Mark Scheme (Results)

January 2024

Pearson Edexcel International Advanced Level

In Statistics S1 (WST01) 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.
- 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.

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.

Special notes for marking Statistics exams (for AAs only)

- Any correct method should gain credit. If you cannot see how to apply the mark scheme but believe the method to be correct then please send to review.
- For method marks, we generally allow or condone a slip or transcription error if these are seen in an expression. We do not, however, condone or allow these errors in accuracy marks.

Question Number	Scheme	Marks
1 (a)	$2\times 36 = 72 \quad 8\times 4 = 32$	M1 A1
		(2)
(b)	$[13]+\dfrac{(204-184)}{120}\times 2$ $\quad$ $[13]+\dfrac{(204.5-184)}{120}\times 2$	M1
	$= \dfrac{40}{3} =$ awrt 13.3	A1
		(2)
(c)	Symmetrically distributed/No skew as the mean ≈ median	B1
		(1)
(d)	$\dfrac{32}{4}+152+\dfrac{120}{2}\left[=220\right]$	M1
	$\dfrac{'220'}{408}\times\dfrac{'219'}{407}$	M1
	$\dfrac{365}{1258}$ or 0.2901… awrt 0.29	A1
		(3)

		Notes	**Total 8**
(a)	**M1**	For any equivalent method to find either frequency Maybe implied by either correct frequency Also maybe implied by two frequencies which add to 104 Also maybe implied by a correct scale on the fd axis , at least 3 labels	
	A1	For 72 and 32	
(b)	**M1**	For any equivalent method to find the median e.g. $\dfrac{Q_2-13}{15-13}=\dfrac{204-184}{304-184}$ or $\dfrac{15-Q_2}{Q_2-13}=\dfrac{304-204}{204-184}$ allow working downwards $[15]-\dfrac{(304-204)}{120}\times 2$	
	A1	awrt 13.3	
(c)	**B1**	For a correct identification of skew [which must either be symmetric/no skew or (slight) negative skew] with a correct supporting reason. Condone mean < median so negative skew Allow use of 'their median' in the comparison provided 'their median' … 13.2 Allow Q_1 = awrt 10.8 or awrt 10.9 **and** Q_3 = awrt 15.1 **and** $Q_2 - Q_1 > Q_3 - Q_2$ so negative skew. Comments referring only to the diagram (being symmetrical therefore no skew) send to review	
(d)	**M1**	For a correct method to find the number of plants between 8cm and 14cm (may be implied by sight of 220)	
	M1	For $\dfrac{n}{408}\times\dfrac{n-1}{407}$ or $\left(\dfrac{n}{408}\right)^2$ with 210 ,, n ,, 230	
	A1	awrt 0.29 may see $\dfrac{3025}{10404}$ from $\left(\dfrac{220}{408}\right)^2$	

Question Number	Scheme	Marks
2 (a)(i)	Mean = 71.83… awrt 71.8	B1
(ii)	Standard deviation = $\sqrt{\frac{62802}{12}-\left(\frac{862}{12}\right)^2}$ or variance = $\frac{62802}{12}-\left(\frac{862}{12}\right)^2$	M1
	$\sqrt{73.47...}$ = 8.571… 8.57 * (to 3s.f.)	A1*
		(3)
(b)	$S_{xx} = 62802 - \frac{862^2}{12}\left[=\frac{2645}{3}=881.66...\right]$	M1
	$r = \frac{512.67}{\sqrt{413.67\times '881.66...'}}$	M1
	= 0.8489… awrt 0.849	A1
		(3)
(c)	Mean = $\frac{5}{9}\times('71.8'-32)$	M1
	= 22.11… awrt 22.1	A1ft
	Standard deviation = $\frac{5}{9}\times 8.57...$	M1
	= 4.76… awrt 4.76	A1
		(4)
(d)	$r = '0.8489...'$ / same (as for *x* and *y*)	M1
	r not affected by (linear) coding oe	A1
		(2)
	Notes	**Total 12**

