Mark Scheme (Results)

January 2023

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.

PEARSON EDEXCEL IAL MATHEMATICS

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
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) be dimensionally correct i.e. all the terms need to be dimensionally correct
e.g. 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 few of the A and B marks may be f.t. – follow through – marks.

3. General 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.

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.

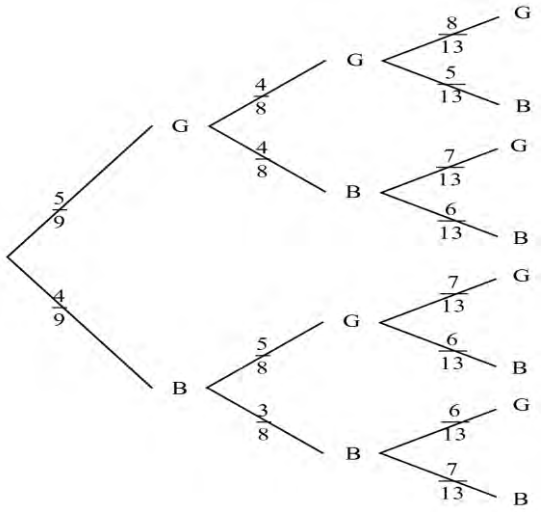
7. Ignore wrong working or incorrect statements following a correct answer.

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	Scheme	Marks
1 (a)	**Time taken (*t* minutes)** | 5 – 10 | 10 – 14 | 14 – 18 | 18 – 25 | 25 – 40 **Frequency (*f*)** | 10 | 16 | 24 | 35 | 15	B1
		(1)
(b)	$10 + 16 + (2 \times 6)$ or $10 + 16 + \frac{24}{2}$ or $\frac{x-26}{50-26} = \frac{16-14}{18-14}$	M1
	$= 38$	A1
		(2)
(c)	$\left[\sum ft =\right] 7.5\times10+12\times16+16\times24+21.5\times'35'+32.5\times'15'[=1891]$	M1
	Mean $= \frac{1891}{100} = 18.91$	A1
		(2)
(d)	Standard deviation $= \sqrt{\frac{41033}{100} - '\left(\frac{1891}{100}\right)'^2}$ or $\sqrt{\frac{41033-100\times'18.91'^2}{99}}$	M1
	$= 7.262...$ or $7.298\ldots$ awrt 7.26 or awrt 7.3[0]	A1
		(2)
(e)	[LQ =] $10+\frac{15}{16}(14-10)[=13.75]$ or $14-\frac{1}{16}(14-10)[=13.75]$ or $\frac{Q_1-10}{14-10}=\frac{25-10}{26-10}[=13.75]$ or $\frac{Q_1-14}{14-10}=\frac{25-26}{26-10}[=13.75]$	[LQ =] $10+\frac{15.25}{16}(14-10)[=13.8125]$ or $14-\frac{0.75}{16}(14-10)[=13.8125]$ or $\frac{Q_1-10}{14-10}=\frac{25.25-10}{26-10}[=13.8125]$ or $\frac{Q_1-14}{14-10}=\frac{25.25-26}{26-10}[=13.8125]$	M1
	IQR $= 23 - '13.75'$ $= 9.25$	IQR $= 23 - '13.8125'$ $=$ awrt 9.19	M1 A1
			(3)

	Notes	**Total 10**
(a)	**B1**	for 35 and 15 (If answers given are in both the table and answer lines then mark the answers given in the table)
(b)	**M1**	for $10 + 16 + (2 \times 6)$ or $10 + 16 + \frac{24}{2}$ or $\frac{x-26}{50-26} = \frac{16-14}{18-14}$
	A1	Cao
(c)	**M1**	A correct method for finding $\sum ft$ May be implied by 1891 Allow one error
	A1	18.91 Allow 18.9
(d)	**M1**	for a correct calculation of the standard deviation ft their mean
	A1	awrt 7.26 or awrt 7.3 if using $n - 1$
(e)	**M1**	for $10+\frac{15}{16}(14-10)$ or $14-\frac{1}{16}(14-10)$ or $\frac{Q_1-10}{14-10}=\frac{25-10}{26-10}$ or $\frac{Q_1-14}{14-10}=\frac{25-26}{26-10}$ or $10+\frac{15.25}{16}(14-10)$ or $14-\frac{0.75}{16}(14-10)$ or $\frac{Q_1-10}{14-10}=\frac{25.25-10}{26-10}$ or $\frac{Q_1-14}{14-10}=\frac{25.25-26}{26-10}$
	M1	UQ – LQ ft their LQ provided LQ < UQ
	A1	For 9.25 or awrt 9.19 if $n+1$ is used

