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Mark Scheme (Results)

October 2023

Pearson Edexcel International Advanced Level
In Statistics S1 (WST01)
Paper 01

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October 2023
Question Paper Log Number 74325
Publications Code WST01_01_rms_20240118
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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.

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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

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- 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.

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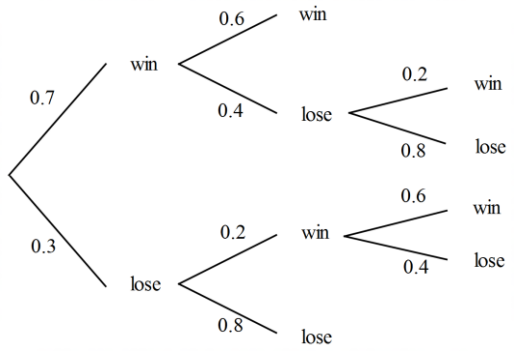
Question Number	Scheme	Marks
1 (a)		B1 B1 B1
		(3)
(b)	$0.7\times0.6=0.42$ oe	M1 A1
		(2)
(c)	$'0.42'+(0.7\times'0.4'\times'0.2')+('0.3'\times'0.2'\times'0.6')=0.512$ oe	M1 A1
		(2)
(d)	$\frac{'0.42'}{'0.512'}=0.8203...$ oe awrt 0.820	M1 A1ft
		(2)
(e)	$\frac{'0.42'+(0.7\times'0.4'\times'0.2')}{0.7}=0.68$ oe or $0.6+'0.4'\times'0.2'=0.68$ oe	M1 A1
		(2)

	Notes		Total 11
(a)	**B1**	For 0.3 in the correct place on the first branch and 0.4 in the correct place on the second branch	
	B1	For 0.2 and 0.8 in the correct place in the second branch	
	B1	For 0.2, 0.8, 0.6 and 0.4 in the correct place in the third branch	
		NB ISW any extra branches drawn on the tree diagram	
(b)	**M1**	For 0.7×0.6	
	A1	Cao	
(c)	**M1**	For $'0.42'+(0.7\times'0.4'\times'0.2')+('0.3'\times'0.2'\times'0.6')$ Follow through part (b) and their tree diagram	
	A1	Cao	
(d)	**M1**	For $\frac{\text{part (b)}}{\text{part (c)}}$ provided the answer is a probability or ft their tree diagram	
	A1ft	awrt 0.820 or ft part (b) and part (c) provided the answer is a probability or ft their tree diagram. Allow 0.82 If ft and a decimal answer is given then this must be at least 3sf	
(e)	**M1**	For a correct ratio of probabilities. Follow through their part (b) and their tree diagram or $0.6+'0.4'\times'0.2'$ ft their tree diagram	
	A1	Cao Allow 0.680	

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Question Number	Scheme	Marks
2 (a)(i)	$Q_2 = 57$	B1
(ii)	$Q_1 = 45$ $Q_3 = 63$	B1 B1
		(3)
(b)	'63'+1.5('63'−'45')[=90] or '45'−1.5('63'−'45')[=18]	M1
	= 90 or = 18	A1ft
	16 and 94 [are outliers]*	A1*
		(3)
(c)	A boxplot drawn with 2 whiskers	M1
	Q_1, Q_2 and Q_3 plotted correctly	A1ft
	Whiskers drawn correctly	A1ft
	Outliers marked at 16 and 94	A1
		(4)
(d)	The **median/Q_2** for February is less/lower than the **median/Q_2** for December oe	B1ft
	The **IQR/range** for February is less/lower than December (allow similar) oe	B1ft
	For a correct interpretation of either average or spread e.g. • on average February weigh less than December oe • the weights of February are less varied/little change in variability than the weights of December oe • They weighed more later in the year oe • Most of the distribution has shifted right, implying that most kangaroos have gained weight but some appear to have lost weight.	B1ft
		(3)

