Mark Scheme (Results)

October 2023

Pearson Edexcel International Advanced Level In Statistics (WST02) Paper 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.

- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

General Instructions for Marking

The total number of marks for the paper is 75.

Edexcel Mathematics mark schemes use the following types of marks:

'M' marks
These are marks given for a correct method or an attempt at a correct method. In Mechanics they are usually awarded for the application of some mechanical principle to produce an equation, e.g. resolving in a particular direction; taking moments about a point; applying a suvat equation; applying the conservation of momentum principle; etc.

The following criteria are usually applied to the equation.

To earn the M mark, the equation
(i) should have the correct number of terms
(ii) each term needs to be dimensionally correct

For example, in a moments equation, every term must be a 'force x distance' term or 'mass x distance', if we allow them to cancel 'g' s.

For a resolution, all terms that need to be resolved (multiplied by sin or cos) must be resolved to earn the M mark.

'M' marks are sometimes dependent (DM) on previous M marks having been earned, e.g. when two simultaneous equations have been set up by, for example, resolving in two directions and there is then an M mark for solving the equations to find a particular quantity – this M mark is often dependent on the two previous M marks having been earned.

'A' marks
These are dependent accuracy (or sometimes answer) marks and can only be awarded if the previous M mark has been earned. e.g. M0 A1 is impossible.

'B' marks
These are independent accuracy marks where there is no method (e.g. often given for a comment or for a graph).

A and B marks may be f.t. – follow through – marks.

General Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes:

- bod means benefit of doubt
- ft means follow through
    - the symbol $\surd$ will be used for correct ft
- cao means correct answer only
- cso means correct solution only, i.e. there must be no errors in this part of the question to obtain this mark
- isw means ignore subsequent working

- awrt means answers which round to
- SC means special case
- oe means or equivalent (and appropriate)
- dep means dependent
- indep means independent
- dp means decimal places
- sf means significant figures
- * means the answer is printed on the question paper
- ⌐ means the second mark is dependent on gaining the first mark

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.

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.

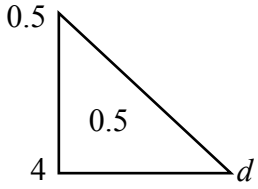
If a candidate makes more than one attempt at any question:

- 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.

Ignore wrong working or incorrect statements following a correct answer.

Question Number	Scheme	Marks
1 (a) (i)	$X \sim \mathrm{B}(14, 0.2)$	
	$[\mathrm{P}(X = 2) =] {}^{14}C_2 \times 0.2^2 \times 0.8^{12}$	M1
	$= 0.2501$ awrt 0.2501	A1
(ii)	$X \sim \mathrm{B}(25, 0.2)$	
	$\mathrm{P}(X > 3) = 1 - \mathrm{P}(X \leqslant 3) = 1 - 0.2340$ or $1 - (0.0038 + 0.0236 + 0.0708 + 0.1358)$	M1
	$= 0.7660$ awrt 0.766	A1
		(4)
(b)(i)	$[np = 6 \Rightarrow] n = \dfrac{6}{0.2}$	M1
	$= 30$	A1
		(2)
(ii)	$Y \sim \mathrm{B}(n, 0.2)$ we require $\mathrm{P}(Y \geqslant 1) > 0.95$	
	$1 - \mathrm{P}(Y = 0) > 0.95 \Rightarrow \mathrm{P}(Y = 0) < 0.05$	M1
	$\left[{}^{n}C_0 \times 0.2^0 \right] \times 0.8^n < 0.05$	M1
	$0.8^{14} = 0.04398...[< 0.05]$ | $n > \dfrac{\ln 0.05}{\ln 0.8} \Rightarrow n > 13.425$	dM1
	$n = 14$	A1
		(4)