Question	Scheme		Marks
2 (a)		$\frac{5}{8}$ & $\frac{3}{8}$ $\frac{8}{13}$ & $\frac{5}{13}$ $\frac{7}{13}$ & $\frac{6}{13}$	B1 B1 B1
			(3)
(b)	$\frac{5}{9}\times\frac{4}{8}+\frac{4}{9}\times'\frac{5}{8}'=\frac{5}{9}$ oe		M1 A1
			(2)
(c)	$\frac{5}{9}\times\frac{4}{8}\times'\frac{8}{13}'+\frac{4}{9}\times'\frac{3}{8}'\times\frac{7}{13}=\frac{61}{234}$ oe		M1 A1
			(2)
(d)	$\frac{\frac{5}{9}\times\frac{4}{8}\times'\frac{8}{13}'}{'\frac{61}{234}'}\left[=\frac{\frac{20}{117}}{\frac{61}{234}}\right]=\frac{40}{61}$ oe		M1 A1ft A1
			(3)
	Notes		**Total 10**
(a)	**B1**	for $\frac{5}{8}$ & $\frac{3}{8}$ in the correct place on the 2nd branches Allow 0.625 & 0.375 or 62.5% & 37.5%	
	B1	for $\frac{8}{13}$ & $\frac{5}{13}$ in the correct place on the 3rd branches Allow awrt 0.615 & awrt 0.385 or awrt 61.5% & awrt 38.5%	
	B1	for $\frac{7}{13}$ & $\frac{6}{13}$ in both correct places on the 3rd branches Allow awrt 0.538 & awrt 0.462 or awrt 53.8% or awrt 46.2%	
(b)	**M1**	for $\frac{5}{9}\times\frac{4}{8}+\frac{4}{9}\times'\frac{5}{8}'$ ft their tree diagram provided these are probabilities Allow $\frac{5}{9}\times\frac{4}{8}\times'\frac{7}{13}'+\frac{5}{9}\times\frac{4}{8}\times'\frac{6}{13}'+\frac{4}{9}\times'\frac{5}{8}'\times'\frac{7}{13}'+\frac{4}{9}\times'\frac{5}{8}'\times'\frac{6}{13}'$	
	A1	$\frac{5}{9}$ oe Allow awrt 0.556 or awrt 55.6%	
(c)	**M1**	for $\frac{5}{9}\times\frac{4}{8}\times'\frac{8}{13}'+\frac{4}{9}\times'\frac{3}{8}'\times\frac{7}{13}$ ft their tree diagram provided these are probabilities	
	A1	$\frac{61}{234}$ oe Allow awrt 0.261 or awrt 26.1%	
(d)	**M1**	for $\frac{\text{a probability}}{\text{part (c)}}$ where numerator < denominator and 0 < part (c) < 1	
	A1ft	for finding the correct numerator Allow awrt 0.171 or awrt 17.1% or ft their tree diagram If the answer is incorrect then working must be shown	
	A1	$\frac{40}{61}$ oe Allow awrt 0.656 or awrt 65.6%	

Question	Scheme	Marks
3 (a)	$\mathrm{E}(X) = 2a + 3\times0.4 + 4(0.6-a)$ $\left[=3.6-2a\right]$	M1 A1
		(2)
(b)	$0 < a < 0.6$ oe	B1
	$2\times0.6+3\times0.4[=2.4]$ or $3.6-2\times0.6[=2.4]$ **and** $3\times0.4+4\times0.6[=3.6]$ or $3.6-2\times0[=3.6]$ **Alternative** $0 > -2a > -1.2$ $3.6 > 3.6-2a > 2.4$	M1
	$2.4 < \mathrm{E}(X) < 3.6$	A1
		(3)
(c)	$\mathrm{Var}(X) = \mathrm{E}(X^2) - \mathrm{E}(X)^2$	
	$\left[\mathrm{E}(X^2)=\right] 4a + 3.6. + 9.6 - 16a[=13.2-12a]$	M1 A1
	$\mathrm{Var}(X) = '(13.2-12a)' - ('3.6-2a')^2$	M1
	$-4a^2 + 2.4a - 0.32 = 0$	A1
	$a = \dfrac{-'2.4' \pm \sqrt{'2.4'^2 - 4\times'-4'\times'-0.32'}}{2\times'-4'}$	M1
	$a = \dfrac{1}{5}$ $a = \dfrac{2}{5}$	A1
		(6)