(a)(i)	**B1**	awrt 71.8 Allow $\frac{431}{6}$ oe
(ii)	**M1**	A correct method to find the standard deviation or the variance ft their mean for M1 only Also allow s.d. $=\sqrt{\frac{S_{xx}}{n}}$
	A1*	Must see at least one simplification of working **and** the given answer 8.57. e.g. $\sqrt{73.47...}$ **or** 8.572 **or** 8.571… **or** $\frac{23\sqrt{5}}{6}$ **or** $\sqrt{\frac{2645}{36}}$ therefore s.d. = 8.57* (to 3s.f.) $\sqrt{\frac{62802}{12}-71.8^2}$ scores M1A0 (use of 71.8 or 71.83 always scores M1A0). To get required accuracy must see at least 71.833 used i.e. $\sqrt{\frac{62802}{12}-71.833^2}$
(b)	**M1**	A correct method to find S_{xx} (implied by awrt 882)
	M1	A correct method to find PMCC using their value of S_{xx}
	A1	awrt 0.849
(c)	**M1**	A correct method to find the mean ft their mean in part (a)
	A1ft	awrt 22.1 ft their mean in part (a)
	M1	A correct method to find the standard deviation (do not isw if any further calculation is done after multiplying by $\frac{5}{9}$)
	A1	awrt 4.76
(d)	**M1**	*r* = their part (b) provided –1 ,, their part (b) ,, 1 allow 2 s.f. on the ft
	A1	Any correct reasoning but M1 must be scored. Allow e.g. 'addition/subtraction **and** multiplication/division does not affect *r*' ,

Question Number	Scheme	Marks
3 (a)	$1-p$, $\frac{7}{8}$ and $\frac{9}{10}$ in the correct place on tree diagram	B1
		(1)
(b)	$\frac{1}{8}p+\frac{1}{10}(1-p)=0.11$	M1 A1ft
	$p=\frac{2}{5}$	A1
		(3)
(c)	$'\frac{2}{5}'\times\frac{1}{8}=\frac{1}{20}$	M1 A1ft
		(2)
(d)	$\mathrm{P}(\mathrm{Y12}\mid R)=\frac{'\frac{2}{5}'\times\frac{7}{8}}{1-0.11}$ or $\mathrm{P}(\mathrm{Y12}\mid R)=\frac{'\frac{2}{5}'\times\frac{7}{8}}{'\frac{2}{5}'\times\frac{7}{8}+'\frac{3}{5}'\times\frac{9}{10}}$	M1
	$=\frac{35}{89}$	A1
		(2)

	Notes		Total 8
(a)	**B1**	For a fully correct tree diagram with all 3 correct labels. Allow if $1-p$ is seen and crossed out/replaced with a numerical probability.	
(b)	**M1**	For $\frac{1}{8}p$ or $\frac{1}{10}'(1-p)'$ seen in an equation for p	
	A1ft	For a fully correct equation in p or correct ft equation based on their tree diagram	
	A1	oe correct answer scores 3 out of 3	
(c)	**M1**	For $p\times\frac{1}{8}$ ft their p, provided p is a probability	
	A1ft	For a correct answer ft their p, provided p is a probability. Correct answer scores 2 out of 2	
(d)	**M1**	For a correct ratio of probabilities. Can ft their p, provided p is a probability	
	A1	For $\frac{35}{89}$ (Allow awrt 0.393)	

Question Number	Scheme	Marks
4 (a)	$LQ = 28$ or $UQ = 48$	B1
	$'48'+1.5('48'-'28')[=78]$	M1
	90 > 78 so, 90 is an outlier*	A1*
		(3)
(b)	$b = \frac{1735.6}{1667.6}[=1.04...]$	M1
	$a = 38.2 - 'b'(42.2)[=-5.72....]$	M1
	$s = -5.72 + 1.04f$ *	A1*
		(3)
(c)	For every **extra mark** (oe) in **French/*f*** , **Spanish/*s* goes up** (oe) by [on average] **1.04 marks**	B1
		(1)
(d) (i)	$s = -5.72 + 1.04 \times 55 = 51.48$ awrt 51.5	M1 A1
(ii)	$s = -5.72 + 1.04 \times 18 = 13$	A1
		(3)
(e)	• The first estimate is an interpolation/The second estimate is an extrapolation • 55 is within the range of data/18 is not within the range of data • 55 is closer to the mean/18 is further away from the mean …..so 51.5 is the more reliable estimate	M1 A1
		(2)

