Pearson
Edexcel

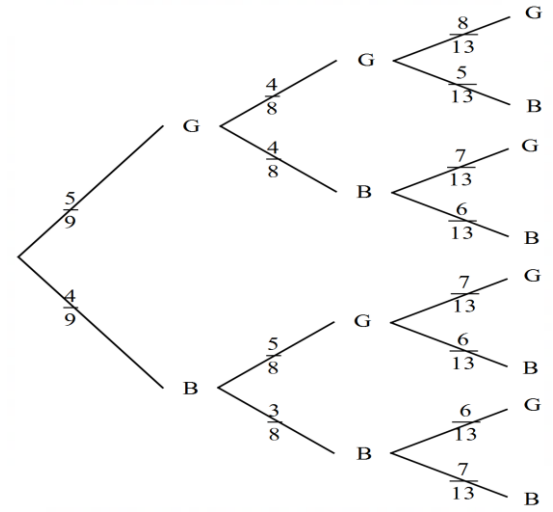
Mark Scheme (Results)

January 2023

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

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 $\frac{Q_1-14}{14-10}=\frac{25-26}{26-10}[=13.75]$	M1
	IQR = $23-'13.75'$	M1
	$= 9.25$	A1
	[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 = $23-'13.8125'$	M1
	= awrt 9.19	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 $p+r=P\left[\left(A\cap B'\right)\cup\left(A'\cap B\right)\right]$
	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. $(0.9965 - 0.5) \times 2$ 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 $\bar{y} = 151.2 + 2.72\bar{x}$ 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 $\bar{x}$ (may be implied by 3rd M1)
	A1	$\sum x$ = awrt 480 or $\bar{x}$ = 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 $\bar{x}$ 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