



# Mark Scheme (Results)

Summer 2023

Pearson Edexcel International Advanced  
Level

In Statistics S1 (WST01)

Paper 01

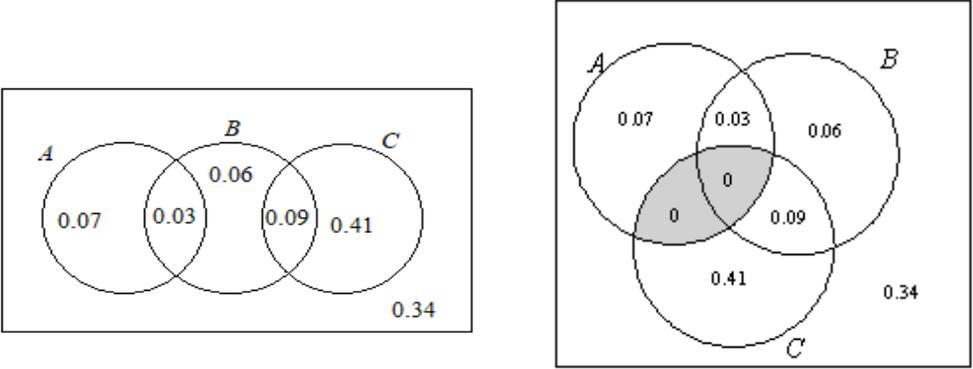
Qu	Scheme	Marks
1(a)	eg 60 people = 1.5 large squares/6 medium squares/150 small squares <b>or</b> eg 1 person = 0.025 large squares/0.6 medium squares/2.5 small squares <b>or</b> eg [1 small square =] 0.4 people/[1 medium square =] 10 people/[1 large square =] 40 people eg a correct f.d. eg 60/(20 – 10) [= 6] eg a correct frequency, 100, 70, 20, 24 associated with the appropriate bar	B1
	eg $\frac{8}{10} \times 20$ <b>or</b> $\frac{15}{30} \times 24$ <b>or</b> $8 \times 2$ <b>or</b> $0.8 \times 15$ <b>or</b> $\frac{40}{2.5}$ <b>or</b> $\frac{30}{2.5}$ <b>or</b> $8 \times 5 \times 0.4$ $2 \times 15 \times 0.4$ <b>or</b> $16$ <b>or</b> $12$ <b>or</b> $70 \times 0.4$	M1
	<b>28</b> people	A1
		(3)
(b)	Median = $[5] + \frac{5}{70} \times 37$ <b>or</b> $[10] - \frac{5}{70} \times 33$	M1
	= 7.642... <b>awrt 7.64</b>	A1
		(2)
(c)	$\sum \text{midpoint} \times \text{freq} = 2.5 \times 100 + 7.5 \times 70 + 15 \times 60 + 25 \times 20 + 45 \times 24 [= 3255]$	M1
	Mean = $\frac{"3255"}{274}$	dM1
	= 11.879... <b>awrt 11.9</b>	A1
		(3)
	<b>Notes</b>	<b>Total 8</b>
(a)	B1: for finding a ratio between people and area. Allow just the numbers for 1 person or for 1 square ie 0.025, 0.6, 2.5, 0.4, 1.66 or 40 <b>or</b> calculating f.d. for any bar correctly, fd = 20, 14, 6, 2 or 0.8 Information may be seen on diagram. Must be clear it is a fd either by correct use, seen on axes associated with correct bar or stated as an fd. May be implied by M1	
	M1: for a correct method to find the number of people between 22 and 30 km <b>or</b> 30 and 45 km or between 22 and 45 km	
	A1: 28	
	<b>NB</b> An answer of 28 gains 3/3 unless from obvious incorrect working	
(b)	M1: Allow equivalent for $n + \frac{5}{70} \times 37$ <b>or</b> $\frac{Q_2 - n}{5} = \frac{137 - 100}{170 - 100}$ <b>or</b> $n - \frac{33}{70} \times 5$ <b>or</b> $\frac{n - Q_2}{5} = \frac{170 - 137}{170 - 100}$ <b>oe</b> Allow alternative methods eg $\frac{Q_2 - 5}{10 - Q_2} = \frac{137 - 170}{170 - 137}$ Allow 37.5 for 37, 137.5 for 137, 32.5 for 33	
	A1: awrt 7.64 <b>or</b> $\frac{107}{14}$ <b>or</b> allow <b>awrt 7.68</b> <b>or</b> $\frac{215}{28}$ if using $n + 1$ Allow awrt 7640 m or 7680 m but must have units.	
(c)	M1: Attempt at correct expression for $\sum \text{midpoint} \times \text{freq}$ - at least 3 products with correct midpoints added with at least 1 of these products fully correct . Allow for 3255	
	M1: dep on M1 being awarded for dividing “their sum” by 274	
	A1: awrt 11.9 <b>or</b> $\frac{3255}{274}$ Allow awrt 11900 m but must have units	