	Notes	Total 12
(a)	**B1**	For either LQ or UQ correct (may be seen in calculation for M1)
	M1	Correct use of $Q_3 + 1.5 \times (Q_3 - Q_1)$ ft their LQ and their UQ provided their UQ > their LQ
	A1*	For both LQ and UQ correct and identifying 90>78 or 90 is an outlier Answer is given so no incorrect working can be seen
(b)	**M1**	For a correct method to find the gradient
	M1	For a correct method to find the intercept (division by 11 is M0)
	A1*	Cao (dep on both M marks) must see printed answer $s = -5.72 + 1.04f$
(c)	**B1**	For a correct numerical interpretation of the gradient in context which must include marks at least once
(d) (i)	**M1**	For a correct substitution into the regression equation. May be seen in (i) or (ii) or implied by one correct answer
	A1	awrt 51.5 Allow 51 or 52
(ii)	**A1**	13 or awrt 13.0
(e)	**M1**	For any equivalent correct reason Ignore extraneous non-contradictory comments For the second bullet point **must** be clear that they are referring to French marks (24,, *f* ,, 68). Do **not** allow comments that refer to the range of Spanish marks e.g. ‘‘51.5’ is within the range of data/‘13’ is not within the range of data’ Do **not** allow ‘55 is closer to the median (than 18)’
	A1	For clearly identifying the estimate from part (d)(i): 51.5 or 55 or (i) or ‘the first estimate’ , etc.

Question Number	Scheme	Marks
5 (a)	$P(X < 38.8) = P\left(Z < \frac{38.8-40}{4}\right)\left[= P\left((Z < -0.3)\right)\right]$	M1
	$= 1 - 0.6179 = 0.3821*$	A1*
		(2)
(b)	P(Qualify) = $1-(0.3821)^3$ or $1-0.3821+0.3821\times(1-0.3821)+0.3821^2\times(1-0.3821)$	M1
	$[= 0.9442]$	
	$P(X > 44) = P\left(Z > \frac{44-40}{4}\right)\left[= P\left((Z > 1)\right)\right]$	M1
	$[= 1 - 0.8413] = 0.1587$	A1
	$P(X > 44 \text{ on 2nd attempt} \mid \text{Qualify}) = \frac{0.3821\times'0.1587'}{'0.9442'}$	M1
	0.06422... awrt 0.0642	A1
		(5)

	Notes	Total 7
(a)	**M1**	For standardising using 38.8, 40 and 4 (allow ±)
	A1*	Must see 1 – 0.6179 or we must see 0.38209 or 0.38208… or better Answer is given so no incorrect working can be seen (but condone poor probability notation)
(b)	**M1**	For a correct method to find the probability of qualifying
	M1	For standardising using 44, 40 and 4 (implied by 1 – 0.8413 or awrt 0.1587)
	A1	awrt 0.16
	M1	For a correct ratio of probabilities ft their 0.1587 and their 0.9442. Use of 0.6179 in the denominator is M0
	A1	awrt 0.0642

Question Number	Scheme	Marks
6 (a)	$\mathrm{P}(B\|A)=\dfrac{\mathrm{P}(B\cap A)}{\mathrm{P}(A)}$	
	$0.3=\dfrac{\mathrm{P}(B\cap A)}{x}\Rightarrow \mathrm{P}(B\cap A)=0.3x$	M1
	$\mathrm{P}(A\cup B)=\mathrm{P}(A)+\mathrm{P}(B)-\text{'}\mathrm{P}(A\cap B)\text{'}$	M1
	$0.65=x+y-0.3x\Rightarrow 0.65=0.7x+y$	
	$14x+20y=13$*	A1*
		(3)
(b)(i)	$\mathrm{P}(B\cup C)=\mathrm{P}(B)+\mathrm{P}(C)$ or $\mathrm{P}(B\cap C)=0$	M1
	$0.85=\dfrac{1}{2}x+2y$	A1
(ii)	Attempt to solve the 2 equations simultaneously	M1
	$x=0.5$ $y=0.3$	A1
		(4)
(c)	$\mathrm{P}(B\|A)=0.3$ **and** $\mathrm{P}(B)=\text{'}0.3\text{'}$ / $\mathrm{P}(A)\times\mathrm{P}(B)=\text{'}0.5\text{'}\times\text{'}0.3\text{'}$ **and** $\mathrm{P}(A\cap B)=0.3\times\text{'}0.5\text{'}$ or $\mathrm{P}(A\cap B)=$ '0.5' + '0.3' – 0.65	M1
	So, A and B are statistically independent	A1ft
		(2)
	Notes	**Total 9**