	Notes	**Total 10**
(a) (i)	**M1**	For writing or using ${}^{14}C_2 \times 0.2^2 \times 0.8^{12}$ (Allow 91 for ${}^{14}C_2$)
	A1	awrt 0.2501 **NB** 0.2501 with no working scores M1A1
(ii)	**M1**	For writing or using $1 - \mathrm{P}(X \leqslant 3)$
	A1	awrt 0.766 **NB** awrt 0.766 with no working scores M1A1
(b)(i)	**M1**	For use of $np = 6$ e.g $0.2n = 6$ (Allow $\geqslant$)
	A1	Cao
(ii)	**M1**	For writing or using $\mathrm{P}(Y \geqslant 1) = 1 - \mathrm{P}(Y = 0)$ (Allow $\mathrm{P}(Y \geqslant 1) = 1 - \mathrm{P}(Y \leqslant 0)$)
	M1	For $0.8^n < 0.05$ oe (Allow = or $\leqslant$)
	dM1	Dependant on previous M1 For substitution of n (allow $0.8^{13} = 0.05497\ldots$) or rearranging to $n > \ldots$ (Allow = or $\geqslant$) If using logs allow any base e.g. $n > \log_{0.8} 0.05$
	A1	Cao

Question Number	Scheme	Marks
2 (a)	[Mode =] 4	B1
		(1)
(b)	$\left[a\int_0^4 x^3\mathrm{d}x=\frac{1}{2}\Rightarrow\right]a\left[\frac{x^4}{4}\right]_0^4=\frac{1}{2}$	M1
	$64a=\frac{1}{2}\Rightarrow a=\frac{1}{128}$ *	A1*
		(2)
(c)	 $\frac{1}{2}\times\frac{1}{2}\times(d-4)=\frac{1}{2}$ or $\frac{1}{2}\times\frac{1}{2}\times(d-4)+\int_0^4 ax^3\mathrm{d}x=1$	M1
	$d=6$	A1
		(2)
(d)	$b=\frac{-\frac{1}{2}}{'6'-4}\left[=-\frac{1}{4}\right]$ $4b+c=0.5$ oe	M1
	$0='-\frac{1}{4}'\times'6'+c$ or $\frac{1}{2}='-\frac{1}{4}'\times4+c$ $10b+2c=0.5$ oe or $'6'b+c=0$ oe	M1
	$b=-\frac{1}{4}$ and $c=\frac{3}{2}$	A1
		(3)
	Notes	**Total 8**

(a)	**B1**	Cao
(b)	**M1**	For integrating the 1st line of the pdf and setting = 0.5 Ignore limits
	A1*	Answer is given so a correct solution must be seen with no errors. There must be at least one line of correct working from the M mark to the final answer.
		Mark parts c and d together
(c)	**M1**	For setting the area of the triangle = 0.5
	A1	Cao
(d)	**M1**	A correct method for finding *b* ft their *d* value or $4b+c=0.5$ oe (this may be seen any part of this question) Allow $4b+c=64a$
	M1	A correct method for finding *c* ft their *b* and *d* value or $10b+2c=0.5$ oe or $'d'\times b+c=0$ oe (these may be seen any part of this question) Allow $db+c=0$
	A1	For both *b* and *c* correct **NB** *b* = - 0.25 oe and *c* = 1.5 oe will score 3/3

Question Number	Scheme	Marks
3 (a)(i)	$3 + [0] + 29 = 32$*	B1*
(ii)	$3 + 15 + 29 = 47$*	B1*
		(2)
(b)	$f(t) = \begin{cases} \frac{1}{15} & 32 \leqslant t \leqslant 47 \\ 0 & \text{otherwise} \end{cases}$	M1 A1
		(2)
(c) (i)	$[E(T) =]\ 39.5$ oe	B1
(ii)	$[\text{Var}(T) =] \frac{(47-32)^2}{12}$	M1
	$\frac{75}{4} = 18.75$	A1
		(3)
(d)	$(40-32) \times \frac{1}{15}$	M1
	$= \frac{8}{15}$	A1
		(2)
	Notes	**Total 9**

