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Mark Scheme (Results)

January 2022

Pearson Edexcel International A 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.

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.
- If a candidate is "hedging their bets" e.g. give Attempt 1…Attempt 2…etc then please send to review.

Question Number	Scheme	Marks

1. (a)	$\mathrm{P}(C') = \dfrac{\mathbf{103}}{\mathbf{120}}$ oe	**awrt 0.858**	B1 (1)
(b)	$\mathrm{P}(A \cap B \cap C') = \mathbf{0}$		B1 (1)
(c)	$\mathrm{P}(A \cup B \cup C') = \dfrac{9+3+2+5+1+93}{120}$ or $\mathrm{P}(A \cup B \cup C') = 1 - \dfrac{7}{120}$		M1
	$= \dfrac{\mathbf{113}}{\mathbf{120}}$ oe	**awrt 0.942**	A1 (2)
(d)	$\mathrm{P}(\text{At most 1}) = \mathrm{P}(0 \text{ or } 1) = \dfrac{93+9+7+1}{120}$ or $\dfrac{120-2-5-3}{120}$		M1
	$= \dfrac{\mathbf{110}}{\mathbf{120}}$ oe	**awrt 0.917**	A1 (2)
(e)	$\mathrm{P}(A \mid \text{At most 1}) = \dfrac{9/120}{"110/120"}$		M1
	$= \dfrac{\mathbf{9}}{\mathbf{110}}$ oe	**awrt 0.0818**	A1 (2)
(f)	$\left[\mathrm{P}(X=0) = \dfrac{93}{120}\right]$ $\mathrm{P}(X=1) = \dfrac{17}{120}$ $\mathrm{P}(X=2) = \dfrac{8}{120}$ $\mathrm{P}(X=3) = \dfrac{2}{120}$		M1
	$\mathrm{E}(X) = \left[\dfrac{93}{120} \times 0\right] + \dfrac{17}{120} \times 1 + \dfrac{8}{120} \times 2 + \dfrac{2}{120} \times 3$		M1
	$= \dfrac{\mathbf{13}}{\mathbf{40}}$ or **0.325** oe		A1 (3)
	Notes		**[11]**

(a) B1 (allow awrt 0.858)

(b) B1 cao condone 0/120 but do not allow other denominators

(c) M1 for either correct expression for $\mathrm{P}(A \cup B \cup C')$

A1 o.e. (allow awrt 0.942)

(d) M1 correct expression

A1 $\dfrac{11}{12}$ o.e. (allow awrt 0.917)

(e) M1 follow through their part (d) if num < denom eg $\dfrac{m/120}{"110/120"}$ or if the fraction in (d) has denominator of 120 $\dfrac{m}{"\text{their } 110"}$ where $0 < m <$ their 110 Allow $\dfrac{n}{120-3-2-5}$ or $\dfrac{n}{110}$ where $0 < n < 110$

A1 o.e. (allow awrt 0.0818)

(f) 1st M1 for the probability distribution of X (condone missing $\mathrm{P}(X=0)$) awrt 0.14 awrt 0.067 and awrt 0.017 May be implied by a correct expression for $\mathrm{E}(X)$. At least 2 correct must be associated with the correct x value

2nd M1 correct follow through expression for $\mathrm{E}(X)$ ft their probabilities and X values

A1 Dep on both previous method marks being awarded. **Working must be checked.**

A correct answer with no working scores 3/3

SC $\mathrm{P}(X=17) = 17/120$ (awrt 0.14) $\mathrm{P}(X=8) = 8/120$ (awrt 0.067) $\mathrm{P}(X=14) = 14/120$ (awrt 0.12) leading to awrt 4.58 or $183/40$ gains M0M1A0

Question Number	Scheme	Marks

2. (a)	$S_{dp} = 5240.8 - \frac{1029 \times 50.8}{10} [= 13.48]$	M1
	$r = \frac{'13.48'}{\sqrt{344.9 \times 0.576}}$	M1
	= 0.9563834526…. awrt **<u>0.956</u>**	A1
		(3)
(b)(i)	$w = 50 - p$	B1
(ii)	–1	B1
		(2)
(c)	–0.956	B1ft
		(1)
		[6]

	Notes
(a)	1st M1 correct expression for S_{dp}
	2nd M1 valid attempt at r with their S_{dp} not equal to 5240.8 and the correct denominator
	A1 awrt 0.956
(b)(i)	B1 allow equivalent rearrangements
(ii)	B1 – 1 cao
(c)	B1ft follow through –1 ×their(a) providing −1 < their (a) < 1

