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Mark Scheme (Results)

October 2025

International Advanced Level in Statistics S2

WST02/01

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

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General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

   - **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
   - **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
   - **B** marks are unconditional accuracy marks (independent of M marks)
   - Marks should not be subdivided.

3. Abbreviations
   These are some of the traditional marking abbreviations that will appear in the mark schemes.
   - bod – benefit of doubt
   - ft – follow through
   - the symbol $\surd$ will be used for correct ft
   - cao – correct answer only
   - cso - correct solution only. There must be no errors in this part of the question to obtain this mark
   - isw – ignore subsequent working
   - awrt – answers which round to
   - SC: special case
   - oe – or equivalent (and appropriate)
   - dep – dependent
   - indep – independent
   - dp decimal places
   - sf significant figures
   - * The answer is printed on the paper
   - ⌊ The second mark is dependent on gaining the first mark

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

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5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. If a candidate makes more than one attempt at any question:
   - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
   - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer

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Question Number	Scheme	Marks
1 (a)	**List** of **all** the **members** [of the sports club]	B1
		(1)
(b)	Individual **members** [of the sports club]	B1
		(1)
(c)	Advantage: Less time consuming to obtain and analyse it/Less expensive	B1
	Disadvantage: May not be representative of the entire population	B1
		(2)
		Total 4

	Notes	
(a)	**B1**	Idea of a list e.g. database/register of all members. All can be implied but do not allow a partial list e.g. A list of 50 members.
(b)	**B1**	Allow member. Do not allow member's opinions.
(c)	**B1**	A correct advantage of taking a sample. If not labelled, assume the response refers to sample (rather than a census).
	B1	A correct disadvantage of taking a sample. If not labelled, assume the response refers to sample (rather than a census).

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Question Number	Scheme	Marks
2 (a)	Mean = 1.98	B1
	Variance = 1.95	B1
	Mean and variance are similar [no reason to doubt the manager's belief]	B1
		(3)
(b)(i)	$P(X \geq 4) = 1 - P(X \leq 3) = 1 - 0.8571$	M1
	$= 0.1429$ (Calc 0.1428765…) awrt **0.143**	A1
(ii)	$P(X \leq 6) - P(X \leq 2) = 0.9955 - 0.6767$	M1
	$= 0.3188$ (Calc 0.318789…) awrt **0.319**	A1
		(4)
(c)	$H_0 : \lambda = 2 \quad H_1 : \lambda > 2$ Allow $H_0 : \lambda = 10 \quad H_1 : \lambda > 10$	B1
	$P(X \geq 17 \mid Po(10)) = 1 - P(X \leq 16) = 1 - 0.9730$ or $P(X \geq 16 \mid Po(10)) = 1 - P(X \leq 15) = 1 - 0.9513$	M1
	= 0.0270 (Calc 0.027041….) or CR $\geqslant$ 16	A1
	Reject H_0/In the CR/Significant	M1
	There is sufficient evidence to suggest that the **mean number** of **complaints** received is **greater** than 2 per day	A1
		(5)
		Total 12

		Notes
(a)	**B1**	cao do not allow fraction
	B1	cao
	B1	Allow mean = variance ignore extraneous non-contradictory comments
(b)(i)	**M1**	For $1 - P(X \leq 3)$ or $1 - 0.8571$
	A1	awrt 0.143 correct answer scores 2/2
(ii)	**M1**	For $P(X \leq 6) - P(X \leq 2)$ or $0.9955 - 0.6767$
	A1	awrt 0.319 correct answer scores 2/2
(c)	**B1**	Both hypotheses correct. Must be attached to H_0 and H_1 in terms of λ or μ
	M1	For writing or using Po(10) **and** $1 - P(X \leq 16)$ or CR: $1 - P(X \leq 15)$ implied by awrt 0.0487 from a CR method
	A1	awrt 0.027 or CR $\geqslant$ 16
	M1	A correct statement consistent with their *p*-value and 0.05 **or** 17 and their CR – no context needed but do not allow contradicting non contextual comments
	A1	(Dep on both M marks) Correct conclusion in context with bold

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		words o.e. Must include the idea of rate so either: **mean number** or **number per day**

