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# Mark Scheme (Results)

## Summer 2024

### 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.

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# 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: Method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
   - **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
   - **B** marks are unconditional accuracy marks (independent of M marks)

   Marks should not be subdivided.

3. Abbreviations
   These are some of the traditional marking abbreviations that will appear in the mark schemes and can be used if you are using the annotation facility on ePEN:
   - 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)
   - d… or dep – dependent
   - indep – independent
   - dp – decimal places
   - sf – significant figures
   - $*$ – The answer is printed on the paper or ag- answer given
   - $\vdash$ or d… – 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. If you are using the annotation facility on ePEN, indicate this action by 'MR' in the body of the script.

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6. If a candidate makes more than one attempt at any question:
   a) If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
   b) 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.

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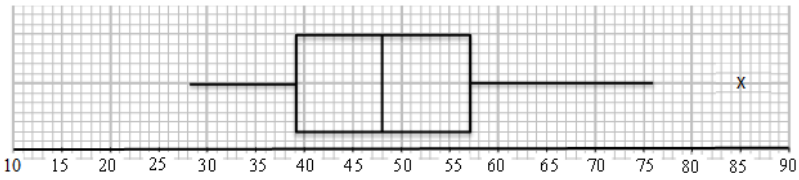
| Question | Scheme | Marks |
|---|---|---|
| 1 (a) | $k = 3$ | B1 |
| | | (1) |
| (b) | $Q_1 = 39 \quad Q_3 = 57$ | B1 B1 |
| | | (2) |
| (c) | $"57"+1.5\times("57"-"39")$ or $"39"-1.5\times("57"-"39")$ | M1 |
| | 84 **and** 12 therefore only 1 outlier [85] | A1 |
| | | (2) |
| (d) |   | M1<br>M1<br>M1<br>A1 |
| | | (4) |
| (e) | A correct difference of the **medians** with supporting figures<br>e.g. On average Birch [trees grow slightly] **taller** as the **median** is larger **48 > 45** oe<br>**or**<br>A correct difference of the **spread** with supporting figures<br>e.g. Maple has a greater spread/variation of **heights** as the **range** is larger **55 > 48** (excluding outlier) oe<br>e.g. Birch has a greater spread/variation of **heights** as the **range** is larger **57 > 55** (with outlier) oe | B1ft |
| | | (1) |
| (f) | 36 „ $a < x$ where 43 „ $x$ „ 45 **or** 54 „ $2a$ „ 80 | M1 |
| | 36 „ $a$ „ "43" and 54 „ $2a$ „ 80 | A1ft |
| | 36 „ $a$ „ 40 | A1 |
| | | (3) |

| | Notes | | Total 13 |
|---|---|---|---|
| (a) | **B1** | Cao | |
| (b) | **B1** | for $Q_1$ correct | |
| | **B1** | for $Q_3$ correct | |
| (c) | **M1** | for either method correct or a correct value (ft their $Q_1$ and their $Q_3$) | |
| | **A1** | Both limits for outliers correct and statement about the outlier or the outlier given. | |
| (d) | **M1** | for a box drawn with only 2 whiskers, only one at each end (condone median line missing) | |
| | **M1** | for upper whisker ending at 76 (or 84 ft their upper outlier limit) and lower whisker ending at 28 | |
| | **M1** | for $Q_1$, $Q_2$ and $Q_3$ plotted, with $Q_2 = 48$ and ft their $Q_1$ and $Q_3$ | |
| | **A1** | for a fully correct box plot with the outlier correctly shown – must be only 1 | |
| (e) | **B1ft** | for a correct comment, **referring to heights**, with reference to a **correctly named statistic.** Must **include the figures** compared.<br>Allow 'grow more/bigger' to imply taller<br>Ignore any reference to skew **SC If Q1/Q3 are incorrect then allow a ft comment about spread referring to the difference in IQR if compared to 18** | |
| (f) | **M1** | for either range correct. Allow $72 \leqslant 2a \leqslant 80$ or $27 \leqslant a \leqslant 40$ for 54 „ $2a$ „ 80<br>Condone < rather than „<br>May be seen as separate inequalities e.g. $2a \leqslant 80$, $2a \geqslant 54$ is allowed for 54 „ $2a$ „ 80<br>A final answer of 36 „ $a$ „ 40 or $36 < a < 40$ implies M1 | |
| | **A1ft** | for both ranges correct ft their $k$. Allow $72 \leqslant 2a \leqslant 80$ or $27 \leqslant a \leqslant 40$ for 54 „ $2a$ „ 80 Condone < rather than „ May be seen as separate inequalities | |
| | **A1** | Allow 36 to 40 or 36, 37, 38, 39, 40<br>**NB** It is possible to get M1A0A1 | |