Qu	Scheme	Marks
2(a)	$S_{tw} = 2304.53 - \frac{297.8 \times 114.8}{15}$ or $S_{ww} = 6089.12 - \frac{297.8^2}{15}$	M1
	$S_{tw} = 25.367...$ awrt 25.4	A1
	$S_{ww} = 176.797$ awrt 177	A1
		(3)
(b)	$r = \frac{"25.367"}{\sqrt{5.3173 \times "176.797..."}}$	M1
	$= 0.82735....$ awrt 0.827 or 0.828	A1
		(2)
(c)	$b = \frac{"25.367..."}{5.3173} [= 4.77065...]$	M1
	$a = \frac{297.8}{15} - \frac{"25.367"}{5.3173} \times \frac{114.8}{15} [= -16.658...]$	M1
	$b = 4.771$ or better or $a = -16.66$ or better seen and $w = -16.7 + 4.77t^*$	A1*cso
		(3)
(d)	[On average,] for each <b>cm/1 cm</b> of tail <b>length/t</b> the <b>weight/w</b> increases by <b>4.77 g/grams</b>	B1
		(1)
(e)	$w = -16.7 + 4.77 \times 2 [= -7.16]$ or $4.77 \times 2 [= 9.54]$ or $[t =] \frac{16.7}{4.77} [= 3.5]$ or sd = awrt 0.6	M1
	$[w =] -7.16$ or $9.54 < 16.7$ or $2 < 3.5$ which is negative/weight cannot be negative or for sd extrapolation since a 2 cm tail is (approx 9 sd)/(more than 3 sd) from the mean	A1
		(2)
(f)	0.827	B1ft
		(1)
(g)	$2y + 10 = -16.7 + 4.77(x + 6)$ oe	B1ft
		(1)
	<b>Notes</b>	<b>Total 13</b>
(a)	M1 for a correct expression for $S_{tw}$ or $S_{ww}$	
	A1 awrt 25.4	
	A1 awrt 177	
(b)	M1 for a valid attempt at $r$ with their $S_{tw}$ not equal to 2304.53 and $S_{ww}$ not equal to 6089.12	
	A1 (M2 on open) awrt 0.827 or awrt 0.828	
(c)	1 <sup>st</sup> M1 for a correct method to find the value of $b$	
	2 <sup>nd</sup> M1 ft their $b$ . For a correct method to find $a$ . Minimum shown $a =$ awrt 19.9 – "their $b$ " $\times$ awrt 7.65 $[= -16.658]$	
	A1* Both method marks must be awarded, equation stated (no fractions) and sight of (4.771 or better) or (-16.66 or better)	
(d)	B1 For a suitable contextual comment that implies that as length increases by 1 cm weight increases by 4.77g. Allow multiples eg each 10 cm increase in tail length weight increases by 47.7g Allow in terms of $t$ and $w$	
(e)	M1 for a correct method to calculate the value of $w$ (condone if written as a fraction) or $4.77 \times 2 [= 9.54]$ or correct method to find tail length when $w = 0$ or sd = awrt 0.6	
	A1 Method mark must be awarded. For $-7.16$ or $9.54 < 16.7$ or $2 < 3.5$ with a relevant explanation stating that weight is negative. If sd = awrt 0.6 is given allow extrapolation since a 2 cm tail is (approx 9 sd)/(more than 3 sd) from the mean.	
(f)	B1ft follow through their answer to (b)	
(g)	B1 ISW no need to be simplified. Allow equivalent eg $y = \frac{-16.7 + 4.77(x + 6)}{2} - 5$ The correct simplified equation is $y = 2.385x + 0.96$ allow awrt 2.39 and 0.96 – 0.98	