(a)(i)	**B1***	For $3 + [0] + 29$
(ii)	**B1***	For $3 + 15 + 29$ Allow $32 + 15$
(b)	**M1**	For $f(t) = \frac{1}{15}$ $32 \leqslant t \leqslant 47$ Allow use of $<$ instead of one/both $\leq$ signs. Allow the use of any letter for f(t) and t (Condone inconsistent use of letters) but we must have f(t) and an inequality
	A1	Fully correct pdf $f(t) = \begin{cases} \frac{1}{15} & 32 \leqslant t \leqslant 42 \\ 0 & \text{otherwise} \end{cases}$ Must be f(t) and t. Condone f(T) and T Allow use of $<$ instead of one/both $\leq$ signs Allow equivalent for the 0 otherwise.
(c)(i)	**B1**	For 39.5 oe
(ii)	**M1**	For use of $\text{Var}(T) = \frac{(\beta-\alpha)^2}{12}$
	A1	For 18.75 oe
(d)	**M1**	For use of $(40-\alpha) \times \frac{1}{\beta-\alpha}$
	A1	For $\frac{8}{15}$ oe Allow awrt 0.533

Question Number	Scheme	Marks
4 (a)	$0.2\times£10+0.3\times£12+0.5\times£15$	M1
	$=[£]13.10$	A1
		(2)
(b)	10 10 10 10 10 12 (×3) 10 10 15 (×3) 10 12 15 (×6) 12 12 12 12 12 15 (×3) 10 12 12 (×3) 15 15 15 12 15 15 (×3) 10 15 15 (×3)	B1 B1
		(2)
(c)	$P(10)=0.2$ $P(12)=0.3$ $P(15)=0.5$	B1
	Median can be 10, 12 or 15	B1
	$P(M=10)=0.2^3+0.2^2\times0.3\times3+0.2^2\times0.5\times3$ **or** $1-0.8^3-3\times0.8^2\times0.2$	M1
	$P(M=12)=0.3^3+0.3^2\times0.5\times3+0.3^2\times0.2\times3+0.2\times0.3\times0.5\times6$	M1
	$P(M=15)=0.5^3+0.5^2\times0.3\times3+0.5^2\times0.2\times3$ **or** $1-0.5^3-3\times0.5^2\times0.5$	M1
	M | 10 | 12 | 15 $P(M=m)$ | $\frac{13}{125}=0.104$ | $\frac{99}{250}=0.396$ | $\frac{1}{2}=0.5$	A1
		(6)

	Notes		Total 10
(a)	**M1**	For $0.2\times10+0.3\times12+0.5\times15$ May be implied by a correct answer	
	A1	Cao Allow 13.1	
(b)	**B1**	B1 for at least 5 possible combinations. Ignore repeats. May be seen in part c	
	B1	For all 10 possible combinations. Ignore repeats. May be seen in part c	
(c)	**B1**	Correct probabilities – may be seen in an equation or implied by a correct probability	
	B1	All 3 medians and no extras	
	M1	A correct method for one of the probabilities (May be implied by a correct probability)	
	M1	A correct method for two of the probabilities (May be implied by 2 correct probabilities)	
	M1	A correct method for all three probabilities (May be implied by 3 correct probabilities) or 3 probabilities that add to 1	
	A1	Cao Need not be in a table but probabilities must be attached to the correct median	

Question Number	Scheme	Marks
5 (a)	**Complaints** received are independent or occurring at a constant rate or singly	B1
		(1)
(b)(i)	$\left[\mathrm{P}\left(X<3\middle\vert X\sim \mathrm{Po}(6)\right)=\right]0.0620$ awrt 0.062	B1
(ii)	$\left[\mathrm{P}\left(X\geqslant 6\right)=\right]1-\mathrm{P}\left(X\leqslant 5\right)$ or $1-0.4457=0.5543$ awrt 0.554	M1A1
		(3)
(c)	$\mathrm{H}_0:\lambda=6 \quad \mathrm{H}_1:\lambda>6$	B1
	$\mathrm{P}(X\geqslant 12)=1-\mathrm{P}(X\leqslant 11)=[1-0.9799]$ or $\mathrm{P}(X\geqslant 11)=1-\mathrm{P}(X\leqslant 10)=[1-0.9574]$	M1
	$=0.0201$ or $\mathrm{CR}\geqslant 11$	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 6 per week	A1ft
		(5)
(d)	$\mathrm{H}_0:\lambda=6 \quad \mathrm{H}_1:\lambda<6$	B1
	6 week period is Po(36) $\Rightarrow$ N(36, 36)	B1
	$\mathrm{P}\left(Y\leqslant 26\right)\approx \mathrm{P}\left(Y<26.5\right)=P\left(Z<\dfrac{26.5-36}{6}\right)$ or $\dfrac{x+0.5-36}{\sqrt{36}}<-1.6449$	M1 M1
	$\left[P\left(Z<-1.583...\right)\right]=0.0571$ (Calculator 0.05667…) or $x<25.63...$ awrt 0.057 awrt 25.6	A1
	Do not reject H_0/Not in the CR/Not significant	M1
	There is insufficient evidence to suggest that the mean **number** of **complaints** received after the changes made is **less** than 6 per week	A1ft
		(7)