(a)	**M1**	Use of $\mathrm{P}(B\|A)=\dfrac{\mathrm{P}(B\cap A)}{\mathrm{P}(A)}$ assuming independence is M0 e.g. $\mathrm{P}(B\cap A)=\mathrm{P}(B)\times\mathrm{P}(A)[=xy]$ May be implied by $\mathrm{P}(B\cap A)=0.3x$ (may be seen on a Venn diagram)
	M1	Use of $\mathrm{P}(A\cup B)=\mathrm{P}(A)+\mathrm{P}(B)-\mathrm{P}(A\cap B)$ with substitution of $\mathrm{P}(A\cup B)$, $\mathrm{P}(A)$ and $\mathrm{P}(B)$ (the equation may be seen in a Venn diagram) $0.65=x+y-0.3x$ implies M1M1
	A1*	Answer is given so no incorrect working can be seen
(b)(i)	**M1**	Use of $\mathrm{P}(B\cup C)=\mathrm{P}(B)+\mathrm{P}(C)$ or sight of $\mathrm{P}(B\cap C)=0$
	A1	Any correct second equation in x and y which need not be simplified.
(ii)	**M1**	Attempt to solve the 2 equations simultaneously. Either a correct substitution seen or a correct method to eliminate x or y
	A1	For $x=0.5$ and $y=0.3$
(c)	**M1**	For finding all of the probabilities needed for a test for independence (probabilities must be labelled) ft their values of x and y $\mathrm{P}(B\|A)$ **and** $\mathrm{P}(B)$ or $\mathrm{P}(A)$, $\mathrm{P}(B)$ **and** $\mathrm{P}(A\cap B)$ For $\mathrm{P}(A\cap B)$ we **must** see working shown
	A1ft	For a correct ft conclusion for their values of x and y (must have scored M1)

Question Number	Scheme	Marks
7 (a)	$\frac{k+4}{8}=1 \quad [k=4^*]$	B1*
		(1)
(b)	x: 1 | 2 | 3 | 4 $P(X=x)$: $\frac{1}{13}$ | $\frac{7}{26}-\frac{1}{13}=\frac{5}{26}$ | $\frac{15}{26}-\frac{7}{26}=\frac{4}{13}$ | $1-\frac{15}{26}=\frac{11}{26}$	M1 M1 A1
		(3)
(c)	4	B1ft
		(1)
(d)	$E(X)=1\times\frac{1}{13}+2\times'\frac{5}{26}'+3\times'\frac{4}{13}'+4\times'\frac{11}{26}'\left[=\frac{40}{13}\right]$	M1
	$E(X^2)=1^2\times\frac{1}{13}+2^2\times'\frac{5}{26}'+3^2\times'\frac{4}{13}'+4^2\times'\frac{11}{26}'\left[=\frac{135}{13}\right]$	M1
	$Var(X)='\frac{135}{13}'-'\left(\frac{40}{13}\right)^{2}\left[=\frac{155}{169}\right]$	M1
	$Var(13X-6)=13^2\times'\frac{155}{169}'$	M1
	= 155	A1
		(5)

Y: 7 | 20 | 33 | 46

$P(Y=y)$: $\frac{1}{13}$ | $\frac{5}{26}$ | $\frac{4}{13}$ | $\frac{11}{26}$

$E(Y)=7\times'\frac{1}{13}'+20\times'\frac{5}{26}'+33\times'\frac{4}{13}'+46\times'\frac{11}{26}'[=34]$

$E(Y^2)=7^2\times'\frac{1}{13}'+20^2\times'\frac{5}{26}'+33^2\times'\frac{4}{13}'+46^2\times'\frac{11}{26}'$ $[=1311]$