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| Question | Scheme | Marks |
|---|---|---|
| 2 (a) | $\left[\mathrm{P}(2X-3>5)=\right]0.45$ | B1 |
| | | (1) |
| (b) | $\mathrm{E}\left(X^2\right)=2^2\times0.25+4^2\times0.3+5^2\times0.2+7^2\times0.1+8^2\times0.15\left[=25.3\right]$ | M1 |
| | $\mathrm{Var}(X)=2^2\times0.25+4^2\times0.3+5^2\times0.2+7^2\times0.1+8^2\times0.15-4.6^2$<br>or<br>$\mathrm{Var}(X)=\text{"25.3"}-4.6^2$ | M1 |
| | $=25.3-4.6^2=4.14$* | A1* |
| | | (3) |
| (c) | $\left[\mathrm{E}(Y)=\right]13.4=a\times4.6-b$ | M1 |
| | $\left[\mathrm{Var}(Y)=\right]a^2\times4.14=66.24$ | M1 |
| | $a=4$ | A1 |
| | $b=5$ | A1 |
| | | (4) |
| (d) | Sam throws 8 and Alex throws 2, 4 or 5<br>Sam throws 7 and Alex throws 2 or 4<br>Sam throws 5 or 4 or 2 and Alex throws 2 | M1 |
| | $0.15\times(0.25+0.3+0.2)$ or $0.1\times(0.25+0.3)$ or $(0.2+0.3+0.25)\times0.25$ | M1 |
| | $0.15\times(0.25+0.3+0.2)$ + $0.1\times(0.25+0.3)$ + $(0.2+0.3+0.25)\times0.25$ | M1 |
| | $=0.355\quad\left(=\frac{71}{200}\right)$ | A1 |
| | | (4) |
| **ALT** | Alex throws 2<br>Alex throws 4 and Sam throws 7 or 8<br>Alex throws 5 and Sam throws 8 | M1 |
| | $0.25$ or $0.3\times(0.1+0.15)$ or $0.2\times0.15$ | M1 |
| | $0.25+0.3\times(0.1+0.15)+0.2\times0.15$ | M1 |
| | $=0.355\quad\left(=\frac{71}{200}\right)$ | A1 |
| | **Notes** | **Total 12** |

| | | |
|---|---|---|
| (a) | **B1** | 0.45 oe |
| (b) | **M1** | for a correct method to find $\mathrm{E}\left(X^2\right)$ At least 3 terms correct and added This is not implied by 25.3 on its own |
| | **M1** | for use of correct equation ft their $\mathrm{E}\left(X^2\right)$ |
| | **A1*** | for a correct expression, with all terms seen, leading to the given answer |
| (c) | **M1** | for writing or using a correct equation for E($Y$) |
| | **M1** | for writing or using a correct method for Var($Y$) |
| | **A1** | for $a$ = 4 may be seen as part of the expression $4X\pm...$ |
| | **A1** | for $b$ = 5 may be seen as part of the expression $...X-5$ |
| (d) | **M1** | for recognising all the required combinations – implied by 3 correct probabilities Ignore any repeats but do not ignore any incorrect combinations |
| | **M1** | for any one correct calculation from the 3 given |
| | **M1** | for any 2 correct calculations from the 3 given |
| | **A1** | 0.355 oe |