	Notes	Total 11
(a)	**M1**	for an attempt to find E(X) with 2 out of the 3 products correct
	A1	for $2a + 1.2 + 4(0.6-a)$ oe
(b)	**B1**	This may be seen as two separate parts e.g. $a > 0$ and $a < 0.6$, Allow the use of $\leqslant$ or $\geqslant$ for < or > We allow this to be written in words e.g. a is between 0 and 0.6
	M1	for a correct method for finding the lower and upper end of the range. May be implied by $2.4 < \mathrm{E}(X) < 3.6$ or sight of 2.4 and 3.6
	A1	Allow e.g. 2.4 ,, $3.6-2a$,, 3.6
		NB $2.4 < \mathrm{E}(X) < 3.6$ or 2.4 ,, $3.6-2a$,, 3.6 scores 3/3
(c)	**M1**	An attempt at an expression for $\mathrm{E}(X^2)$ with 2 terms correct. May be seen in an attempt at Var(X)
	A1	a correct expression for $\mathrm{E}(X^2)$ May be seen in an attempt at Var(X) Does not have to be fully simplified, allow $4a + 3.6 + 9.6 - 16a$ or better
	M1	use of $\mathrm{Var}(X) = \mathrm{E}(X^2) - \mathrm{E}(X)^2$ ft their $\mathrm{E}(X^2)$ and their part (a)
	A1	a correct 3TQ e.g. $25a^2 - 15a + 2 = 0$
	M1	correct method for solving their 3TQ e.g. $(5a-2)(5a-1)=0$ May be implied by $a = \dfrac{1}{5}$ and $a = \dfrac{2}{5}$ If the 3TQ is incorrect then a correct substitution of their values into the quadratic formula (If a and c are both negative, allow the omission of negatives in $4ac$ and allow a correct single value in the denominator) or a complete method using completing the square or a correct factorisation must be seen before their values of a
	A1	$a = \dfrac{1}{5}$ oe and $a = \dfrac{2}{5}$ oe Allow any letter for a

Question	Scheme	Marks
4 (i)(a)	$p+q=\frac{7}{25}$ oe $\quad q+r=\frac{1}{5}$ oe $\quad p+r=\frac{8}{25}$ oe	M1 M1 M1
	$2p+2q+2r=\frac{7}{25}+\frac{1}{5}+\frac{8}{25}\left[=\frac{4}{5}\right]$*	A1* (4)
(i)(b)	eg $p+q+r+s=1$	M1
	$p=\frac{1}{5}$ oe $\quad q=\frac{2}{25}$ oe $\quad r=\frac{3}{25}$ oe $\quad s=\frac{3}{5}$ oe	A1 A1 A1 A1
		(5)
(ii)	$\frac{x}{x+5}+\frac{5}{x}=\frac{x^2+5(x+5)}{x(x+5)}$ or $\frac{x}{x+5}+\frac{5}{x}=\frac{x+5-5}{x+5}+\frac{5}{x}$	M1
	$=\frac{x^2+5x+25}{x^2+5x}$ oe or $=1-\frac{5}{x+5}+\frac{5}{x}$	M1
	$=1+\frac{25}{x^2+5x}$ or as $x^2+5x+25>x^2+5x$ $\mathrm{P}(C)+\mathrm{P}(D)>1$ or As $x+5>x$ then $\frac{5}{x+5}<\frac{5}{x}\Rightarrow-\frac{5}{x+5}+\frac{5}{x}>0$ So $\mathrm{P}(C)+\mathrm{P}(D)>1$	A1
	$\mathrm{P}(C\cup D)>1$ or $\mathrm{P}(C\cap D)>0$	A1 cso
		(4)