	Notes	**Total 13**
(a)(i)	**B1**	Cao
(ii)	**B1**	Cao
	B1	Cao
(b)	**M1**	For use of either $Q_3 + 1.5(Q_3 - Q_1)$ or $Q_1 - 1.5(Q_3 - Q_1)$ ft part (a)
	A1ft	For either 90 or 18 ft part (a)
	A1*	For identifying both outliers with no incorrect/missing working (This can ft part (a))
(c)	**M1**	A boxplot drawn with 2 whiskers
	A1ft	For Q_1, Q_2 and Q_3 plotted correctly ft part (a)
	A1ft	Whiskers drawn at 18 and 90 ft part (b) **or** 23 and 86
	A1	Outliers marked at 16 and 94
(d)	**B1ft**	A correct comparison of medians ft their boxplot drawn or part (a) (No figures are required but if quoted then they need to be correct ft) Must mention the word median/Q_2
	B1ft	A correct comparison of range/IQR ft their boxplot drawn or part (a) (No figures are required but if quoted then they need to be correct ft) Must mention either IQR or range
	B1ft	A correct interpretation of either the average or the spread ft their boxplot drawn or part (a)
		NB Ignore any reference to skew or outliers

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Question Number	Scheme	Marks
3 (i) (a)	$w = 0.15$	B1
	$x = 0.7 - 0.15 = 0.55$	B1
	$y = 0.65 - 0.55 = 0.1$	B1
	$z = 1 - 0.15 - 0.55 - 0.1 = 0.2$	B1
		(4)
(b)	$'0.15' + '0.1' = '0.25'$	B1ft
		(1)
(c)	$[\mathrm{P}(C) \times \mathrm{P}(O)] = '0.65' \times '0.7' \neq '0.55' [= \mathrm{P}(C \cap O)]$ or $[\mathrm{P}(C \mid O) =] \dfrac{'0.55'}{'0.7'} \neq '0.65' [= \mathrm{P}(C)]$ oe	M1
	$'0.455' \neq '0.55'$ or $'0.7857'... \neq '0.65'$ [So not independent]*	A1*
		(2)
3 (ii) (a)		
	$\left[P(F \cup H) = \dfrac{2}{7} + \dfrac{1}{4} = \right] \dfrac{15}{28}$	B1
		(1)
(b)	$\dfrac{5}{8} = \dfrac{2}{7} + \mathrm{P}(G) - \dfrac{2}{7}\mathrm{P}(G)$	M1
	$\mathrm{P}(G) = \dfrac{\frac{5}{8} - \frac{2}{7}}{1 - \frac{2}{7}} = \dfrac{19}{56} \div \dfrac{5}{7}$	dM1
	$\mathrm{P}(G) = \dfrac{19}{40}$	A1
		(3)
(c)	$\left[P(F \cap G) = \dfrac{2}{7} \times '\dfrac{19}{40}' = \right] \dfrac{19}{140}$	B1ft
		(1)

	Notes	**Total 12**
(i)(a)	**B1**	$w = 0.15$ If answer is given in the script and the Venn diagram, then mark the script
	B1	$x = 0.55$ If answer is given in the script and the Venn diagram, then mark the script
	B1	$y = 0.1$ If answer is given in the script and the Venn diagram, then mark the script
	B1	$z = 0.2$ If answer is given in the script and the Venn diagram, then mark the script
(b)	**B1ft**	For $w + y = '0.25'$ follow through their w and their y (You will need to check for their values) provided this is a probability
(c)	**M1**	For $'(x+y)' \times '(w+x)' \neq 'x'$ or $\dfrac{'x'}{'w+x'} \neq 'x+y'$ ft their w, x and y
	A1*	A fully correct solution with values evaluated and no errors ft their w, x and y
(ii) (a)	**B1**	For $\dfrac{15}{28}$ oe Allow awrt 0.536
(b)	**M1**	For use of $\mathrm{P}(F \cup G) = \mathrm{P}(F) + \mathrm{P}(G) - \mathrm{P}(F) \times \mathrm{P}(G)$
	dM1	Dependent on M1. For a correct rearrangement to find $\mathrm{P}(G)$ e.g. $\left(\dfrac{5}{8} - \dfrac{2}{7}\right) \div \left(1 - \dfrac{2}{7}\right)$ Allow $\dfrac{19}{56} = \dfrac{5}{7}\mathrm{P}(G)$ May be implied by $\dfrac{19}{40}$
	A1	For $\dfrac{19}{40}$ oe
(c)	**B1ft**	For $\dfrac{19}{140}$ oe or $\dfrac{2}{7} \times \mathrm{P}(G)$ evaluated correctly and where $\mathrm{P}(G)$ is a probability

