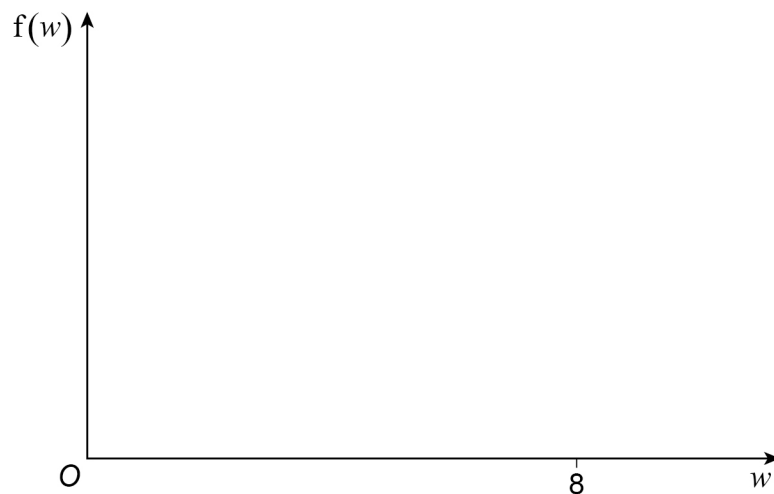
- 2 (a)** Show that $k = \frac{3}{256}$

[3 marks]

- 2 (b)** Sketch the graph of the probability density function on the axes below.

Show the coordinates of the maximum point.

[2 marks]



2 (c) Find $P(W > 6.5)$

[2 marks]

Answer _____

7

Turn over for the next question

Turn over ►



3 The number of customers being served on a particular day at a fast-food restaurant between 6 pm and 7 pm is modelled by a Poisson distribution with parameter $\lambda = 12$

3 (a) (i) Find the probability of exactly 8 customers being served between 6 pm and 7 pm.

Give your answer to four significant figures.

[2 marks]

Answer _____

3 (a) (ii) Find the probability of more than 16 customers being served between 6 pm and 7 pm.

Give your answer to four significant figures.

[3 marks]

Answer _____



- 3 (b)** The time T **minutes** between customers being served on this particular day at the same fast-food restaurant between 6 pm and 7 pm is modelled by an exponential distribution.

- 3 (b) (i)** Show that the mean of T is 5

[1 mark]

- 3 (b) (ii)** Find $P(T < 8)$

Give your answer to four significant figures.

[2 marks]

Answer _____

Question 3 continues on the next page

Turn over ►



3 (b) (iii) It is given that $P(T < t) = 0.8$

Find the value of t

Give your answer to the nearest minute.

[2 marks]

Answer _____

3 (c) State with a reason whether an exponential distribution with mean 5 minutes is an appropriate model for the time between customers being served on this particular day at the fast-food restaurant between 1 pm and 2 pm.

[2 marks]



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0 9

- 4** The mass C in grams of a single packet of crisps made by a food company is modelled by

$$C \sim N(31, 0.2^2)$$

- 4 (a) (i)** State the probability that the mass of a single packet of crisps is exactly 30 grams.

[1 mark]

Answer _____

- 4 (a) (ii)** Find $P(30.6 < C < 31.3)$

Give your answer to four significant figures.

[3 marks]

Answer _____



4 (a) (iii) The mass of 90 % of the packets of crisps is at least c grams.

Find the value of c

Give your answer to four significant figures.

[3 marks]

Answer _____

Question 4 continues on the next page

Turn over ►





4 (b) (iii) Five variety packs are selected at random.

Find the probability than **none** of the selected variety packs have a total mass less than advertised.

Give your answer to four significant figures.

[3 marks]

Answer _____

15

Turn over for the next question

Turn over ►



5 Ria grows mandarin oranges on her farm.

Following 10 months of growth, Ria takes a random sample of 12 mandarin oranges.

Her measurements for the diameters in centimetres (cm) of these mandarin oranges are shown below.

5.9	4.9	4.8	5.3	5.4	5.2
5.2	5.0	5.1	4.8	5.2	4.9

5 (a) (i) Calculate the sample mean.

Give your answer to three significant figures.

[1 mark]

Answer _____

5 (a) (ii) Calculate the unbiased estimator of the variance.

Give your answer to three significant figures.

[2 marks]

Answer _____



[7 marks]

[illegible]

10

6 The continuous random variable X has cumulative distribution function $F(x)$

6 (a) Some parts of the cumulative distribution function are shown below.

Write down the missing parts of the cumulative distribution function.

