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 **or** eg 1 person = 0.025 large squares/0.6 medium squares/2.5 small squares **or** 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 $\dfrac{8}{10}\times 20$ **or** $\dfrac{15}{30}\times 24$ **or** 8×2 **or** 0.8×15 **or** $\dfrac{40}{2.5}$ **or** $\dfrac{30}{2.5}$ **or** $8\times 5\times 0.4$ $2\times 15\times 0.4$ **or** 16 **or** 12 **or** 70×0.4	M1
	<u>**28**</u> people	A1
		(3)
(b)	Median $=[5]+\dfrac{5}{70}\times 37$ or $[10]-\dfrac{5}{70}\times 33$	M1
	$= 7.642...$ **awrt 7.64**	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
	$\text{Mean} = \dfrac{"3255"}{274}$	dM1
	$= 11.879\ldots$ **awrt 11.9**	A1
		(3)
	Notes	**Total 8**
(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 **or** 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 **or** 30 and 45 km or between 22 and 45 km	
	A1: 28	
	NB An answer of 28 gains 3/3 unless from obvious incorrect working	
(b)	M1: Allow equivalent for $n+\dfrac{5}{70}\times 37$ or $\dfrac{Q_2-n}{5}=\dfrac{137-100}{170-100}$ or $n-\dfrac{33}{70}\times 5$ or $\dfrac{n-Q_2}{5}=\dfrac{170-137}{170-100}$ oe Allow alternative methods eg $\dfrac{Q_2-5}{10-Q_2}=\dfrac{137-170}{170-137}$ Allow 37.5 for 37, 137.5 for 137, 32.5 for 33	
	A1: awrt 7.64 or $\dfrac{107}{14}$ or allow **awrt 7.68** or $\dfrac{215}{28}$ 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 or $\dfrac{3255}{274}$ Allow awrt 11900 m but must have units	

Qu	Scheme	Marks
2(a)	$S_{tw} = 2304.53 - \dfrac{297.8 \times 114.8}{15}$ $\quad$ or $\quad$ $S_{ww} = 6089.12 - \dfrac{297.8^2}{15}$	M1
	$S_{tw} = 25.367...$ **awrt 25.4**	A1
	$S_{ww} = 176.797$ **awrt 177**	A1
		(3)
(b)	$r = \dfrac{"25.367"}{\sqrt{5.3173 \times "176.797..."}}$	M1
	$= 0.82735....$ **awrt 0.827 or 0.828**	A1
		(2)
(c)	$b = \dfrac{"25.367..."}{5.3173}[= 4.77065...]$	M1
	$a = \dfrac{297.8}{15} - \dfrac{"25.367"}{5.3173} \times \dfrac{114.8}{15}[= -16.658....]$	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 **cm/1 cm** of tail **length/t** the **weight/w increases** by **4.77 g/grams**	B1
		(1)
(e)	$w = -16.7 + 4.77 \times 2[= -7.16]$ or $4.77 \times 2[= 9.54]$ or $[t =]\dfrac{16.7}{4.77}[= 3.5]$ 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)
Notes		**Total 13**
(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 epen) awrt 0.827 or awrt 0.828	
(c)	1st M1 for a correct method to find the value of b	
	2nd 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 $y = \dfrac{-16.7 + 4.77(x+6)}{2} - 5$ The correct simplified equation is $y = 2.385x + 0.96$ allow awrt 2.39 and $0.96 - 0.98$	

Qu	Scheme		Marks
3(a)	$\left[\bar{x}=\right]\dfrac{3711}{81}\left[=45.814...\right]$	$\left[\sum l=\right]3711+81\times600\left[=52311\right]$	M1
	$\left[\bar{l}=\right]"45.814..."+600$	$\left[\bar{l}=\right]\dfrac{"52311"}{81}$	M1
	$\left[\bar{l}=\right]645.81...$	**awrt 646**	A1
			(3)
(b)	$\left[\sigma_x^{\,2}=\right]\dfrac{475181}{81}-\left(\dfrac{3711}{81}\right)^2\left[=3767\right]$	$\left[\text{Var}(L)=\right]\dfrac{34088381}{81}-\left(\dfrac{"52311"}{81}\right)^2$	M1
	$=3767.43...\Rightarrow\sigma_l^{\,2}=3767.43...$	$=3767.43…$ **awrt 3770**	A1
			(2)
(c)	40		B1cao
			(1)
(d)	IQR = 5400 − 3800 [= 1600]		M1
	$5400+1.5\times"1600"$ [= 7800] or $3800-1.5\times"1600"$ [= 1400]		M1
	7800 > 7700 and 1400 < 1600 therefore there are no outliers		A1
			(3)
	Notes		**Total 9**
(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 $\dfrac{3711}{81}$ or ft their $\sum l$ if it is clearly labelled or comes from $3711+81\times600$		
	A1 awrt 646 or $\dfrac{17437}{27}$ or $\dfrac{52311}{81}$ 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 sd$\left[\sigma_x\right]$ = 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 $\dfrac{34088381}{81}-\left(\dfrac{"52311"}{81}\right)^2$		
(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 **and** 7700 and 1600 (as the minimum not IQR) seen **and** explicitly stating **no outliers**		

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)	$P(C|Red) = \dfrac{"0.25" \times "0.06"}{"0.039"} \left[= \dfrac{0.015}{"0.039"} \right]$	M1,M1
	$= 0.3846\ldots$ or $\dfrac{5}{13}$	A1
		(3)