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Question Number	Scheme	Marks
3 (a)	If all possible samples are chosen from a population, then **all** the **values** of a **statistic** and their associated **probabilities** is a sampling distribution **or** a **probability distribution** of a **statistic**	B1
		(1)
(b)	111 112 (×3) 122 (×3) 222	B1 B1
		(2)
(c)	$\frac{5}{3}$	B1
		(1)
(d)	$p^3 = \frac{27}{125}$	M1
	$p = 0.6$ and $q = 0.4$	A1
	$\left[b = \mathrm{P}\left(\frac{4}{3}\right)\right] = 3 \times p^2 \times q$	M1
	$\left[c = \mathrm{P}\left(\frac{5}{3}\right)\right] = 3 \times p \times q^2$	M1
	$\left[d = \mathrm{P}(2)\right] = q^3$	M1
	$b = \frac{54}{125} = 0.432$ $c = \frac{36}{125} = 0.288$ $d = \frac{8}{125} = 0.064$	A1
		(6)
(e)	m: 1, 2 P($M = m$): $\frac{81}{125} = 0.648$, $\frac{44}{125} = 0.352$	B1 M1 A1
		(3)
		Total 13

		Notes
(a)	**B1**	A correct explanation including underlined words o.e.
(b)	**B1**	For three correct combinations
	B1	All four combinations (condone permutations) with no additional incorrect ones
(c)	**B1**	Allow awrt 1.67
(d)	**M1**	For a correct method to find p
	A1	For $p = 0.6$ and $q = 0.4$ may be implied by a correct calculation
	M1	A correct method to find $\mathrm{P}\left(\frac{4}{3}\right)$ ft their p and q
	M1	A correct method to find $\mathrm{P}\left("\frac{5}{3}"\right)$ ft their p and q
	M1	A correct method to find $\mathrm{P}(2)$ ft their p and q
	A1	cao
(e)	**B1**	For $m = 1$ and $m = 2$ only

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	M1	For either $\frac{27}{125}+'\frac{54}{125}'$ ft their *b* or $'\frac{36}{125}'+'\frac{8}{125}'$, ft their c and *d*
	A1	cao

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Question Number	Scheme	Marks
4 (a)	$F(10)=1 \Rightarrow -k(100-200+52)=1$ **or** $F(6)=\frac{2}{3} \Rightarrow -k(36-120+52)=\frac{2}{3}$	M1
	$48k=1$ leading to $k=\frac{1}{48}$ *	A1*
		(2)
(b)	$[P(X=4)=]0$	B1
		(1)
(c)	F(4.5) – F(2.5) + F(8.5) – F(5.5)	M1
	$\frac{1}{6}(4.5-2)-\frac{1}{24}(2.5-1)^2-\frac{1}{48}(8.5^2-20\times 8.5+52)-\frac{1}{6}(5.5-2)$ $\left[=\frac{5}{12}-\frac{3}{32}+\frac{61}{64}-\frac{7}{12}\right]$	M1
	$=\frac{133}{192}$	A1
		(3)
(d)	Attempt to differentiate either function	M1
	$[r(x)=]\frac{1}{12}(x-1)=\frac{1}{12}x-\frac{1}{12}$	A1
	$[s(x)=]\frac{1}{24}(10-x)=\frac{5}{12}-\frac{1}{24}x$	A1
		(3)
		Total 9

		Notes
(a)	**M1**	For using F(10) = 1 or F(6) = $\frac{2}{3}$
	A1*	Fully correct solution with substitution seen leading to $k=\frac{1}{48}$
(b)	**B1**	cao
(c)	**M1**	For writing or using F(4.5) – F(2.5) implied by $\frac{31}{96}$ **or** F(8.5) – F(5.5) implied by $\frac{71}{192}$
	M1	For a fully correct method with values substituted into correct part of cdf
	A1	Allow awrt 0.693
(d)	**M1**	Attempt to differentiate either function with $x^n \rightarrow x^{n-1}$ (implied by either correct answer)
	A1	A correct expression for r(x) oe
	A1	A correct expression for s(x) oe