Qu	Scheme		Marks
3(a)	$[\bar{x} = ] \frac{3711}{81} [= 45.814...]$	$[\sum l = ] 3711 + 81 \times 600 [= 52311]$	M1
	$[\bar{l} = ] "45.814..." + 600$	$[\bar{l} = ] \frac{"52311"}{81}$	M1
	$[\bar{l} = ] 645.81...$	<b>awrt 646</b>	A1
			(3)
(b)	$[\sigma_x^2 = ] \frac{475181}{81} - \left(\frac{3711}{81}\right)^2 [= 3767]$	$[\text{Var}(L) = ] \frac{34088381}{81} - \left(\frac{"52311"}{81}\right)^2$	M1
	$= 3767.43... \Rightarrow \sigma_l^2 = 3767.43...$	$= 3767.43... \quad \mathbf{awrt 3770}$	A1
			(2)
(c)	40		B1cao
			(1)
(d)	IQR = 5400 – 3800 [= 1600]		M1
	5400 + 1.5 × "1600" [= 7800] or 3800 – 1.5 × "1600" [= 1400]		M1
	7800 > 7700 and 1400 < 1600 therefore there are no outliers		A1
			(3)
	<b>Notes</b>		<b>Total 9</b>
(a)	M1 for a correct method to find $\bar{x}$ or $\sum l$ Allow 45.8 or better. Ignore labels		
	M1 for a correct method to find $\bar{l}$ ft their $\bar{x}$ if it is clearly labelled or it comes from $\frac{3711}{81}$ or ft their $\sum l$ if it is clearly labelled or comes from $3711 + 81 \times 600$		
	A1 awrt 646 or $\frac{17437}{27}$ or $\frac{52311}{81}$ oe		
(b)	M1 correct method to find Var (X) implied by awrt 3770 or a correct method to find Var (L) ft their $\sum l$ or Allow calculation of $\text{sd}[\sigma_x] = \text{awrt } 61.4$ Ignore labels		
	A1 awrt 3770 labelled clearly as Var(L) or Var (L) = Var(X) or $\sigma_l = \sigma_x$ stated or variance is not changed by coding is stated or they have gained the answer from $\frac{34088381}{81} - \left(\frac{"52311"}{81}\right)^2$		
(c)	B1 cao		
(d)	M1 correct method to find IQR. May be implied by a correct limit. NB $1.5 \times (5400 - 3800) = 2400$		
	M1 for a correct method to find the upper or the lower outlier boundary.		
	A1 both 7800 and 1400 correct <b>and</b> 7700 and 1600 (as the minimum not IQR) seen <b>and</b> explicitly stating <b>no outliers</b>		