	Notes	Total 9
(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 $0.3 \times$ " their 0.98"	
	A1 0.294 oe	
(c)	M1 may ft their tree diagram if method shown	
	A1 0.039 oe	
(d)	M1 allow $\dfrac{p}{\text{"their part (c)"}}$ or $\dfrac{p}{0.039}$ where $0 < p < 1$ and $p <$ denominator and their (c) is a probability or allow $\dfrac{"0.25" \times "0.06"}{q}$ or $\dfrac{0.015}{q}$ where $0 < q < 1$ and $q >$ numerator	
	M1 for $\dfrac{"0.25" \times "0.06"}{"0.039"}$ 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)	$\begin{array}{\|c\|c\|c\|c\|c\|c\|} \hline \mathrm{P}(Y=y) & 2k & k & k & 8k & 17k & k \\ \hline \end{array}$	M1
	$2k+k+k+8k+17k+k=1$ or $30k=1$ $\left[\Rightarrow k=\frac{1}{30}\right]$*	A1*
		(2)
(b)	$k+k+8k$ or $1-(2k+17k+k)$	M1
	$=\frac{1}{3}$ **oe** **awrt 0.333**	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** **awrt 4.33**	A1
		(2)
(d)	$\mathrm{P}(Y\geqslant 15-2Y)$ or $[X=]$ 13 11 9 7 5 3 only or $[Y=]$ 5 or 6 only	M1
	$[\mathrm{P}(Y\geqslant 5)=\mathrm{P}(Y=5)+\mathrm{P}(Y=6)]=\dfrac{"17"}{30}+\dfrac{"1"}{30}$	M1
	$=\dfrac{3}{5}$ **oe**	A1ft
		(3)
(e)	$\mathrm{Var}(X)=4\mathrm{Var}(Y)$	M1
	$[\mathrm{E}(Y^2)=](1\times 2k)+(2^2\times k)+(3^2\times k)+(4^2\times 8k)+(5^2\times 17k)+(6^2\times k)\left[=\frac{302}{15}\text{ or awrt }20.1\right]$	M1
	$[\mathrm{Var}(Y)=]"\frac{302}{15}"-\left("\frac{13}{3}"\right)^2\left[=\frac{61}{45}\text{ or awrt }1.36\right]$	M1d
	$[\mathrm{Var}(X)=]\ \frac{244}{45}$ **oe** **awrt 5.42**	A1
	ALT for 1st 3 marks	(4)
	$[\mathrm{E}(X)=]\ (13\times 2k)+(11\times k)+(9\times k)+(7\times 8k)+(5\times 17k)+(3\times k)\left[=\frac{19}{3}\text{ or awrt }6.33\right]$	M1
	$[\mathrm{E}(X^2)=](13^2\times 2k)+(11^2\times k)+(9^2\times k)+(7^2\times 8k)+(5^2\times 17k)+(3^2\times k)\left[=\frac{683}{15}\text{ or awrt }45.5\right]$	M1
	$[\mathrm{Var}(X)=]"\frac{683}{15}"-\left("\frac{190}{30}"\right)^2$	M1d
	Notes	**Total 13**
(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 $\mathrm{P}(Y=2)+\mathrm{P}(Y=3)+\mathrm{P}(Y=4)$ or $1-\mathrm{P}(Y=1)+\mathrm{P}(Y=5)+\mathrm{P}(Y=6)$ 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 $\sum x\mathrm{P}(x)$ 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 2nd M1	
	M1 finding their $\mathrm{P}(Y=5)+$ their $\mathrm{P}(Y=6)$ or $\mathrm{P}(X=5)+\mathrm{P}(X=3)$ eg $17k+k$	
	A1ft ft their probabilities	
(e)	M1 written or used $4\mathrm{Var}(Y)$ (may come at the end of the calculation) or written or used $\mathrm{E}(X)$ allow awrt 6.33 **NB** condone $-2^2\mathrm{Var}(Y)$ if used $4\mathrm{Var}(Y)$	
	M1 Correct method, at least 3 products correct, to find $\mathrm{E}(Y^2)$ or $\mathrm{E}(X^2)$ condone incorrect labels	
	M1d dep on the 2nd M mark being awarded. For correct use of $\mathrm{E}(Y^2)-[\mathrm{E}(Y)]^2$ or $\mathrm{E}(X^2)-[\mathrm{E}(X)]^2$ For the **ALT** In addition to the 2nd M1 the 1st M1 must be awarded. Condone incorrect labelling	
	A1 awrt 5.42	

Qu	Scheme	Marks
6(a)	0.6	B1
		(1)
(b)	$\left[P(A\cap B)=\right]0.1\times0.3$ **or** $0.3=\dfrac{P(A\cap B)}{0.1}$	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** $0.3=\dfrac{P(B)-0.15}{0.1}$ $\therefore$ P(B) = 0.18*	A1*
		(3)
(c)		M1 M1 B1ft B1ft A1
		(5)
Notes		**Total 9**
(a)	B1cao	
(b)	M1 for use of $P(B\mid A)=\dfrac{P(A\cap B)}{P(A)}$ with 0.1 and 0.3 substituted. Allow for 0.1×0.3 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	

	NB 0.03 used/stated with no working could get M0M1A0
	    Using $P(A\cap B)=0.1\times P(B)$ then they get M0M0A0
	Verification could get M1M1A0
	    M1 for 0.1×0.3
	    M1 for $0.25-0.18-0.1=-0.03$ or $0.3=\dfrac{0.18-0.15}{0.1}$ 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). (**Do Not** 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 1st diagram or must have zeros (condone blank or dash) in the 2 other regions of the circle if in 2nd 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 2nd M1	

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