Question Number	**Scheme**	**Marks**

3. (a)	lower quartile = 116 upper quartile = 125 "125" + 1.5 × ("125" – "116") or "125" + 1.5 × (9) Outlier is greater than 138.5, so $c = 9$*	B1 M1 A1*cso (3)
(b)	$\bar{x} = \frac{-96}{24}[= -4]$ $\quad \sum d = 125 \times 24 - 96[= 2904]$ $\bar{d} = '\bar{x}' + 125$ $\quad \bar{d} = \frac{"2904"}{24}$ $\bar{d} = 121$	M1 M1 A1 (3)
(c)	$[\sigma_x = \sigma_d] = \sqrt{\frac{1306}{24}}$ $[\sigma_d] = 7.3767...$ awrt **7.38**	M1 A1 (2)
(d)	$[\mathrm{P}(D > 118 \mid X < 0)] = \frac{\mathrm{P}(118 < D < 125)}{\mathrm{P}(D < 125)}$ or $\frac{\mathrm{P}(-7 < X < 0)}{\mathrm{P}(X < 0)}$ or $\frac{5/24}{14/24}$ $= \frac{5}{14}$	M1 A1 (2) [**10**]

Notes

(a) B1 both values correct. Both values must be seen either in the calculation or separately. They are not implied by the IQR = 9

M1 use of $Q_3 + 1.5 \times$ IQR with their values. May be implied by 138.5 if B1 awarded

A1*cso for **138.5** and conclusion ***c* = 9** (do not accept $c = 139$) with no errors. Answer is given so working must be shown.

(b) 1st M1 for correct expression for $\bar{x}$ | 1st M1 for correct expression for $\sum d$

2nd M1 use of $\bar{d} = '\bar{x}' + 125$ | 2nd M1 use of "$\sum d$" ÷ 24 must be clear it is their sum

A1 121

NB condone no labelling or incorrect labelling throughout part(b)

(c) M1 correct expression $\sqrt{\frac{1306}{24}}$

A1 awrt 7.38 final answer

(d) M1 correct probability statement (allow a probability of $\frac{k}{14}$ where $0 < k < 14$ to score M1)

A1 allow awrt 0.357

Question Number	Scheme	Marks
4. (a)	$\frac{2}{5}$	B1 (1)
(b)	$\mathrm{E}(W)=3$ $\mathrm{E}(5-2W)=5-2\mathrm{E}(W)$ $\mathrm{E}(X)=-1$	B1 M1 A1 (3)
(c)	$\mathrm{P}(X<W)=\mathrm{P}(5-2W<W)=\mathrm{P}(W>\frac{5}{3})$ or $\mathrm{P}(W\geqslant 2)$ $=\frac{4}{5}$	M1 A1 (2)
(d)(i)	$[y]$: 1, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$ $[p]$: $\frac{1}{5}$, $\frac{1}{5}$, $\frac{1}{5}$, $\frac{1}{5}$, $\frac{1}{5}$	B1
(ii)	$\mathrm{E}(Y)=\frac{1}{5}\left(1+\frac{1}{2}...+\frac{1}{5}\right)$ or $\frac{1}{5}+\frac{1}{10}+\frac{1}{15}+\frac{1}{20}+\frac{1}{25}$ $\left[=\frac{137}{300}=0.4566...\right]$ $\mathrm{E}(Y^2)=\frac{1}{5}\left(1^2+\left(\frac{1}{2}\right)^2+...+\left(\frac{1}{5}\right)^2\right)$ or $\frac{1}{5}+\frac{1}{20}+\frac{1}{45}+\frac{1}{80}+\frac{1}{125}$ $\left[=\frac{5269}{18000}=0.2927...\right]$ $\mathrm{Var}(Y)='0.2927...'-('0.4566...')^2$ awrt **<u>0.0842</u>**	M1 M1 M1 A1 (5)
(e)	$\mathrm{Var}(2-3Y)=(-3)^2\mathrm{Var}(Y)$ awrt **<u>0.758</u>**	M1 A1ft (2)
	Notes	**[13]**
(a)	B1 oe	
(b)	B1 sight of $\mathrm{E}(W)=3$ or the x values 3, 1, −1, −3, −5 (they may be added) M1 use of $\mathrm{E}(5-2W)=5-2\mathrm{E}(W)$ or $\frac{1}{5}(3+1+...+-5)$ Condone use of X instead of W A1 cao and labelled E(X)	
(c)	M1 for identifying $W>\frac{5}{3}$ or $W\geqslant 2$ eg $1-\mathrm{P}(W=1)\geqslant 2$ or $1-\mathrm{P}(W\leqslant 1)\geqslant 2$ A1 oe	
(d)(i)	B1 Correct distribution (probabilities may be implied by correct use). May be seen in any part	
(ii)	M1 attempt at expression for E(Y) using their values of y and p (at least 2 terms seen) or awrt 0.457 (0.45 if have 0.3 rather than 1/3) Condone incorrect labelling M1 attempt at expression for $\mathrm{E}(Y^2)$ using their values of y and p (at least 2 terms seen) or awrt 0.293 (0.2885 if have 0.3 rather than 1/3) Condone incorrect labelling M1 For use of $"\mathrm{E}(Y^2)"-("\mathrm{E}(Y)")^2$ ft their values for E(Y^2) and E(Y) A1 awrt 0.0842 or $\frac{947}{11250}$	
(e)	M1 for use of $(-3)^2\mathrm{Var}(Y)$ with their $\mathrm{Var}(Y)>0$ condone $(3)^2\mathrm{Var}(Y)$ A1ft $\frac{947}{1250}$ or 9 × "their part (d) > 0" evaluated correctly to 3sf or exact fraction	