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Question Number	Scheme	Marks
4 (a)	$\mathrm{E}\left(\frac{1}{X}\right)=1\times\frac{1}{10}+\frac{1}{2}\times\frac{1}{5}+\frac{1}{3}\times\frac{3}{10}+\frac{1}{4}\times\frac{2}{5}=\frac{2}{5}$*	B1*
		(1)
(b)	$\mathrm{E}\left(\left(\frac{1}{X}\right)^2\right)=1^2\times\frac{1}{10}+\left(\frac{1}{2}\right)^2\times\frac{1}{5}+\left(\frac{1}{3}\right)^2\times\frac{3}{10}+\left(\frac{1}{4}\right)^2\times\frac{2}{5}\left[=\frac{5}{24}\right]$	M1
	$\mathrm{Var}\left(\frac{1}{X}\right)=\frac{5}{24}-\left(\frac{2}{5}\right)^2=\frac{29}{600}$	M1 A1
		(3)
(c) (i)	$\left[\mathrm{E}(Y)=\right]12$	B1
(ii)	$\left[\mathrm{Var}(Y)=\right]30^2\,'\mathrm{Var}\left(\frac{1}{X}\right)'=\frac{87}{2}$ or If y : 30 15 10 7.5 then $\left[\mathrm{Var}(Y)=\right]\frac{375}{2}-12^2=\frac{87}{2}$	M1 A1
		(3)
(d)	$\left[Y<20\Rightarrow\right]\frac{30}{X}<20\Rightarrow X>1.5$ or y : 30 15 10 7.5	M1
	$\mathrm{P}(Y<20)=\mathrm{P}(X>1.5)=\frac{9}{10}$	A1
	$\left[\mathrm{P}(X<3\,\vert\,Y<20)=\right]\frac{\mathrm{P}(X=2)}{\mathrm{P}(X>1.5)}=\frac{\frac{1}{5}}{\left(\frac{9}{10}\right)}=\frac{2}{9}$ or $\left[\mathrm{P}(X<3\,\vert\,Y<20)=\right]\frac{\mathrm{P}(Y=15)}{\mathrm{P}(Y<20)}=\frac{\frac{1}{5}}{\left(\frac{9}{10}\right)}=\frac{2}{9}$	dM1 A1 A1
		(5)

	Notes	**Total 12**
(a)	**B1***	Value given, so must see sight of a correct expression, with no incorrect working seen. (Allow equivalent expressions.)
(b)	**M1**	For attempt at an expression for $\mathrm{E}\left(\left(\frac{1}{X}\right)^2\right)$ with at least 3 correct terms (Allow equivalent expressions.) May be embedded in a correct expression for Var (X)
	M1	For a correct expression for $\mathrm{Var}\left(\frac{1}{X}\right)$ (Need not be simplified) ft a stated value of $\mathrm{E}\left(\left(\frac{1}{X}\right)^2\right)$
	A1	Cao Allow awrt 0.0483
(c) (i)	**B1**	For [E(Y)] = 12
(ii)	**M1**	For correct use of $30^2\,\mathrm{Var}\left(\frac{1}{X}\right)$ ft their $\mathrm{Var}\left(\frac{1}{X}\right)$ or $\frac{375}{2}-12^2$ (May be implied by $\frac{87}{2}$ oe)
	A1	For $\left[\mathrm{Var}(Y)=\right]\frac{87}{2}$ oe
(d)	**M1**	For a correct inequality for $Y<20$ or all 4 values of Y found (these may be seen in part (c))
	A1	For $\mathrm{P}(Y<20)=\frac{9}{10}$ (May be seen as the denominator (e.g 0.2 + 0.3 + 0.4 oe) in a ratio of probabilities and scores M1A1)
	dM1	Dependant on 1st M1 For $\frac{\mathrm{P}(X=2)}{\mathrm{P}(X>1.5)}$ or $\frac{\mathrm{P}(Y=15)}{\mathrm{P}(Y<20)}$ Allow $\frac{\mathrm{P}(1.5<X<3)}{\mathrm{P}(X>1.5)}$ or a correct ratio of probabilities ft $\mathrm{P}(Y<20)$
	A1	For a correct numerator
	A1	For $\frac{2}{9}$ oe (Allow a decimal answer that is 3sf or better e.g. 0.222)