Qu	Scheme	Marks
4(a)		B1B1
		(2)
(b)	$0.3 \times "0.98"$	M1
	$= 0.294$	A1
		(2)
(c)	$(0.3 \times 0.02) + ("0.45" \times "0.04") + ("0.25" \times "0.06")$	M1
	$= 0.039$	A1
		(2)
(d)	$P(C Red) = \frac{"0.25" \times "0.06"}{"0.039"} \left[ = \frac{0.015}{"0.039"} \right]$	M1,M1
	$= 0.3846... \text{ or } \frac{5}{13}$	A1
		(3)
	<b>Notes</b>	<b>Total 9</b>
(a)	B1 for 0.45, 0.25 and 0.98 Allow fractions B1 0.04, 0.96 and 0.06, 0.94 Allow fractions	
(b)	M1 may ft their tree diagram if method shown $0.3 \times "0.98"$ A1 0.294 oe	
(c)	M1 may ft their tree diagram if method shown A1 0.039 oe	
(d)	M1 allow $\frac{p}{\text{"their part (c)"}}$ or $\frac{p}{0.039}$ where $0 < p < 1$ and $p < \text{denominator}$ and their (c) is a probability or allow $\frac{"0.25" \times "0.06"}{q}$ or $\frac{0.015}{q}$ where $0 < q < 1$ and $q > \text{numerator}$	
	M1 for $\frac{"0.25" \times "0.06"}{"0.039"}$ ft their tree diagram and their part(c) if all 3 figures shown in working. We will condone num > denom	
	A1 awrt 0.385	
	NB if correct ft on numerator and denominator leads to "num" > "denom" then max score is M0M1A0	

Qu	Scheme	Marks							
5(a)	<table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td>P(Y = y)</td> <td>2k</td> <td>k</td> <td>k</td> <td>8k</td> <td>17k</td> <td>k</td> </tr> </table>	P(Y = y)	2k	k	k	8k	17k	k	M1
P(Y = y)	2k	k	k	8k	17k	k			
	$2k + k + k + 8k + 17k + k = 1$ or $30k = 1 \Rightarrow k = \frac{1}{30}$ *	A1*							
		(2)							
(b)	$k + k + 8k$ or $1 - (2k + 17k + k)$	M1							
	$= \frac{1}{3}$ oe <span style="float: right;"><b>awrt 0.333</b></span>	A1							
		(2)							
(c)	$(1 \times 2k) + (2 \times k) + (3 \times k) + (4 \times 8k) + (5 \times 17k) + (6 \times k) =$	M1							
	$\frac{13}{3}$ oe <span style="float: right;"><b>awrt 4.33</b></span>	A1							
		(2)							
(d)	$P(Y \geq 15 - 2Y)$ or $[X = ] 13 \ 11 \ 9 \ 7 \ 5 \ 3$ only or $[Y = ] 5$ or $6$ only	M1							
	$[P(Y \geq 5) = P(Y = 5) + P(Y = 6)] = \frac{17}{30} + \frac{1}{30}$	M1							
	$= \frac{3}{5}$ oe	A1ft							
		(3)							
(e)	$\text{Var}(X) = 4\text{Var}(Y)$	M1							
	$[E(Y^2) = ](1 \times 2k) + (2^2 \times k) + (3^2 \times k) + (4^2 \times 8k) + (5^2 \times 17k) + (6^2 \times k) [= \frac{302}{15}$ or awrt 20.1]	M1							
	$[ \text{Var}(Y) = ] \frac{302}{15} - \left( \frac{13}{3} \right)^2 [= \frac{61}{45}$ or awrt 1.36]	M1d							
	$[ \text{Var}(X) = ] \frac{244}{45}$ oe <span style="float: right;"><b>awrt 5.42</b></span>	A1							
	<b>ALT for 1<sup>st</sup> 3 marks</b>	(4)							
	$[E(X) = ] (13 \times 2k) + (11 \times k) + (9 \times k) + (7 \times 8k) + (5 \times 17k) + (3 \times k) [= \frac{19}{3}$ or awrt 6.33]	M1							
	$[E(X^2) = ](13^2 \times 2k) + (11^2 \times k) + (9^2 \times k) + (7^2 \times 8k) + (5^2 \times 17k) + (3^2 \times k) [= \frac{683}{15}$ or awrt 45.5]	M1							
	$[ \text{Var}(X) = ] \frac{683}{15} - \left( \frac{190}{30} \right)^2$	M1d							
	<b>Notes</b>	<b>Total 13</b>							
(a)	M1 for finding the probabilities in terms of $k$ . The individual probabilities must be seen either in a table or in the calculation (but do not need to be simplified)								
	A1* Method mark must be awarded. For a correct equation which would lead to $k = 1/30$ *								
	NB Verification - $2\left(\frac{1}{30}\right) + \left(\frac{1}{30}\right) + \left(\frac{1}{30}\right) + 8\left(\frac{1}{30}\right) + 17\left(\frac{1}{30}\right) + \left(\frac{1}{30}\right) = 1$ gains M1 A0								
(b)	M1 for using $P(Y = 2) + P(Y = 3) + P(Y = 4)$ or $1 - P(Y = 1) + P(Y = 5) + P(Y = 6)$ Allow in terms of $k$ or with $k = 1/30$ subst or with their probabilities. Do not allow in terms of $y$								
	A1 awrt 0.333								
(c)	M1 for using $\sum xP(x)$ At least 3 terms given Allow with $k = 1/30$ subst or ft their probabilities.								
	A1 awrt 4.33								
(d)	M1 forming correct inequality in $Y$ or 13,11,9,7,5,3 seen anywhere or for 5 and 6 only. Implied by 2 <sup>nd</sup> M1								
	M1 finding their $P(Y = 5) +$ their $P(Y = 6)$ or $P(X = 5) + P(X = 3)$ eg $17k + k$								
	A1ft ft their probabilities								
(e)	M1 written or used $4\text{Var}(Y)$ (may come at the end of the calculation) or written or used $E(X)$ allow awrt 6.33 <b>NB</b> condone $-2^2 \text{Var}(Y)$ if used $4\text{Var}(Y)$								
	M1 Correct method, at least 3 products correct, to find $E(Y^2)$ or $E(X^2)$ condone incorrect labels								
	M1d dep on the 2 <sup>nd</sup> M mark being awarded. For correct use of $E(Y^2) - [E(Y)]^2$ or $E(X^2) - [E(X)]^2$ For the <b>ALT</b> In addition to the 2 <sup>nd</sup> M1 the 1 <sup>st</sup> M1 must be awarded. Condone incorrect labelling								
	A1 awrt 5.42								