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Question Number	Scheme	Marks
5 (a)	$[X \sim \mathrm{B}(15, 0.25) \quad \mathrm{P}(X > 4) =] 1 - \mathrm{P}(X \leq 4) = 1 - 0.6865$	M1
	= 0.3135 (Calc 0.313514...) awrt **0.314**	A1
		(2)
(b)	$\mathrm{P}(X \geq 1) > 0.95 \Rightarrow 1 - \mathrm{P}(X = 0) > 0.95$ so $\left[{}^{n}C_{0}(0.25)^{0} \right](0.75)^{n} < 0.05$	M1
	$n > 10.4(1...)$ or $n > \dfrac{\log(0.05)}{\log(0.75)}$ or $n > \log_{0.75}(0.05)$	M1
	$n =$ **11**	A1
		(3)
(c)	$X \sim \mathrm{B}(100, 0.25)$ so N(25, 18.75)	B1
	$\mathrm{P}(21.5 < Y < 30.5) = \mathrm{P}(Y < 30.5) - \mathrm{P}(Y < 21.5)$	M1
	$\mathrm{P}\left(Z < \dfrac{30.5 - 25}{\sqrt{18.75}}\right) - \mathrm{P}\left(Z < \dfrac{21.5 - 25}{\sqrt{18.75}}\right) = \mathrm{P}(Z < 1.27) - \mathrm{P}(Z < -0.81)$	M1 M1
	= 0.8980 – 0.2090 = 0.689 (Calc 0.688526...) awrt **0.689**	A1
		(5)
(d)	H_0: $p = 0.3$ and H_1: $p > 0.3$	B1
	$R \sim$B(25, 0.3) $\mathrm{P}(X \geq 10) = 1 - \mathrm{P}(X \leq 9) = 1 - 0.8106$ or CR method: $\mathrm{P}(X \geq 11) = 1 - \mathrm{P}(X \leq 10) = 1 - 0.9022 = 0.0978$	M1
	= 0.1894 or CR $\geqslant$ 11	A1
	Do not reject H_0/not significant/not in the CR	M1
	There is **not** significant evidence that the **proportion** of tulips producing **red** flowers is **greater than 0.3**	A1
		(5)

	Notes	**Total 15**
(a)	**M1**	For $1 - \mathrm{P}(X \leq 4)$ or $1 - 0.6865$
	A1	awrt 0.314 correct answer 2/2
(b)	**M1**	For $1 - \mathrm{P}(X = 0) > 0.95$ or $(0.75)^{n} < 0.05$ (condone =)
	M1	For $n > 10.41$ or $n > \dfrac{\log(0.05)}{\log(0.75)}$ or $n > \log_{0.75}(0.05)$ (condone < or =) or for the 2 trials for $n = 10$ and 11
	A1	cao
(c)	**B1**	For writing or using N(25, 18.75) NB: Poisson approximation send to review
	M1	For writing or using 21.5 or 30.5
	M1	For either standardisation using their mean and standard deviation. Allow 20.5/21/21.5 29.5/30/30.5
	M1	For both standardisations using their mean and standard deviation. Allow 20.5/21/21.5 29.5/30/30.5

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	A1	(Dep on all M marks) awrt 0.689 (Exact binomial awrt 0.685 scores 0/5)
(d)	**B1**	Both hypotheses correct. Must be attached to H_0 and H_1 in terms of *p* or π
	M1	For writing or using B(25, 0.3) **and** $1-\mathrm{P}(X \leq 9)$ or for CR : $1-\mathrm{P}(X \leq 10)$
	A1	awrt 0.189 or CR $\geqslant$ 11
	M1	A correct statement – no context needed but do not allow contradicting non contextual comments
	A1	(Dep on both M marks) Correct conclusion in context using bold word o.e.

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Question Number	Scheme		Marks
6 (a)	$[A=]X(20-X)=20X-X^2$		M1
	$[\mathrm{E}(X)=]10$	$[\mathrm{E}(A)=]\frac{1}{20}\int_{[0]}^{[20]} 20x-x^2\,\mathrm{d}x$	B1
	$[\mathrm{Var}(X)=]\frac{100}{3}$	$[\mathrm{E}(A)=]\frac{1}{20}\left[10x^2-\frac{1}{3}x^3\right]_{[0]}^{[20]}$	B1
	$\mathrm{E}(X^2)=10^2+\frac{100}{3}\left[=\frac{400}{3}\right]$	Correct limits 0 and 20	M1
	$\mathrm{E}(A)=20\times 10-"\frac{400}{3}"$	$\mathrm{E}(A)=\frac{1}{20}\left(10(20^2)-\frac{1}{3}(20^3)-0\right)$	M1
		$=\frac{200}{3}$	A1
			(6)
(b)	$\left[\mathrm{P}\left(A>5X^2\right)=\right]\mathrm{P}\left("20X-X^2">5X^2\right)$		M1
	$\Rightarrow \mathrm{P}\left(X<\frac{10}{3}\right)$		M1
	$\frac{1}{20}\times"\frac{10}{3}"$		M1
	$=\frac{1}{6}$		A1
			(4)
			Total 10