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| Question | Scheme | Marks |
|---|---|---|
| 3(a) | Width = 1.25 [cm] | B1 |
| | 18.75 cm$^2$ for freq of 20 so $\frac{18.75}{20}\times 16 = 15$ cm$^2$ for a frequency of 16 or $w\times h = 15$ or fd = 5 | M1 |
| | [$h = 15\div 1.25$ or $h = 8\div 5\times 7.5$ =] 12 (cm) | A1 |
| | | (3) |
| (b) | $Q_2 = [32+]\frac{7}{20}\times 4$ or using $n+1$ gives $Q_2 = [32+]\frac{7.5}{20}\times 4$ | M1 |
| | =33.4 ( $n+1$ gives 33.5) | A1 |
| | | (2) |
| (c) | $\bar{y} = \frac{104}{50}[=2.08]$ \| $\sum(w-20) = 10\times 104[=1040]$ or $\sum w = 10\times 104 + 50\times 20[=2040]$ | M1 |
| | $\bar{w} = 10\times$"2.08"$+20$ = 40.8* \| $\frac{"1040"}{50}+20 = 40.8$ or $\frac{"2040"}{50} = 40.8$ | A1* |
| | | (2) |
| (d) | $[\text{Variance of } y =]\frac{233.54}{50} - ("2.08")^2 \left[=\frac{861}{2500} = 0.3444\right]$ or 10 × sd of $y$ = sd of $w$<br>or $100\times 233.54 = \sum(w^2) - 40\times"2040" + 50\times 400\left[\Rightarrow \sum(w^2) = 84954\right]$ oe | M1 |
| | $[\text{Variance of } w =]"0.3444"\times 100$ or $\frac{"84954"}{50} - 40.8^2 \left[=\frac{861}{25} = 34.44\right]$<br>or sd of $y = \sqrt{"0.3444"}\left[=\frac{\sqrt{861}}{50} = 0.5868...\right]$ | M1 |
| | sd of $w$ = $\sqrt{"0.3444"\times 100}$ or $\sqrt{"34.44"}$ or $10\times"\frac{\sqrt{861}}{50}"$ | M1 |
| | = 5.868… awrt 5.87 | A1 |
| (e)(i) | The mean would not change (as 40.8 is the mean) | B1 |
| (ii) | The standard deviation would decrease (as 40.8 is in the middle so data closer together) | B1 |
| | Both correct with a correct reason for why the standard deviation decreases | ddB1 |
| | | (3) |

| | **Notes** | **Total 14** |
|---|---|---|
| (a) | **B1** | for width = 1.25 no need for units |
| | **M1** | for sight of 15 or "their $w$"×"their $h$"$=15$ or fd = 5 May be implied by $h$ = 12 |
| | **A1** | for height = 12 no need for units |
| (b) | **M1** | for $\frac{7}{20}\times 4$ or $\frac{13}{20}\times 4$ or $\frac{m-32}{25-18} = \frac{4}{20}$ oe or $\frac{36-m}{38-25} = \frac{4}{20}$ oe (allow 25.5 rather than 25) |
| | **A1** | 33.4 or if using $(n+1)$ 33.5 |
| (c) | **M1** | for a correct method to find the mean of $y$ or $\sum(w-20)$ or $\sum w$<br>($10\times 104 + k$ where $k \neq 20\times 50$ is M0) |
| | **A1*** | for a correct method to find mean of $w$ which leads to 40.8 |
| (d) | **M1** | for a correct method to find the Variance of $y$ or writing/using 10 ×sd of $y$ = sd of $w$ or a correct equation to find $\sum w^2$ |
| | **M1** | for a correct method to find the Variance of $w$ or sd of $y$ ft their Var($y$) |
| | **M1** | for a correct method to find the sd of $w$ ft their Var($w$) |
| | **A1** | awrt 5.87 **NB** an exact answer $\frac{\sqrt{861}}{5}$ scores A0 |
| (e)(i) | **B1** | for no change (No reason needed) Allow mean = 40.8 to imply no change |
| (ii) | **B1** | for sd decreases/be smaller/go down (condone Var decreases) (No reason needed) |
| | **ddB1** | Both previous B1 awarded. For a correct reason for the sd decreasing Allow $(x-\bar{x}) = 0$<br>Allow $\sum(x-\bar{x})^2$ doesn't change and $n$ increases. Allow the values would be more concentrated about the mean |

