

INTERNATIONAL A-LEVEL MATHEMATICS

MA04

(9660/MA04) Unit S2 Statistics

Mark scheme

June 2025

Version: 0.1 Pre-Standardisation



2 5 6 X M A 0 4 / M S

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Key to mark scheme abbreviations

M	Mark is for method
m	Mark is dependent on one or more M marks and is for method
A	Mark is dependent on M or m marks and is for accuracy
B	Mark is independent of M or m marks and is for method and accuracy
E	Mark is for explanation
✓ or ft	Follow through from previous incorrect result
CAO	Correct answer only
CSO	Correct solution only
AWFW	Anything which falls within
AWRT	Anything which rounds to
ACF	Any correct form
AG	Answer given
SC	Special case
oe	Or equivalent
A2, 1	2 or 1 (or 0) accuracy marks
–x EE	Deduct x marks for each error
NMS	No method shown
PI	Possibly implied
SCA	Substantially correct approach
sf	Significant figure(s)
dp	Decimal place(s)
ISW	Ignore subsequent working

Q	Answer	Marks	Comments
1(a)(i)	$3a + 5$	B1	
		1	

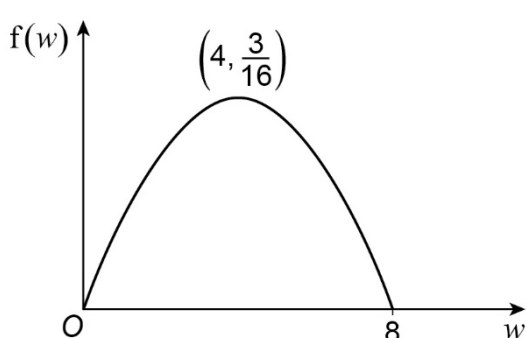
Q	Answer	Marks	Comments
1(a)(ii)	$b - a^2$	B1	
		1	

Q	Answer	Marks	Comments
1(b)(i)	$2E(X) - 3E(Y)$ $= -10a$	M1 A1	PI
		2	

Q	Answer	Marks	Comments
1(b)(ii)	$4\text{Var}(X) + 9\text{Var}(Y)$ $= 4(b - a^2) + 9(5b + a^2) = 50 + a^2$ $49b + 5a^2 = 50b + a^2$ $\Rightarrow b = 4a^2$	B1 M1 A1	PI Substitutes their $\text{Var}(X)$ and sets equal to $50b + a^2$ CAO
		3	

	Question 1 Total	7	
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Q	Answer	Marks	Comments
2(a)	$\int_0^8 kw(8-w)dw = 1$ $k \left[4w^2 - \frac{w^3}{3} \right]_0^8 = 1$ $k \left(256 - \frac{512}{3} \right) = 1$ $\frac{256k}{3} = 1$ $\Rightarrow k = \frac{3}{256}$	M1 M1 A1	Correct integral set equal to 1 Integrates correctly and attempts to use limits AG Must be convincingly shown
		3	

Q	Answer	Marks	Comments
2(b)		B1 B1	Sight of $\frac{3}{16}$ either calculated or labelled on graph Correct form of curve starting at (0,0) and ending at (8,0)
		2	

Q	Answer	Marks	Comments
2(c)	$\int_{6.5}^8 \frac{3}{256} w(8-w)dw = \frac{3}{256} \left[4w^2 - \frac{w^3}{3} \right]_{6.5}^8$ $= \frac{3}{256} \left(\frac{256}{3} - \left(4 \times 6.5^2 - \frac{6.5^3}{3} \right) \right)$ $= \frac{189}{2048}$	M1 A1	Integrates correctly and substitutes in correct limits Allow AWRT 0.0923
		2	

	Question 2 Total	7	
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Q	Answer	Marks	Comments
3(a)(i)	$P(X=8) = \frac{e^{-12} \times 12^8}{8!}$ $= 0.06552$	M1 A1	AWRT 0.06552
		2	

Q	Answer	Marks	Comments
3(a)(ii)	$X \sim \text{Po}(12)$ $P(X > 16) = 1 - P(X \leq 16)$ $= 1 - 0.8987 \quad [\text{from tables}]$ $= 0.1013$	M1 M1 A1	PI PI
		3	

Q	Answer	Marks	Comments
3(b)(i)	$\frac{60}{12} = 5$	B1	
		1	

Q	Answer	Marks	Comments
3(b)(ii)	$[P(T < 8) =] 1 - e^{-\frac{8}{5}}$	M1	PI
	$= 0.7981$	A1	AWRT 0.7981
		2	