	Notes	**Total 13**
	NB In (i) Allow the use of exact decimals throughout and mark (a) and (b) together	
(i)(a)	**M1**	for $p+q=\frac{7}{25}$ oe or $p+q=\mathrm{P}(A)$
	M1	for $q+r=\frac{1}{5}$ oe or $q+r=\mathrm{P}(B)$
	M1	for $p+r=\frac{8}{25}$ oe or $p+r=P\lfloor(A\cap B')\cup(A'\cap B)\rfloor$
	A1*	we must see $2p+2q+2r=\frac{7}{25}+\frac{1}{5}+\frac{8}{25}$ and no errors
(i)(b)	**M1**	any correct equation involving at least two of *p*, *q*, *r* and *s*. May be implied by two correct values. Do not allow just $2p+2q+2r=\frac{4}{5}$ This mark may be awarded in part (a)
	A1	for $\frac{1}{5}$ or 0.2 oe This mark may be awarded in part (a)
	A1	for $\frac{2}{25}$ or 0.08 oe This mark may be awarded in part (a)
	A1	for $\frac{3}{25}$ or 0.12 oe This mark may be awarded in part (a)
	A1	for $\frac{3}{5}$ oe This mark may be awarded in part (a)
	SC	for one correct value M0 A1 A0 A0 A0
(ii)	**M1**	For an attempt to add P(*C*) and P(*D*) e.g. $\frac{x^2}{x(x+5)}+\frac{5(x+5)}{x(x+5)}$ May be implied by $\frac{x^2+5x+25}{x^2+5x}$ or $1-\frac{5}{x+5}+\frac{5}{x}$
	M1	For $\frac{x^2+5x+25}{x^2+5x}$ oe or $1-\frac{5}{x+5}+\frac{5}{x}$
	A1	for recognising that $\mathrm{P}(C)+\mathrm{P}(D)$ is > 1
	A1 cso	a fully correct solution showing that *C* and *D* cannot be mutually exclusive

Question	Scheme	Marks
5 (a)	$\mathrm{P}(L<3.86)=\mathrm{P}\left(Z<\pm\dfrac{3.86-4.5}{0.4}\right)$	M1
	$=\mathrm{P}(Z<-1.6)=1-0.9452$ or $1-0.945200\ldots=0.0548$ awrt 0.0548	M1 A1 (3)
(b)(i)	$\mathrm{P}(L<Q_3)=0.75$ gives $\dfrac{Q_3-4.5}{0.4}=0.67$ or $\mathrm{P}(L<Q_1)=0.25$ gives $\dfrac{Q_1-4.5}{0.4}=-0.67$	M1 B1
	$[Q_3=]4.768$ awrt 4.77 or $Q_1=4.232$ awrt 4.23	A1
(ii)	$[Q_1=]'4.232'$ awrt 4.23 or $[Q_3=]'4.768'$ awrt 4.77	B1 ft (4)
(c)	$1.5('Q_3'-'Q_1')[=0.804]$ (0.81)	M1
	Lower limit = 3.428 (3.42 – 3.43) Upper limit = 5.572 (5.57 – 5.58)	A1 A1 (3)
(d)	$\mathrm{P}('3.42'<L<'5.58')=\mathrm{P}\left(\dfrac{'3.42'-4.5}{0.4}<Z<\dfrac{'5.58'-4.5}{0.4}\right)$	M1 A1ft
	$=\left[\mathrm{P}(-2.7<Z<2.7)\right]=0.9930*$ (Calculator gives 0.99306…)	A1* (3)
(e)	$\mathrm{P}(5<L<'5.58')=\mathrm{P}\left(\dfrac{5-4.5}{0.4}<Z<\dfrac{'5.58'-4.5}{0.4}\right)=0.1021$ (Calculator gives 0.10218…) awrt 0.102	M1 A1
	$\mathrm{P}(L>5\mid'3.42'<L<'5.58')=\dfrac{\mathrm{P}(5<L<'5.58')}{\mathrm{P}('3.42'<L<'5.58')}\left[=\dfrac{'0.102'}{0.993}\right]$	M1
	$=0.1027$ awrt 0.103	A1 (4)
	Notes	**Total 17**