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| Question | Scheme | Marks |
|---|---|---|
| 4 (a) | $S_{dg} = 141978.84 - \frac{1456.8 \times 713.2}{8}$ or $S_{gg} = 72675.98 - \frac{713.2^2}{8}$ | M1 |
| | $S_{dg} = 12105.12$ | A1 |
| | $S_{gg} = 9094.2$ | A1 |
| | | (3) |
| (b) | $r = \frac{"12105.12"}{\sqrt{16769.78 \times "9094.2"}}$ | M1 |
| | $= 0.9802\ldots$ awrt **0.98** | A1 |
| | | (2) |
| (c) | $b = \frac{"12105.12"}{16769.78} [= 0.7218...]$ | M1 |
| | $a = \frac{713.2}{8} - "0.7218..." \times \frac{1456.8}{8} [= -42.297....]$ | M1 |
| | $g = -42.3 + 0.722d$ * | A1*cso |
| | | (3) |
| (d) | for each 1 [cm] increase in length/$d$ the girth/$g$ increases by "0.722…" | B1 |
| | | (1) |
| (e)(i) | 138.2 awrt **138** | B1 |
| (ii) | [unreliable] as get a negative girth | B1 |
| | | (2) |
| (f) | $0.722x = 17.3$ | M1 |
| | $x = 23.96...$ awrt **24** | A1 |
| | | (2) |
| | **Notes** | **Total 13** |

| | | |
|---|---|---|
| (a) | **M1** | for a correct expression for $S_{dg}$ or $S_{gg}$ |
| | **A1** | for 12105.12 Allow $\frac{302628}{25}$ |
| | **A1** | for 9094.2 Allow $\frac{45471}{5}$ |
| | | If exact answers are not seen then SC award M1A0A1 for both awrt 12100 and awrt 9090 if correct methods are seen<br>If exact answers are not seen then SC award M1A0A0 for both awrt 12100 and awrt 9090 if no working seen |
| (b) | **M1** | for a valid attempt at $r$ with their $S_{dg}$ not equal to 141978.84 |
| | **A1** | awrt 0.98 |
| (c) | **M1** | for a correct method to find the value of $b$ May be implied by 0.7218 or better |
| | **M1** | for a correct method to find $a$ ft their $b$ May be implied by –42.29 or better |
| | **A1*** | both method marks must be awarded with sight of 0.7218 or better **or** –42.29 or better |
| (d) | **B1** | for a suitable contextual comment that mentions 0.722 (or better) If units are stated they must be correct. |
| (e)(i) | **B1** | awrt 138 Allow 1.38m |
| (ii) | **B1** | For a correct reason eg sd = 45.8 cm so girth is nearly 3sd below mean so likely outlier<br>Allow substitution of 50 leading to $g$ = –6.2 and suitable reason e.g. this is not possible/this is negative Do not allow substitution of 0.5 to imply the girth is negative |
| (f) | **M1** | for a correct equation. implied by awrt 24 |
| | **A1** | awrt 24 |

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| Question | Scheme | Marks |
|---|---|---|
| 5 (a) | $\mathrm{P}(X<18) = \mathrm{P}\left(Z < \pm\left(\frac{18-15}{2}\right)\left[=\pm 1.5\right]\right)$ | M1 |
| | $= 0.9332$<br>awrt 0.933 | A1 |
| | | (2) |
| (b) | $\frac{x-15}{2} = 0.2533$ | M1B1 |
| | $x = 15.506\ldots$ awrt 15.5 | A1 |
| | | (3) |
| (c) | $\mathrm{P}(T > \mu - 10) = 0.975$ | M1 |
| | $\frac{(\mu \pm 10)-\mu}{\sigma} = \pm 1.96 \Rightarrow \sigma = \frac{10}{1.96}\left[=5.10...\right]$ | M1 |
| | $\mathrm{P}(T > \mu - 5) = \mathrm{P}\left(Z > \frac{\mu-5-\mu}{"5.10..."}\left[=-0.98\right]\right)$ [= 0.836…] | M1 |
| | $\mathrm{P}(T > \mu - 5 \mid T > \mu - 10) = \frac{"0.836..."}{"0.975"}$ | M1 |
| | $= 0.8579...$ awrt 0.858 | A1 |
| | | (5) |
| | **Notes** | **Total 10** |