	Notes	**Total 16**
(a)	**B1**	A correct assumption. Must be in context so need 'complaints' and then independent/random or constant rate or singly
(b)(i)	**B1**	awrt 0.062
(ii)	**M1**	For writing or using $1-\mathrm{P}(X\leqslant 5)$ May be implied by awrt 0.554
	A1	awrt 0.554
(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 $1-\mathrm{P}(X\leqslant 11)$ or $1-\mathrm{P}(X\leqslant 10)$
	A1	For 0.0201 or CR $\geqslant 11$
	M1	A correct statement – no context needed but do not allow contradicting non contextual comments
	A1ft	Correct conclusion in context with the words highlighted in bold
(d)	**B1**	Both hypotheses correct. Must be attached to H_0 and H_1 in terms of λ or μ Allow use of 36 rather than 6
	B1	For writing or using N(36, 36)
	M1	For standardising using 25.5/26/26.5, their mean and their standard deviation or standardising using x–0.5/x/x + 0.5, their mean and their standard deviation and setting equal to –1.6449
	M1	For a correct continuity correction written or used e.g. 26.5 or x + 0.5
	A1	awrt 0.057 (NB Poisson used gives 0.0512685… and scores M0M0A0) or CR < awrt 25.6 (Allow $\leqslant$)
	M1	A correct statement – no context needed but do not allow contradicting non contextual comments
	A1ft	Correct conclusion in context with the words in bold (Allow The mean **number** of **complaints** has **stayed the same/not changed** oe)

Question Number	Scheme	Marks
6(a)	$\left[\mathrm{P}\left(Y<\frac{1}{4}k \mid Y<k\right)=\right]\frac{\mathrm{F}\left(\frac{1}{4}k\right)}{\mathrm{F}(k)}=\frac{\frac{1}{21}\left(\frac{k}{4}\right)^2}{\frac{1}{21}k^2}=\frac{1}{16}$ oe	M1 A1
		(2)
(b)	$\frac{1}{21}k^2=-\frac{1}{15}k^2+\frac{4}{5}k-\frac{7}{5}$ $\quad$ $\frac{\mathrm{d}}{\mathrm{d}y}\left(\frac{1}{21}y^2\right)=\frac{2}{21}y$ or $\frac{\mathrm{d}}{\mathrm{d}y}\left(\frac{2}{15}\left(6y-\frac{y^2}{2}\right)-\frac{7}{5}\right)=\frac{2}{15}(6-y)$	M1
	$\Rightarrow 4k^2-28k+49=0$ oe $\quad$ $\frac{\mathrm{d}}{\mathrm{d}y}\left(\frac{1}{21}y^2\right)=\frac{2}{21}y$ & $\frac{\mathrm{d}}{\mathrm{d}y}\left(\frac{2}{15}\left(6y-\frac{y^2}{2}\right)-\frac{7}{5}\right)=\frac{2}{15}(6-y)$	A1
	$\Rightarrow (2k-7)^2=0$ $\quad$ $\frac{2}{21}k=\frac{2}{15}(6-k)$	M1
	$k=\frac{7}{2}$ oe	A1
		(4)
(c)	$\mathrm{f}(y)=\begin{cases}\frac{2}{21}y & 0\leqslant y\leqslant \text{'3.5'}\\ \frac{2}{15}(6-y) & \text{'3.5'}<y\leqslant 6\\ [0] & [\text{otherwise}]\end{cases}$	M1 M1
	$\mathrm{E}(Y)=\frac{2}{21}\int_0^{\text{'3.5'}}y^2\mathrm{d}y+\frac{2}{15}\int_{\text{'3.5'}}^{6}\left(6y-y^2\right)\mathrm{d}y \quad \Rightarrow \quad \frac{2}{21}\left[\frac{y^3}{3}\right]_0^{\text{'3.5'}}+\frac{2}{15}\left[3y^2-\frac{y^3}{3}\right]_{\text{'3.5'}}^{6}$	M1 M1
	$\frac{2}{21}\left(\frac{343}{24}\right)+\frac{2}{15}\left(\frac{325}{24}\right)=\frac{19}{6}=3.166...$ awrt 3.17	dM1 dA1
		(6)
		Total 12