Question Number	Scheme	Marks
5. (a)	P($X < 37$) = $\mathrm{P}\left(Z < \frac{37-40}{2.4}\right) = \mathrm{P}(Z < -1.25)$	M1
	= 1 – 0.8944 ; = 0.105649… awrt **0.106**	M1; A1 (3)
(b)	P(one value is greater than 32) = $\sqrt{0.16}$ [=0.4]	M1
	$\frac{32-m}{2.4} = 0.2533$	M1 B1
	$m = 31.392...$ awrt **31.4**	A1 (4)
(c)	P($Y < 0$) = $\mathrm{P}\left(Z < \frac{0-4}{8}\right) = \mathrm{P}(Z < -0.5)$ [= 0.3085]	M1
	Let X be the number of negative values	
	P($X \geqslant 1$) = 1 – P($X = 0$) oe	M1
	$= 1 - (0.6915)^5$	M1
	= 0.84188… awrt **0.842**	A1 (4) **[11]**

	Notes
(a)	1st M1 standardising 37 (or 43) with 40 and 2.4 (allow ±) 2nd M1 for $1 - p$ (where $0.88 < p < 0.90$) Implied by correct answer. A1 for awrt 0.106 (calc. 0.105649…..)
(b)	1st M1 correct expression for one value > 32 (may be implied by sight of 0.2533… Allow any value between 0.25 and 0.26 inclusive) 2nd M1 standardising 32 with m and 2.4 and setting equal to z value $0.2 < \lvert z \rvert < 0.3$ B1 for $z = \pm 0.2533$ or better (calc gives 0.2533470931…..) used in a linear equation for m A1 awrt 31.4 or better **SC** [using 0.16]Allow M0M1 B0 A0 for $\frac{32-m}{2.4} = z$ where $0.99 \leqslant \lvert z \rvert < 1.04$
(c)	1st M1 standardising 0 with 4 and 8 (allow ±) or seeing 0.3085 or 0.6915 2nd M1 realising they need to find 1 – P($X = 0$) ie writing or using 1− P(no negative values)oe May be implied by $1 - p^5$ $0 < p < 1$ 3rd M1 use of $1 - p^5$ where p is $1 - "\text{their } \mathrm{P}\left(Z < \frac{0-4}{8}\right)"$ A1 awrt 0.842 (tables: 0.8418894… calculator: 0.84193233….) NB If they use Binomial ▪ and get 0.842 full marks. ▪ and get 0.125 then award M1M1M0A0 ▪ otherwise send to Review