[2 marks]

$$F(x) = \begin{cases} 0 & \text{.....} \\ \frac{1}{5}x & 0 < x \leq 2 \\ \frac{(x-2)^2 + 6}{15} & 2 < x \leq 5 \\ \text{.....} & \text{.....} \end{cases}$$

6 (b) Find $P(1 < X < 3)$

[2 marks]

Answer _____



6 (c) It is given that $P(X > k) = 0.3$

Find the exact value of k

[3 marks]

$k =$ _____

6 (d) The probability density function of X is $f(x)$

Find $f(x)$

[3 marks]

$f(x) = \left\{ \begin{array}{ll} \dots\dots\dots & \dots\dots\dots \\ \dots\dots\dots & \dots\dots\dots \\ \dots\dots\dots & \dots\dots\dots \end{array} \right.$



7 A machine makes rope cut into lengths, each of which is two hundred metres.

Faults in the rope occur independently, randomly and at a constant mean rate along the length of the rope.

It is given that the mean number of faults per two hundred metre length of rope is 5

The random variable X represents the number of faults in a two hundred metre length of rope.

7 (a) Show that $P(X = 4) = \frac{625}{24} e^{-5}$

[1 mark]

7 (b) Claire is a designer who has changed the design of the rope.

She claims that the mean number of faults per two hundred metre length of rope has changed as a result of the new design.

Claire randomly selects a two hundred metre length of rope with the new design to test her claim.

7 (b) (i) State the hypotheses needed to test Claire's claim.

[1 mark]

7 (b) (ii) Find the critical region for Claire's hypothesis test at the 10% level of significance.

Use probabilities to justify your answer.

[4 marks]



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7 (b) (iii) Claire finds 2 faults in the randomly selected two hundred metre length of rope.

[2 marks]

Turn over ►



7 (c) Claire decides to carry out a second hypothesis test at the 10% level of significance with a different randomly selected two hundred metre length of rope.

7 (c) (i) Find the probability of a Type I error for Claire's second hypothesis test.

Give your answer to three significant figures.

[1 mark]

Answer _____

7 (c) (ii) Describe, in the context of Claire's second hypothesis test, a Type II error.

[1 mark]

10



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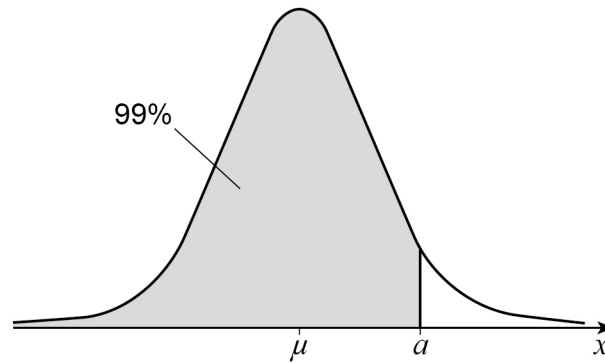


- 8 (a) The random variable X is defined as $X \sim N(\mu, \sigma^2)$

Figure 1 and **Figure 2** show the graph of the probability density function for X

- 8 (a) (i) On **Figure 1** the shaded region to the left of the line $x = a$ represents 99% of the total area beneath the graph of the probability density function and the x -axis.

Figure 1



Find an expression for a in terms of μ and σ

Give any values to four decimal places.

[2 marks]

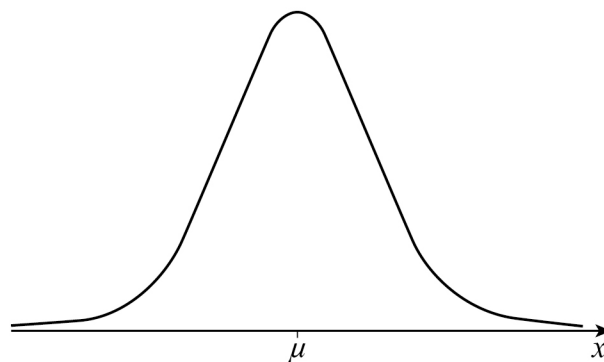
Answer _____

- 8 (a) (ii) It is given that $c < d < \mu$

On **Figure 2**, sketch a possible region which represents $P(c < X < d)$

[1 mark]

Figure 2



8 (b) (i) Richard assumes that for a large enough sample size, $\bar{Y} \sim N\left(15.2, \frac{s^2}{n}\right)$

State the name of the theorem which Richard has used to make his assumption.

Find the range of possible values of s^2

[5 marks]

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Answer

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