$Var(13X-6)='1311'-'34'^2$

	Notes	**Total 10**
(a)	**B1***	$\frac{k+4}{8}=1$ oe Allow verification method $\frac{4+4}{8}=1$ provided they conclude $k = 4$
(b)	**M1**	For a correct method to find one probability from $x = 2$, $x = 3$ or $x = 4$ (implied by any one correct probability from $x = 2$, $x = 3$ or $x = 4$)
	M1	For a correct method to find a second probability from $x = 2$, $x = 3$ or $x = 4$ (implied by any two correct probabilities from $x = 2$, $x = 3$ or $x = 4$)
	A1	For a fully correct probability distribution. Need not be in a table, but 1, 2, 3 and 4 must be associated with correct probability
(c)	**B1ft**	Must be consistent with the highest probability in their distribution in part (b). If no distribution is found, then the answer must be 4
(d)	**M1**	For a correct method to find E(X) (implied by awrt 3.08) ft their table use of $\sum xF(x)$ is M0 or for a correct probability distribution for $13X - 6$ ft their probabilities in (b)
	M1	For a correct method to find E(X^2) (implied by awrt 10.4) ft their table use of $\sum x^2F(x)$ is M0 or for a correct method to find E(Y) ft their table
	M1	Use of $E(X^2)-E(X)^2$ ft their E(X^2) and their E(X) or for a correct method to find E(Y^2) ft their table
	M1	Use of $13^2\,Var(X)$ ft their Var(X) or use of $E(Y^2)-E(Y)^2$ ft their E(Y^2) and their E(Y)
	A1	Cao

Question Number	Scheme	Marks
8 (a)	$P(X > \mu + 2k) = 0.2$ or $P(X < \mu - 2k) = 0.2$ or $P(X < \mu + 2k) = 0.8$ or $P(X > \mu - 2k) = 0.8$	M1
	$\frac{\mu + 2k - \mu}{6} = 0.8416$ or $\frac{\mu - 2k - \mu}{6} = -0.8416$	M1 A1
	$k = 2.5248...$ awrt 2.52	A1
		(4)
(b)	$P\left(Y > \frac{3}{2}\mu\right) \Rightarrow P\left(Z > \frac{\frac{3}{2}\mu - \mu}{\sigma}\right) \Rightarrow P\left(Z > \frac{\frac{1}{2}\mu}{\sigma}\right)$	M1
	$\mu = \frac{3}{2}\sigma^2 \Rightarrow P\left(Z > \frac{'\frac{1}{2}\left(\frac{3}{2}\sigma^2\right)'}{\sigma}\right)\left[= P\left(Z > \frac{3}{4}\sigma\right)\right]$ or $\sigma = \sqrt{\frac{2\mu}{3}} \Rightarrow P\left(Z > \frac{\frac{1}{2}\mu}{\sqrt{\frac{2\mu}{3}}}\right) = \left[P\left(Z > \frac{1}{2}\sqrt{\frac{3\mu}{2}}\right)\right]$ or $\frac{\frac{1}{2}\mu}{\sigma} = k$ and $2\mu = 3\sigma^2$	M1
	$'\frac{3}{4}\sigma' = 1.5$ or $\frac{1}{2}\sqrt{\frac{3\mu}{2}} = 1.5$ or $3\sigma^2 = 6\sigma$	M1
	$\mu = 6$ only, $\sigma = 2$ only	A1 A1
		(5)

	Notes	**Total 9**
(a)	**M1**	For any of the given tail probability statements which may be seen on a diagram Also may be implied by awrt ±0.84 seen
	M1	For standardising using μ and 6 and setting = to *z* value, where $0.8 < \lvert z \rvert < 0.9$ Implied by $(\pm)\frac{k}{3} = (\pm)0.84$ or better
	A1	For a fully correct standardisation with a compatible *z* value. $\lvert z \rvert$ must be 0.8416 or better
	A1	awrt 2.52 (Allow 2.525) Answer only 2.52 is M1M1A0A1 Answer only 2.5248 is M1M1A1A1
(b)	**M1**	For standardising using $\frac{3}{2}\mu$, μ and σ
	M1	For substitution of $\mu = \frac{3}{2}\sigma^2$ into their standardisation **or** setting up two equations in μ and σ
	M1	For their expression for σ only or μ only used with ±1.5
	A1	$\mu = 6$ or $\sigma = 2$
	A1	$\mu = 6$ and $\sigma = 2$ must reject any other values if found

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