Question Number	Scheme		Marks
6. (a)	$\overline{f} = 10.8 + 0.748\overline{p} = 10.8 + 0.748(62.4)$ awrt **57.5**		M1 A1 (2)
(b)	For each additional **mark** scored on the **pre-test**, the average **mark** on the **final exam increases** by 0.748		B1 (1)
(c)	The statement is not reliable as there is no data below 19 (extrapolation).		B1 (1)
(d)	76		B1 (1)
(e)	$p < 10.8 + 0.748p$ $0.252p < 10.8$ $p <$ awrt **42.9**		M1 M1 A1 (3)
(f)	[No change to] $S_{pp} = 15\ 573.76$		
	$\sum pf = 133486 - 2842 + 9016$ [= 139660]	$\sum pf$ increases by $98(92-29)$[= 6174]	M1
	$\sum f = "57.47" \times 34 + (92-29)$ or $\frac{133486 - 11648.35}{2120} \times 34 + (92-29)$ [= 1954 + 92 − 29 ≈ 2017]	$\frac{\sum p \sum f}{n}$ increases by $\frac{2120(92-29)}{34}$ [= 3928.235...]	M1
	$S_{pf} = "139660" - \frac{2120 \times "2017"}{34}$ [= 13894…]	S_{pf} increases by '6174' –'3928.235' [=2245.764…]	dM1
	$b = \frac{"13894..."}{15573.76}$ [= 0.89…]	$b = \frac{11648.35 + "2245.764"}{15573.76}$	M1
	awrt **0.9**		A1 (5)
	Notes		**[13]**
(a)	M1 for substituting 62.4 into the regression equation. Allow answer between 57 and 58 A1 awrt 57.5		
(b)	B1 must include context and reference to 0.748 Needs to refer to each mark being 0.748 or a multiple of eg 10 marks is 7.48 Allow equivalent words eg score/ point for mark, pre or test for pre-test, exam or final for final exam		
(c)	B1 Not reliable with correct supporting reason eg it (10.8)is an outlier, outside the range		
(d)	B1 76 cao		
(e)	1st M1 for setting up inequality in p only or for drawing the line $f = p$ on the graph. May be implied by $p < n$ (ignore any lower limit) where $40 \leqslant n < 46$ (allow incorrect inequality sign or =) Allow trial and improvement. 2nd M1 rearranging to the form $ap < b$ with correct inequality sign. Allow $(1-0.748)p < 10.8$ May be implied by $p < n$ (ignore any lower limit) where $42 < n < 44$ A1 $p <$ awrt 42.9 (ignore any lower limit) ISW		
(f)	1st M1 Correct method to find new $\sum pf$ or change in $\sum pf$ 2nd M1 Correct method to find new $\sum f$ or change in $\frac{\sum p \sum f}{n}$ Allow 2018 or 2017 3rd dM1 dep on both previous method marks being awarded. Correct method to find new S_{pf} with their changed $\sum pf$ and $\sum f$ or change in S_{pf} 4th M1 expression for $b = \frac{'S_{pf}'}{15573.76}$ with their changed S_{pf} and unchanged S_{pp} A1 awrt 0.9 (from correct working)		

Question Number	Scheme	Marks
7. (a)	$P(X=3) = F(3) - F(2) = \frac{1}{38}$	M1
	$P(X=3) = \frac{7}{n} \times \frac{6}{n-1} \times \frac{5}{n-2}$	M1
	$\frac{7}{n} \times \frac{6}{n-1} \times \frac{5}{n-2} = \frac{1}{38} \rightarrow n(n-1)(n-2) = 7980$ (*)	M1 A1cso
		(4)
(b)	$21 \times 20 \times 19 = 7980$	B1cso
		(1)
(c)	$a = F(0) = P(X=0) = \frac{14}{21} \times \frac{13}{20} \times \frac{12}{19}$	M1
	$a = \frac{26}{95}$	A1
	$P(X=1)\ \ 3 \times \frac{14}{21} \times \frac{13}{20} \times \frac{7}{19} \left[= \frac{91}{190} \right]$ **or** $P(X=2)\ \ 3 \times \frac{7}{21} \times \frac{6}{20} \times \frac{14}{19} \left[= \frac{21}{95} \right]$	M1 M1
	$b = F(1) = P(X=0) + P(X=1) = "\frac{26}{95}" + "\frac{91}{190}"$ or $b = \frac{37}{38} - "\frac{21}{95}"$	dM1
	$b = \frac{143}{190}$	A1
		(6)
		[11]

	Notes
(a)	1st M1 for use of F(3) – F(2) Accept $\frac{1}{38}$
	2nd M1 product of 3 probabilities where the denominators are n, $(n-1)$ and $(n-2)$ and the numerators are decreasing k, $(k-1)$ and $(k-2)$ This may be seen as a single term in a longer expression.
	3rd M1 setting up equation for $P(X=3)$ = product of correct 3 probabilities without replacement
	A1cso fully correct solution with no errors seen
(b)	B1cso correctly evaluated product. Allow $21(21-1)(21-2) = 7980$
(c)	1st M1 product of 3 probabilities for $P(X=0)$ The three probabilities can be in any arrangement May be implied by $\frac{26}{95}$
	1st A1 $a = \frac{26}{95}$ oe must be clear this is the value for a
	2nd M1 product of 3 probabilities for $P(X=1)$ or $P(X=2)$ or $\frac{91}{190}$ or $\frac{91}{570}$ or $\frac{21}{95}$ or $\frac{7}{95}$ oe seen. Condone incorrect labelling. The three probabilities can be in any arrangement
	3rd M1 × 3 or adding the 3 sets of the 3 fractions or $\frac{91}{190}$ or $\frac{21}{95}$ Condone incorrect labelling
	4th dM1 their $P(X=0)$ + their $P(X=1)$ or $F(2) - P(X=2)$ (dep on 2nd M1 being scored)
	2nd A1 $b = \frac{143}{190}$ oe must be clear this is the value for b
	NB if $a = 0.273\ldots$ and $b = 0.7526$ implies the method marks.

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