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INTERNATIONAL A-LEVEL

MATHEMATICS

MA04

(9660/MA04) Unit S2 Statistics

Mark scheme

June 2025

Version: 0.1 Pre-Standardisation

256XMA04/MS

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

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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	

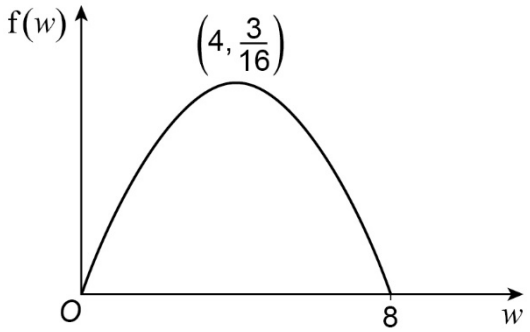
Q	Answer	Marks	Comments
1(a)(ii)	$b-a^2$	B1	
		1	

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

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

	Question 1 Total	**7**	

Q	Answer	Marks	Comments
2(a)	$\int_0^8 kw(8-w)\,\mathrm{d}w = 1$	**M1**	Correct integral set equal to 1
	$k\left[4w^2 - \frac{w^3}{3}\right]_0^8 = 1$		
	$k\left(256 - \frac{512}{3}\right) = 1$	**M1**	Integrates correctly and attempts to use limits
	$\frac{256k}{3} = 1$		
	$\Rightarrow k = \frac{3}{256}$	**A1**	**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)	$\int_{6.5}^{8} \frac{3}{256} w(8-w)\mathrm{d}w = \frac{3}{256}\left[4w^2 - \frac{w^3}{3}\right]_{6.5}^{8}$ $= \frac{3}{256}\left(\frac{256}{3} - \left(4\times 6.5^2 - \frac{6.5^3}{3}\right)\right)$ $= \frac{189}{2048}$	**M1** **A1**	Integrates correctly and substitutes in correct limits Allow **AWRT** 0.0923
		2	

	Question 2 Total	**7**	

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

Q	Answer	Marks	Comments
3(a)(ii)	$X \sim \mathrm{Po}(12)$ $\mathrm{P}(X>16) = 1-\mathrm{P}(X\leq 16)$ $= 1 - 0.8987$ [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)	$\left[\mathrm{P}(T<8)=\right]\ 1-\mathrm{e}^{-\frac{8}{5}}$ $=0.7981$	M1 A1	PI AWRT 0.7981
		2	

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

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

	Question 3 total	**12**	

Q	Answer	Marks	Comments
4(a)(i)	$\left[\mathrm{P}(C=30)=\right]\ 0$	**B1**	
		1	

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

Q	Answer	Marks	Comments
4(a)(iii)	$z=-1.2816$	**B1**	Allow $\pm$
	$-1.2816=\dfrac{c-31}{0.2}$	**M1**	**oe**
	$c=30.74$	**A1**	**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)	$\mathrm{P}\left(M < \dfrac{310-312}{\sqrt{3}}\right)$	**M1**	**PI** Standardises with their mean and variance in **(b)(i)**
	$\mathrm{P}(M < -1.1547...) = 1 - \mathrm{P}(M < 1.1547...)$	**M1**	**PI**
	$= 0.1241$	**A1**	**AWFW** [0.1241,0.1251]
		3	

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

	Question 4 total	**15**	

Q	Answer	Marks	Comments
5(a)(i)	$\overline{x} = 5.14$	**B1**	**AWRT** 5.14
		1	

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

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

	Question 5 total	**10**	

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

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

Q	Answer	Marks	Comments
6(c)	$\mathrm{P}(X > k) = 0.3 \Rightarrow \mathrm{P}(X < k) = 0.7$ $\Rightarrow 2 < k < 5$	**M1**	**PI**
	$\frac{(k-2)^2+6}{15} = 0.7$ $(k-2)^2 = \frac{9}{2}$	**M1**	Attempts to rearrange for k
	$k = \frac{4+3\sqrt{2}}{2}$	**A1**	**ACF** **M1 A0** for $\frac{4\pm3\sqrt{2}}{2}$ without discounting the negative value **oe AWRT** 4.12 scores 2/3
		3	

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

	Question 6 total	**10**	

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

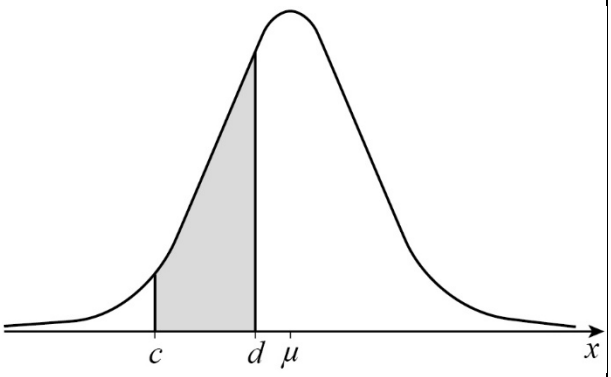
Q	Answer	Marks	Comments
7(b)(iii)	As 2 is not in the CR	**B1**	
	We have evidence to suggest that the number of errors in a 200m roll has not changed at the 10% level of significance	**B1**	Must not be definitive
		2	

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**	

Q	Answer	Marks	Comments
8(a)(i)	$2.3263 = \dfrac{a-\mu}{\sigma}$ $a = 2.3263\sigma + \mu$	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)	$z = -0.4958$	**B1**	
	$-0.4958 = \dfrac{15-15.2}{\sqrt{\dfrac{s^2}{n}}}$	**M1**	Allow use of 36, 35 or 30 for n
	$\dfrac{s^2}{35} \leq 0.162\left[722522...\right]$ or $\dfrac{s^2}{30} \geq 0.162\left[722522...\right]$	**m1**	Attempt to isolate s^2 for one equation with 35 or 30
	$s^2 \leq 5.69\left[5278825...\right]$ and $s^2 \geq 4.88\left[1667565...\right]$	**A1**	**AWRT** 5.70 or 4.88
	$4.88 \leq s^2 \leq 5.70$	**A1**	Upper limit **AWFW** [5.69, 5.70]
		5	

	Question 8 Total	**9**	