Qu	Scheme	Marks
6(a)	0.6	B1
		(1)
(b)	$[P(A \cap B) = ] 0.1 \times 0.3$ or $0.3 = \frac{P(A \cap B)}{0.1}$	M1
	$0.25 = 0.1 + P(B) - "0.03"$ or $0.25 = 0.1 + P(B) - P(A \cap B)$	M1
	$0.25 = 0.1 + P(B) - 0.03$ or $0.3 = \frac{P(B) - 0.15}{0.1} \therefore P(B) = 0.18^*$	A1*
		(3)
(c)		M1 M1 B1ft B1ft A1
		(5)
<b>Notes</b>		<b>Total 9</b>
(a)	B1cao	
(b)	M1 for use of $P(B A) = \frac{P(A \cap B)}{P(A)}$ with 0.1 and 0.3 substituted. Allow for $0.1 \times 0.3$ seen	
	M1 $0.25 = 0.1 + P(B) - p$ where $0 < p < 1$ or $p = P(A \cap B)$ oe eg $0.25 - 0.1 + p = P(B)$ (allow any letter for P(B))	
	A1* $P(B) = 0.18$ depends on both previous M marks for a fully correct equation in terms of P(B) (allow any letter for P(B)) followed by $P(B) = 0.18$	
	<b>NB</b> 0.03 used/stated with no working could get M0M1A0 Using $P(A \cap B) = 0.1 \times P(B)$ then they get M0M0A0 <b>Verification</b> could get M1M1A0 M1 for $0.1 \times 0.3$ M1 for $0.25 - 0.18 - 0.1 = -0.03$ or $0.3 = \frac{0.18 - 0.15}{0.1}$ or $0.25 = 0.1 + 0.18 - P(A \cap B)$	
(c)	M1 for 3 circles as per either diagram. If using Diagram 2 we must see exactly 2 zeros in one of the intersections (as shaded). ( <b>Do Not</b> accept blank or dash instead of 0) Condone missing rectangle. Ignore labels	
	M1 for 0.09 and 0.41 marked correctly in diagram – condone incorrect/no label but must be in the left or right hand circles in 1 <sup>st</sup> diagram or must have zeros (condone blank or dash) in the 2 other regions of the circle if in 2 <sup>nd</sup> diagram	
	B1ft their "0.03" in correct place on diagram. Correct label required	
	B1ft for 0.34 or ft 0.75 – "their 0.41" where their $0.41 \neq 0.5$ No other ft accepted. Do not allow 0.75	
	A1 fully correct Venn diagram including the rectangle and all 3 labels.	
	SC no labels could get M1M1B0B1A0 if using 3 intersecting circles must have blanks or 0 for the 2 <sup>nd</sup> M1	