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Question Number	Scheme	Marks
5 (a)	$X \sim \mathrm{N}(210, 25^2)$	
	$\mathrm{P}(X < 240) = \mathrm{P}\left(Z < \dfrac{240-210}{25}\right)\left[= \mathrm{P}(Z < 1.2)\right]$	M1
	$= 0.8849$*	A1*
		(2)
(b)	$\mathrm{P}(190 < X < 240) = 0.8849 - \mathrm{P}\left(Z < \dfrac{190-210}{25}\right)\left[= 0.8849 - \mathrm{P}(Z < -0.8)\right]$	M1
	$0.8849 - 0.2119 = 0.673$ awrt 0.673	A1
		(2)
(c)	$\dfrac{210+k-210}{25} = 1.96$ or $\dfrac{210-k-210}{25} = -1.96$	M1 B1
	$k = 49$ awrt 49	A1
		(3)
(d)	$\mathrm{P}(X < S) = 0.15 \Rightarrow \dfrac{S-210}{25} = -1.0364$	M1 B1
	$S = 184.09$ awrt 184	A1
		(3)
(e)	$Y \sim \mathrm{N}(\mu,\ \sigma^2)$	
	$\mathrm{P}(Y < 152) = 0.05 \Rightarrow \dfrac{152-\mu}{\sigma} = -1.6449$	M1 A1
	$\mathrm{P}(Y > 180) = 0.40 \Rightarrow \dfrac{180-\mu}{\sigma} = 0.2533$	A1
	$28 = 1.8982\sigma$	dM1
	$\sigma = 14.75...$ and $\mu = 176.26...$	A1
		(5)
	Notes	**Total 15**

(a)	**M1**	For standardising using 240, 210 and 25
	A1*	Cao As the answer is given then no incorrect working should be seen
(b)	**M1**	For standardising using 190/230, 210 and 25 and subtracting from 0.8849 May be implied by $\Phi(1.2) + \Phi(0.8) - 1$ or 0.8849 + 0.7881 – 1
	A1	awrt 0.673
(c)	**M1**	For standardising and setting equal to a z value, where $1.9 < \lvert z \rvert < 2$
	B1	For $\lvert z \rvert = 1.96$ or better
	A1	awrt 49
(d)	**M1**	For standardising using *S* (allow any letter) and setting equal to a *z* value, where $1 < \lvert z \rvert < 1.1$
	B1	For *z* = -1.0364
	A1	awrt 184
(e)	**M1**	For a correct method to form an equation in μ and σ set equal to a *z* value, where $-1.6 < z < -1.7$ or $0.2 < z < 0.3$ (Signs must be compatible)
	A1	For a correct equation for $\mathrm{P}(Y < 152)$
	A1	For a correct equation for $\mathrm{P}(Y > 180)$
	dM1	Dependent on previous M mark. For solving the 2 equations simultaneously. If answers are incorrect then working must be shown. May be implied by σ = awrt 14.8 and μ = awrt 176
	A1	For σ = awrt 14.8 and μ = awrt 176