		Notes
(a)	**M1**	For a correct expression for area
	B1	For 10 or correct expression for E(*A*) ignore limits
	B1	For $\frac{100}{3}$ or fully correct integration
	M1	For use of $\mathrm{E}(X^2)=\mathrm{E}(X)^2+\mathrm{Var}(X)$ ft their E(*X*) and Var(*X*) or correct limits seen or used
	M1	For use of $20\mathrm{E}(X)-\mathrm{E}(X^2)$ ft their E(*X*) and E(X^2) or complete numerical expression for E(*A*)
	A1	Allow awrt 66.7
(b)	**M1**	For $"20X-X^2">5X^2$ Allow = ft their area which must be in terms of *X*
	M1	For rearranging and attempting to solve $"20X-X^2">5X^2$ May be implied by $\frac{10}{3}$
	M1	For correct area $\frac{1}{20}\times"\frac{10}{3}"$
	A1	Allow awrt 0.167

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Question Number	Scheme	Marks
7 (a)	$\int_0^m \left(\frac{1}{4}x - \frac{1}{64}x^3\right) \mathrm{d}x \left[= \frac{1}{2}\right]$	M1
	$\left[\frac{1}{8}x^2 - \frac{1}{256}x^4\right]_0^m \left[= \frac{1}{2}\right]$	A1
	$m^4 - 32m^2 + 128 = 0$ **or** for either F(2.1645) or F(2.1655)	M1
	$m^2 = 16 \pm \sqrt{128}$ ($= 4.686...$ or $27.313...$) **or** both F(2.1645) and F(2.1655)	M1
	$m = \sqrt{16 - \sqrt{128}} = 2.165$ *	A1*
		(5)
(b)	$\mathrm{E}\left(\frac{1}{Y}\right) = \frac{4}{255}\int_1^4 (y^{-1}y^3)\,\mathrm{d}y = \frac{4}{255}\int_1^4 (y^2)\,\mathrm{d}y$	M1
	$\frac{4}{255}\left[\frac{y^3}{3}\right]_1^4 = \frac{4}{255} \times \frac{63}{3}\left[= \frac{28}{85}\right]$	dM1
	$\mathrm{E}\left(\frac{1}{Y^2}\right) = \frac{4}{255}\int_1^4 (y^{-2}y^3)\,\mathrm{d}y = \int_1^4 \frac{4}{255}y\mathrm{d}y$	M1
	$\frac{4}{255}\left[\frac{y^2}{2}\right]_1^4 = \frac{4}{255} \times 7.5\left[= \frac{2}{17}\right]$	dM1
	$\mathrm{Var}\left(\frac{1}{Y}\right) = \frac{2}{17} - \left(\frac{28}{85}\right)^2 = \frac{66}{7225}$ *	A1*
		(5)
(c)	$\mathrm{Var}\left(4 - \frac{5}{Y}\right) = 25 \times \frac{66}{7225}$	M1
	$= \frac{66}{289} = 0.2283...$ awrt **0.228**	A1
		(2)

	Notes	**Total 12**
(a)	**M1**	For $\int \mathrm{f}(x)\,\mathrm{d}x$ ignore limits and $= 0.5$
	A1	For correct integration ignore limits and $= 0.5$
	M1	For substitution of limits leading to a correct equation **or** use of 2.1645 or 2.1655
	M1	Solving the equation leading to $m^2 = ...$ or substitution of both 2.1645 (= 0.499891) and 2.1655 (=0.500273)
	A1*	$m = \sqrt{16 - \sqrt{128}}$ or $0.499... < m < 0.500...$ leading to the given answer
(b)	**M1**	For $\int \frac{1}{y}\mathrm{f}(y)\,\mathrm{d}y$ Ignore limits
	dM1	Dep on previous M1. For substitution of limits into integrated expression
	M1	For $\int \frac{1}{y^2}\mathrm{f}(y)\,\mathrm{d}y$ Ignore limits

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	dM1	Dep on previous M1. For substitution of limits into integrated expression
	A1*	Dep on all M marks. For use of $\mathrm{E}\left(\frac{1}{Y^2}\right)-\left(\mathrm{E}\left(\frac{1}{Y}\right)\right)^2$ leading to the given answer
(c)	**M1**	For use of $5^2\,\mathrm{Var}\left(\frac{1}{Y}\right)$
	A1	awrt 0.228