Q	Answer	Marks	Comments
3(b)(iii)	$1 - e^{-\frac{t}{5}} = 0.8$	M1	Attempt to find t by simplifying an equation using a cdf of exponential or integration of pdf oe
	$t = 8.047... \text{ mins}$ $t = 8 \text{ [minutes]}$	A1	
		2	

Q	Answer	Marks	Comments
3(c)	Lunch time meals being served between 1 pm and 2 pm	E1	A plausible reason as to why the model is appropriate or not appropriate
	Model not appropriate, as more people eat fast food at lunch time	E1	A concluding comment as to the appropriateness of the model based on their reason
		2	

	Question 3 total	12	
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Q	Answer	Marks	Comments
4(a)(i)	$[P(C = 30) =] 0$	B1	
		1	

Q	Answer	Marks	Comments
4(a)(ii)	$P\left(\frac{30.6 - 31}{0.2} < z < \frac{31.3 - 31}{0.2}\right)$ $[P(-2 < z < 1.5)] = 0.93319 - (1 - 0.97725)$ [from tables] $= 0.9104$	M1 M1 A1	PI PI AWRT 0.9104
		3	

Q	Answer	Marks	Comments
4(a)(iii)	$z = -1.2816$ $-1.2816 = \frac{c - 31}{0.2}$ $c = 30.74$	B1 M1 A1	Allow $\pm$ oe AWRT 30.74
		3	

Q	Answer	Marks	Comments
4(b)(i)	$\mu = 312$	B1	
	$\sigma^2 = 3$	B1	
		2	

Q	Answer	Marks	Comments
4(b)(ii)	$P\left(M < \frac{310-312}{\sqrt{3}}\right)$	M1	PI Standardises with their mean and variance in (b)(i)
	$P(M < -1.1547...) = 1 - P(M < 1.1547...)$	M1	PI
	$= 0.1241$	A1	AWFW [0.1241, 0.1251]
		3	

Q	Answer	Marks	Comments
4(b)(iii)	$X \sim B(5, 0.8758[934605...])$	B1	$X \sim B(5, 1-p)$ from 4(b)(ii)
	$P(X = 0) = (0.8758[934605...])^5$	M1	ft Their p^5
	$= 0.5155[329395...]$	A1	AWFW [0.5127, 0.5156]
		3	

	Question 4 total	15	
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Q	Answer	Marks	Comments
5(a)(i)	$\bar{x} = 5.14$	B1	AWRT 5.14
		1	

Q	Answer	Marks	Comments
5(a)(ii)	$s^2 = \frac{1}{12-1} \left(318.29 - \frac{61.7^2}{12} \right)$ $s^2 = 0.0954$	M1 A1	Attempt at variance formula Allow one slip Implied by correct answer AWRT 0.0954
		2	

Q	Answer	Marks	Comments
5(b)	$H_0 : \mu = 5.0$ $H_1 : \mu > 5.0$ $\bar{X} \sim N\left(5.0, \frac{0.0954}{12}\right)$ $t = \frac{5.14 - 5.0}{\frac{\sqrt{0.0954}}{\sqrt{12}}}$ $= 1.57$ $t_{11}(90\%) = 1.363$ Reject H_0 as $1.36 < 1.57$ Evidence to suggest that the Mandarin oranges on Ria's farm have greater diameters on average at the 10% level of significance	B1 M1 M1 A1 B1 A1ft E1	Both hypotheses Condone 5 cm used throughout PI $\bar{X} \sim N\left(5, \frac{s^2}{12}\right)$ Calculates t with their s^2 AFWW [1.57, 1.59] ft Their t and $t_{11}(90\%)$ provided signs are consistent Implied by correct conclusion in context Must not be definitive
		7	

	Question 5 total	10	
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Q	Answer	Marks	Comments
6(a)	$F(x) = \begin{cases} 0 & x \leq 0 \\ \frac{1}{5}x & 0 < x \leq 2 \\ \frac{(x-2)^2 + 6}{15} & 2 < x \leq 5 \\ 1 & x > 5 \end{cases}$	B1 B1	$x \leq 0$ 1 and $x > 5$
		2	

Q	Answer	Marks	Comments
6(b)	$F(3) - F(1) =$ $\left(\frac{(3-2)^2 + 6}{15} \right) - \left(\frac{1}{5} \times 1 \right)$ $= \frac{4}{15}$	M1 A1	Allow 0.26
		2	