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Question Number	Scheme	Marks
6 (a)(i)	$x = 1.2 + 0.2(1.4x + 1.5)$ o.e or $y = 1.4(1.2 + 0.2y) + 1.5$ o.e	M1
	$x = \frac{25}{12}$ $y = \frac{53}{12}$	A1A1
(ii)	$\left[\sum x = \right] \frac{25}{12} \times 12 \left[= 25\right]$	A1*
		(4)
(b)	$\left[\sum y = \right]' \left(\frac{53}{12}\right)' \times 12 = 53$	M1A1ft
	$S_{xy} = \frac{6961}{60} - \frac{(25 \times '53')}{12} = 5.6$	M1 A1
		(4)
(c)	$\frac{'5.6'}{S_{xx}} = 1.4$ and $\frac{'5.6'}{S_{yy}} = 0.2$ $S_{xx} = 4$ and $S_{yy} = 28$ $r = \frac{'5.6'}{\sqrt{'4' \times '28'}} = 0.5291...$	$\frac{'5.6'}{\sqrt{\frac{'5.6'}{1.4} \times \frac{'5.6'}{0.2}}}$ $\frac{5.6}{\frac{5.6}{\sqrt{1.4 \times 0.2}}}$ $\sqrt{1.4 \times 0.2} = 0.5291$	$\frac{S_{xy}}{S_{xx}} = 1.4$ and $\frac{S_{xy}}{S_{yy}} = 0.2$ $r^2 = 1.4 \times 0.2$ awrt 0.529
		(4)

	Notes	Total 12
(a)(i)	**M1**	For either of the two equations o.e or an attempt to solve the two equations simultaneously. May be implied by $x = \frac{25}{12}$ / 2.08 or better or $y = \frac{53}{12}$ / 4.42 or better
	A1	For either $x = \frac{25}{12}$ / 2.08 or better or $y = \frac{53}{12}$ / 4.42 or better
	A1	For both $x = \frac{25}{12}$ / 2.08 or better and $y = \frac{53}{12}$ / 4.42 or better (May be written as a coordinate) **NB This is M1 on EPEN**
(ii)	**A1***	For $\frac{25}{12} \times 12$ Allow use of $\sum x$ rather than $\bar{x}$ e.g. $\sum x = 14.4 + 0.2\left(1.4\sum x + 18\right)$ oe As the answer is given no incorrect working must be seen. **NB Working must be shown**
(b)	**M1**	For $'\left(\frac{53}{12}\right)' \times 12$ ft their y coordinate. Allow use of $\sum y$ rather than $\bar{y}$ e.g. $\sum y = 1.4\left(14.4 + 0.2\sum y\right) + 18$ oe
	A1ft	For $\sum y = 53$ or ft their y coordinate × 12 (An answer of exactly 5.6 implies M1A1)
	M1	Use of $S_{xy} = \frac{6961}{60} - \frac{25 \times '\sum y'}{12}$ ft their $\sum y$ If $\sum y$ is not stated then M0 is awarded
	A1	5.6 (Allow awrt 5.6)

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(c)	**M1**	For use of the gradient to find S_{xx} and S_{yy} ft their S_{xy} or use of $\frac{S_{xy}}{\sqrt{\frac{S_{xy}}{1.4}\times\frac{S_{xy}}{0.2}}}$ or setting both $\frac{S_{xy}}{S_{xx}}$ and $\frac{S_{xy}}{S_{yy}}$ equal to their respective gradients
	A1	$S_{xx}=4$ and $S_{yy}=28$ or $\frac{S_{xy}}{\sqrt{1.4\times0.2}}$ or $\frac{\left(S_{xy}\right)^2}{S_{xx}\times S_{yy}}=1.4\times0.2$
	M1	For a correct expression for *r* ft their S_{xy}, S_{xx} and S_{yy} or $\sqrt{1.4\times0.2}$ If answer is incorrect then you must see their stated values substituted into a correct expression for *r*. An answer of $\frac{\sqrt{7}}{5}$ implies M1A1M1 only
	dA1	Dependant on all previous marks being awarded. awrt 0.529

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