(a)	**M1**	For a correct probability statement or a correct ratio of probabilities
	A1	For $=\frac{1}{16}$ oe or 0.0625
(b)	**M1**	For setting the two lines of the cdf = to each other or $\frac{2}{21}y$ or $\frac{2}{15}(6-y)$ (Implied by a correct 3TQ)
	A1	For a correct 3TQ or $\frac{2}{21}y$ and $\frac{2}{15}(6-y)$
	M1	For solving their 3TQ. If the 3TQ is not correct, then a correct method must be shown or setting their 2 lines of the pdf = to each other
	A1	$k = 3.5$ oe **NB** $k = 3.5$ with no incorrect working scores 4/4
(c)	**M1**	Attempting to differentiate 1 of the functions. May be seen in part (b) or in an attempt to find E(Y)
	M1	Attempting to differentiate both with one correct. May be seen in part (b) or in an attempt to find E(Y)
	M1	For writing or using $\mathrm{E}(Y)=\int_0^{3.5}y\ \mathrm{f}(y)\ \mathrm{d}y+\int_{3.5}^{6}y\ \mathrm{f}(y)\ \mathrm{d}y$ Ignore limits
	M1	For attempting to integrate
	dM1	Dependent on previous M1. For substitution of limits, must be 0 or 6 and ft their 3.5. May be implied by $\frac{49}{36}$ oe or $\frac{65}{36}$ oe or $\frac{19}{6}$ oe. If the integral is not correct, then we must see evidence of substitution.
	dA1	Dependent on previous M1. For $\frac{19}{6}$ or awrt 3.17

Question Number	Scheme	Marks
7(a)	$\frac{97.5-\mu}{\sigma}=1.25$ $\quad$ $\frac{85.5-\mu}{\sigma}=-0.75$	M1 M1 M1 M1 M1
	$2\sigma=12$	M1
	$\sigma=6$ * $\quad[\mu=90]$	dA1*
		(7)
(b)	$np=90$ and $np(1-p)=36$	M1
	$1-p=0.4$	M1
	$p=0.6$ and $n=150$	A1
		(3)
	Notes	**Total 10**

NB Condone use of np for μ and $\sqrt{np(1-p)}$ for σ

(a)	**M1**	For standardising using 96.5/97/97.5 and = z value, where $1<z<1.5$
	M1	For standardising using 85.5/86/86.5 and = z value, where $-1<z<-0.5$
	M1	For use of a correct continuity correction in either equation
	M1	For a correct z value used in either equation
	M1	An attempt at both equations with one fully correct
	M1	For solving simultaneously eliminating μ or σ As this is a show that question then working must be seen.
	dA1	Dependent on all previous M marks being awarded $\sigma=6$ *
(b)	**M1**	For $np=\mu$ and $np(1-p)=\sigma^2$ Follow through their μ (Condone $npq=\sigma^2$)
	M1	For solving simultaneously. May be implied by a correct value for p and n
	A1	Both $p=0.6$ and $n=150$

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