Q	Answer	Marks	Comments
6(c)	$P(X > k) = 0.3 \Rightarrow P(X < k) = 0.7$ $\Rightarrow 2 < k < 5$ $\frac{(k-2)^2 + 6}{15} = 0.7$ $(k-2)^2 = \frac{9}{2}$ $k = \frac{4 + 3\sqrt{2}}{2}$	M1 M1 A1	PI Attempts to rearrange for k ACF M1 A0 for $\frac{4 \pm 3\sqrt{2}}{2}$ without discounting the negative value oe AWRT 4.12 scores 2/3
		3	

Q	Answer	Marks	Comments
6(d)	$\frac{d}{dx} \left(\frac{1}{5}x \right) = \frac{1}{5}$ or $\frac{d}{dx} \left(\frac{(x-2)^2 + 6}{15} \right) = \frac{2(x-2)}{15}$ $f(x) = \begin{cases} 0 & \text{otherwise} \\ \frac{1}{5} & 0 < x \leq 2 \\ \frac{2(x-2)}{15} & 2 < x \leq 5 \end{cases}$	M1 A1 B1	Attempt to differentiate both terms oe Correct limits with correct functions Correct first line
		3	

	Question 6 total	10	
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Q	Answer	Marks	Comments
7(a)	$e^{-5} \times \frac{5^4}{4!}$ $= \frac{625}{24} e^{-5}$	B1	Substitutes $x = 4$ and $\lambda = 5$ AG
		1	

Q	Answer	Marks	Comments
7(b)(i)	$H_0 : \lambda = 5$ $H_1 : \lambda \neq 5$	B1	
		1	

Q	Answer	Marks	Comments
7(b)(ii)	$P(X \leq 1) = 0.0404 < 0.05$	M1	Finding at least one probability
	$P(X \leq 2) = 0.1247 > 0.05$		
	$X \leq 1$	A1	Both probabilities and correct CR
	$P(X \geq 9) = 0.0681 > 0.05$	M1	Finding at least one probability
	$P(X \geq 10) = 0.0318 < 0.05$		
	$X \geq 10 \Rightarrow \text{CR} = \{X \leq 1 \text{ or } X \geq 10\}$	A1	Both probabilities and correct CR
		4	

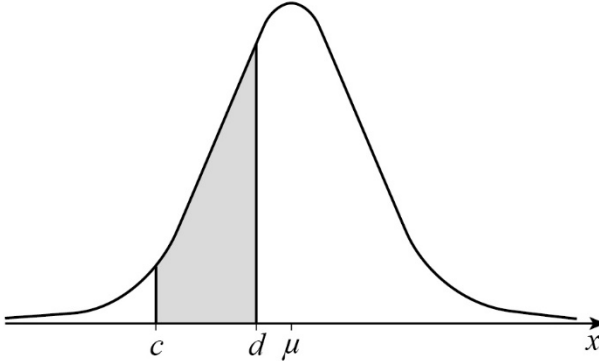
Q	Answer	Marks	Comments
7(b)(iii)	As 2 is not in the CR	B1	Must not be definitive
	We have evidence to suggest that the number of errors in a 200m roll has not changed at the 10% level of significance	B1	
		2	

Q	Answer	Marks	Comments
7(c)(i)	$[0.0318 + 0.0404 =] 0.0722$	B1	AWFW [0.0722, 0.0723]
		1	

Q	Answer	Marks	Comments
7(c)(ii)	Concluding that the number of faults has not changed when in fact it has	B1	
		1	

	Question 7 total	10	
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Q	Answer	Marks	Comments
8(a)(i)	$2.3263 = \frac{a - \mu}{\sigma}$ $a = 2.3263\sigma + \mu$	M1 A1	
		2	

Q	Answer	Marks	Comments
8(a)(ii)		B1	Shaded region to the left of the mean and c and d labelled
		1	

Q	Answer	Marks	Comments
8(b)(i)	Central limit theorem	B1	
		1	

Q	Answer	Marks	Comments
8(b)(ii)	$z = -0.4958$ $-0.4958 = \frac{15 - 15.2}{\sqrt{\frac{s^2}{n}}}$ $\frac{s^2}{35} \leq 0.162[722522\dots]$ or $\frac{s^2}{30} \geq 0.162[722522\dots]$ $s^2 \leq 5.69[5278825\dots]$ and $s^2 \geq 4.88[1667565\dots]$ $4.88 \leq s^2 \leq 5.70$	B1 M1 m1 A1 A1	Allow use of 36, 35 or 30 for n Attempt to isolate s^2 for one equation with 35 or 30 AWRD 5.70 or 4.88 Upper limit AFWW [5.69, 5.70]
		5	

	Question 8 Total	9	
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