Qu	Scheme	Marks
7(a)(i)	$P(J > 510) = P\left(Z > \frac{510 - 500}{25}\right)$ or $P(Z > 0.4)$	M1
	$= 1 - 0.6554 \Rightarrow 0.3446$ *	A1*
		(2)
(ii)	$\frac{d - 500}{25} = -1.4$ (calc -1.3997...)	M1B1
	$d = 465$ (calc 465.007)	dA1
		(3)
(b)	$(1 - 0.3446)^5$	M1
	$= 0.1209...$ <b>awrt 0.121</b>	A1
		(2)
(c)	$\frac{r - 520}{k} = -1.0364$	M1A1
	$\frac{3r - 800 - 520}{k} = 2.5758$	M1A1
	$-240 = (3 \times -"1.0364k") - "2.5758" k$ or $\frac{r - 520}{"-1.0364"} = \frac{3r - 1320}{"2.5758"}$ oe	ddM1
	$k = 42.216...$ <b>awrt 42</b>	A1
	$r = 476.246...$ <b>awrt 476</b>	dA1
		(7)
	<b>Notes</b>	<b>Total 14</b>
(a)(i)	M1 for standardising using 500 and 25. Allow for 0.4	
	A1* M1 must be awarded. For $1 - 0.6554 = 0.3446$ or using calc $0.34457... = 0.3446$ or better	
(ii)	M1 correct standardisation using 500 and 25 equated to a $z$ value where $1 <  z  < 2$	
	B1 correct expression with compatible signs eg $\frac{500 - d}{25} = 1.4$ (calc 1.3997...) or allow incompatible signs with $500 - ("535" - 500)$	
	SC $\frac{510 - d}{25} = 1.4$ (calc 1.3997...) can get M0B1A0	
	dA1 dependent on M1 awarded for 465 or 465.007...	
(b)	M1 for $(p)^5$ where $0 < p < 1$	
	A1 awrt 0.121	
(c)	M1 $\frac{r - 520}{k} = z$ value where $ z  > 1$	
	1 <sup>st</sup> A1 $\frac{r - 520}{k} =$ awrt $-1.0364$ (calc 1.036433...) (signs must be compatible)	
	2 <sup>nd</sup> M1 $\frac{3r - 800 - 520}{k} = z$ value where $ z  > 2$	
	2 <sup>nd</sup> A1 $\frac{3r - 800 - 520}{k} =$ awrt 2.5758 (calc 2.5758293...) (signs must be compatible)	
	3 <sup>rd</sup> M1 (dep on both Ms) for forming a correct equation in $k$ or $r$ only <b>using their <math>z</math> values</b> . ISW once correct equation seen eg $-5.685k = -240$ or $\frac{3(-1.0364k + 520) - 800 - 520}{k} = 2.5758$ Implied by $r$	
	<b>and <math>k</math> correct</b>	
	3 <sup>rd</sup> A1 for awrt 42	
	4 <sup>th</sup> A1 for awrt 476 Must come from equations with <b>compatible signs</b>	
	NB awrt 476 and awrt 42 does not mean full marks. They could get M1A0M1A0 M1A1A1 if they do not have accurate $z$ values	