| | | |
|---|---|---|
| (a) | **M1** | for standardising correctly May be implied by ±1.5 |
| | **A1** | awrt 0.933 (Do not ISW) |
| (b) | **M1** | for correct standardisation = to a *z* value such that $0.25 \text{ „ } \lvert z \rvert \text{ „ } 0.26$ |
| | **B1** | for use of awrt $\pm 0.2533$ |
| | **A1** | awrt 15.5 |
| (c) | **M1** | for the correct probability of 0.975 – may be seen as the denominator of the fraction. May be implied by use of $\lvert z \rvert = 1.96$ or better |
| | **M1** | For $\frac{\mu+10-\mu}{\sigma} = 1.96$ or $\frac{\mu-10-\mu}{\sigma} = -1.96$, leading to a value for $\sigma$<br>May be implied by ±0.98 |
| | **M1** | for a correct method to find $\mathrm{P}(T > \mu - 5)$ using their value for $\sigma$ May be implied by –0.98 If $\mathrm{P}(T < \mu + 5)$ is calculated then this may be implied by 0.98 |
| | **M1** | for $\frac{p}{0.975}$ where $0.5 < p < 0.975$ (must be a probability not their *z* value) If the denominator is incorrect only follow through their $\mathrm{P}(T > \mu - 10)$ if clearly labelled and > 0.95 |
| | **A1** | awrt 0.858 |

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| Question | Scheme | Marks |
|---|---|---|
| 6(a) | 0.16 oe | B1 |
| | | (1) |
| (b) | **Mark parts (b) and (c) together**<br>**If values are given in the diagram and the script, then the script takes precedence** | |
| | $[\mathrm{P}(C)=]0.04+0.15+0.12+p[=0.31+p]$ $[\mathrm{P}(C')=]0.1+0.23+q[=0.33+q]$<br>$[\mathrm{P}(S)=]0.1+0.15+0.12+0.23[=0.6]$ $[\mathrm{P}(S')=]1-(0.12+0.15+0.1+0.23)[=0.4]$<br>$[\mathrm{P}(S\cap C)=]0.15+0.12[=0.27]$ $[\mathrm{P}(S'\cap C')=]q$ | M1M1 |
| | $("0.31"+p)\times"0.6"="0.27"$ oe $("0.33"+q)\times"0.4"=q$ oe | M1d |
| | $p=0.14$ oe $q=0.22$ oe | A1 |
| | | (4) |
| (c) | $q=1-(0.04+0.12+0.15+0.1+0.23+"p")$ $p=1-(0.04+0.12+0.15+0.1+0.23+"q")$ | M1 |
| | $q=0.22$ oe $p=0.14$ oe | A1ft |
| | | (2) |
| (d)(i) | $[\mathrm{P}((C\cup S)\cap G')]=0.39$ oe | B1 |
| | | (1) |
| (ii) | $\mathrm{P}(C\mid(S\cap G))=\frac{0.15}{0.15+0.1}$ | M1 |
| | = 0.6 oe | A1 |
| | | (2) |
| (e) | Number of teenagers $=\frac{76}{0.15+"p"}$ oe | M1 |
| | Number who don't play Scrabble $="\left(\frac{76}{0.15+p}\right)"\times 0.4$ $(=104.8...)$ | M1 |
| | = 104.8… awrt 105 | A1 |
| | | (3) |
| | **Notes** | **Total 13** |

| | | |
|---|---|---|
| (a) | **B1** | correct probability |
| (b) | **M1** | for 2 correct probability expressions |
| | **M1** | all 3 correct probability expressions Allow P($C$) = 0.45 |
| | **M1d** | dependent on the 1st M1 being awarded for use of $\mathrm{P}(C\cap S)=\mathrm{P}(C)\times\mathrm{P}(S)$ oe or $\mathrm{P}(C'\cap S')=\mathrm{P}(C')\times\mathrm{P}(S')$ ft their probabilities if labelled clearly |
| | **A1** | for 0.14 or exact equivalent or 0.22 or exact equivalent |
| (c) | **M1** | for a correct expression for $q$ ft their value of $p$ or a correct expression for $p$ ft their value of $q$ May be implied by a correct value for $q$ ft their $p$ or a correct value for $p$ ft their $q$ |
| | **A1ft** | for 0.22 or exact equivalent ft their value of $p$ or 0.14 or exact equivalent ft their value of $q$ ($p + q = 0.36$ provided $p$ and $q$ are probabilities) |
| (d)(i) | **B1** | for 0.39 or exact equivalent do not allow 0.04 + 0.12 + 0.23 |
| (ii) | **M1** | for $\frac{0.15}{0.15+0.1}$ |
| | **A1** | for 0.6 or exact equivalent |
| (e) | **M1** | Relating 76 to their $\mathrm{P}(C\cap G)$ May be implied by awrt 262 |
| | **M1** | for number of teenagers × 0.4 ft their number of teenagers e.g. 0.4 × "262" provided that the number of teenagers is not 76 |
| | **A1** | awrt 105 ISW |

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