(a)	**M1**	for standardising with 3.86, 4.5 and 0.4
	M1	for $1-p$ where $0.5<p<1$
	A1	for awrt 0.0548 (**NB** awrt 0.0548 scores 3/3)
(b)(i)	**M1**	for standardising with Q_3 or Q_1 (o.e.), 4.5 and 0.4 and setting equal to a z value, $0.65<\lvert z\rvert<0.7$
	B1	for use of 0.67,, $\lvert z\rvert$,, 0.675 This may be implied by a final answer of 4.769… or 4.2302…
	A1	awrt 4.77 or awrt 4.23 for Q_1 correctly labelled **NB** it is possible to score M1B0A1
(b)(ii)	**B1ft**	awrt 4.23 if Q_3 given in (i) or awrt 4.77 if Q_1 given in (i) ft their part (b)(i) You will need to check whether $Q_1+Q_3=9$
(c)	**M1**	use of $1.5(Q_3-Q_1)$ ft their Q_3 and Q_1 If these are not correct then working must be shown
	A1	for lower limit awrt 3.42 to 3.43
	A1	for upper limit awrt 5.57 to 5.58
(d)	**M1**	for a correct standardisation for either their 3.42 **or** their 5.58 May be implied by awrt –2.7 or awrt 2.7 If lower/upper limits are incorrect then the standardisation must be shown
	A1ft	for a correct standardisation for their 3.42 **and** their 5.58 May be implied by awrt –2.7 **and** awrt 2.7 If lower/upper limits are incorrect then the standardisation must be shown or clear use of symmetry e.g. $(0.9965-0.5)\times2$ Do not allow use of negative limits
	A1*	answer is given so there must be a fully correct solution given with no errors Allow 0.9930… or better or 0.9965 – 0.0035 oe or 1 – 0.0035 – 0.0035 oe
(e)	**M1**	for writing or using $\mathrm{P}(5<L<'5.58')$ Maybe implied by awrt 0.102
	A1	awrt 0.102
	M1	for a correct probability statement in either form or a correct ratio ft their lower and upper limits Allow $\dfrac{\mathrm{P}(5<L<'5.58')}{0.993}$
	A1	awrt 0.103

Question	Scheme	Marks
6 (a)	An increase/change of 1°C will allow an extra 2.72 grams [of sugar] to dissolve	B1
		(1)
(b)	$151.2 + 2.72 \times 90 = 396$	M1 A1
		(2)
(c)	The temperature/90[°C] is outside of the range ; so (may be) unreliable	B1 ; dB1
		(2)
(d)	Use of $\overline{y} = 151.2 + 2.72\overline{x}$ So $\sum x = \left(\frac{\frac{3119}{12} - 151.2}{2.72} \right) \times 12 = 479.63235...$	M1 A1
	$S_{yy} = 851093 - \frac{3119^2}{12} \left[= 40412.9166... \right]$	M1
	$S_{xx} = 24500 - \frac{'479.63235...'^2}{12} \left[= 5329.4005... \right]$	M1
	$S_{xy} = 2.72 \times '5329.4005...' \left[= 14495.9693... \right]$	M1
	$r = \frac{'14495.9693...'}{\sqrt{'5329.4005...' \times '40412.9166...'}}$ or $r = 2.72 \times \sqrt{\frac{'5329.4005...'}{'40412.9166'}}$	M1
	$= 0.988$ *	A1*
		(7)
(e)	e.g. the points lie reasonably close to a straight line/positive correlation and the PMCC is close to 1 therefore supports a linear model	B1 B1
		(2)
	Notes	**Total 14**

(a)	**B1**	for a correct interpretation of the gradient in context including grams and degrees
(b)	**M1**	for substitution of 90 into the regression line
	A1	cao 396 on its own scores 2 out 2
(c)	**B1**	for a comment that implies the temperature/90[°C] is outside of the range. Allow extrapolation if not linked to 396. (Do not allow comments that imply that 396 is out of range or the use of "it")
	dB1	dependent on 1st B1 for a correct conclusion
(d)	**M1**	for clear use of the regression line to find $\sum x$ or $\overline{x}$ (may be implied by 3rd M1)
	A1	$\sum x$ = awrt 480 or $\overline{x}$ = awrt 40 (may be implied by 3rd M1)
	M1	for a correct expression for S_{yy} May be implied by awrt 40400
	M1	for a correct expression for S_{xx} ft their $\sum x$ or $\overline{x}$ May be implied by awrt 5330
	M1	for use of the gradient to find S_{xy} ft their S_{xx} May be implied by awrt 14500 or use of $r = b\sqrt{\frac{'S_{xx}'}{'S_{yy}'}}$
	M1	for a correct expression for r ft their S_{xy}, S_{xx} and S_{yy} or 2.72, $'S_{xx}'$ and $'S_{yy}'$ If these are not correct then they must be labelled before an expression for r is given for this mark to be awarded
	A1*	Answer is given so a fully correct solution must be seen
(e)	**B1**	for either the points lie reasonably close to a straight line/points or data are linear/positive correlation or the PMCC is close to 1 (Ignore any reference to strength)
	B1	for both the points lie reasonably close to a straight line/points or data are linear/positive correlation and the PMCC is close to 1 (Ignore any reference to strength) with a correct conclusion

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