Pearson Edexcel

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# Mark Scheme (Results)

## January 2019

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

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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.

**PEARSON EDEXCEL IAL MATHEMATICS**

**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.

   - 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
   - $\sqsubset$ 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.

6. Ignore wrong working or incorrect statements following a correct answer.

# January 2019
# WST01 STATISTICS 1
# Mark Scheme

| Question Number | Scheme | Marks |
|---|---|---|
| **1.(a)** | $B$ and $C$ or "band" and "choir" but NOT P($B$) and P($C$) | B1 (1) |
| **(b)** | [$L$ and $C$ independent implies] $\text{P}(L \cap C) = \text{P}(L) \times \text{P}(C) = 0.4 \times 0.3$ | M1 |
| | $p =$ **0.12** | A1 (2) |
| **(c)** | $q = 0.4 - 0.13 -$ their $p =$ **0.15** | B1ft |
| | $r = 0.3 -$ their $p =$ **0.18** | B1ft |
| | $s = 1 - (0.4 + 0.3 -$ their $p)$ or $1 - (0.4 +$ their $r) =$ **0.42** | B1ft (3) |
| **(d)** | $\text{P}(L \mid B \cup C)$ or $\dfrac{\text{P}(L \cap [B \cup C])}{\text{P}(B \cup C)} = ; \dfrac{0.13 + "0.12"}{0.13 + 0.3}$ | M1; A1ft |
| | $= \dfrac{25}{43}$ | A1 (3) |
| | | **[9 marks]** |

**Notes**

**(a)** B1 for $B$ and $C$ indicated. Allow other non-trivial pairs e.g. $B$ and $L \cap C$ but not $L$ and $L'$

**Correct answers only to parts (b), (c) or (d) score all the relevant marks.**

**(b)** M1 for clear attempt to use the rule for independence. Rule stated and one correct sub.
A1 for 0.12 (either labelled $p$ or part (b) or correctly placed on Venn diagram)

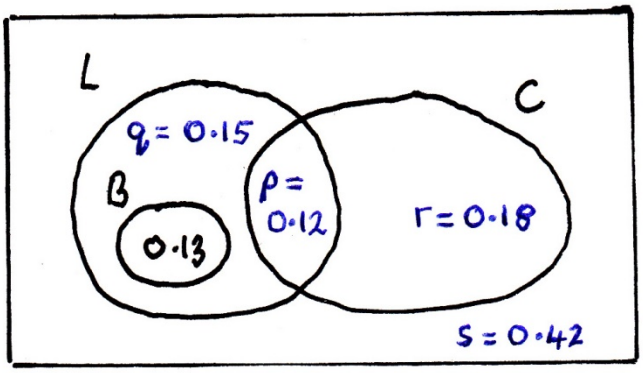
**(c)** 1st B1ft for 0.15 or a correct $q$ allowing ft of their $p$
2nd B1ft for 0.18 or a correct $r$ allowing ft of their $p$
3rd B1ft for 0.42 or a correct $s$ allowing ft of their $p$ or $r$

The ft requires all values concerned to be probabilities. (Labelled or on Venn diagram)

**(d)** M1 for a correct probability expression (letters and symbols) and any ratio of probabilities (num < denom). May be implied by a correct (or correct ft ) probability ratio.
1st A1ft for a correct (or correct ft ) probability ratio (num < denom)

2nd A1 for $\dfrac{25}{43}$ or exact equivalent

NB completed Venn diagram. (If answers conflict the script takes preference over diagram)

| Question Number | Scheme | Marks |
|---|---|---|
| |  Accept probabilities in any exact form<br>e.g. $\frac{3}{20}$ for 0.15<br>or $\frac{3}{25}$ for 0.12 etc | |

| Question Number | Scheme | Marks |
|---|---|---|
| **2.(a)** | [E($X$) = ] $(-2\times0.15)+(-1\times a)+0+(1\times a)+(3\times0.4)$ or $-0.3-a+a+1.2$ | M1 |
| | $=$ **0.9** | A1 |
| | | (2) |
| **(b)** | [ E($X^2$) = ] $\{(-2)^2\times0.15\}+\{(-1)^2\times a\}+\{1^2\times a\}+\{3^2\times0.4\}$ | M1 |
| | or $0.6+2a+3.6$ | |
| | So $4.2+2a=4.54$ | dM1 |
| | $a=$ **0.17** | A1 |
| | Use of sum of probabilities = 1 e.g. $0.15+$ "0.34" $+0.4+b=1$ | M1 |
| | $b=$ **0.11** | A1 |
| | | (5) |
| **(c)** | [Var($X$) = ] $4.54-(\text{their } 0.9)^2$ [= 3.73] | M1 |
| | Var($Y$) = $(-2)^2$ Var($X$) | M1 |
| | = **14.92** (accept 14.9) | A1 |
| | | (3) |
| | | **[10 marks]** |

| | Notes |
|---|---|
| | **Correct answers with no working can score all the relevant marks.** |
| **(a)** | M1 for an attempt at E($X$) i.e. at least 3 non-zero correct products seen |
| | A1 for 0.9 or any exact equivalent |
| **(b)** | 1st M1 for an attempt at an expression in $a$ for E($X^2$) (at least 3 non-zero correct products ) |
| | 2nd dM1 dependent on 1st M1 for using their E($X^2$) and 4.54 to form a linear equation in $a$ |
| | 1st A1 for $a = 0.17$ or exact equivalent |
| | 3rd M1 for use of sum of probabilities = 1 to form a linear equation for $b$ (ft their $a \in [0,1]$) |
| | or for the equation $0.15 + 2a + b + 0.4 = 1$ or $2a + b = 0.45$ |
| | 2nd A1 for $b = 0.11$ or exact equivalent |
| **(c)** | 1st M1 for a correct expression for Var($X$) (ft their 0.9 for E($X$)) |
| | Allow expression based on working out E($X^2$) and ft their E($X$), their $a \in [0,1]$, their $b \in [0,1]$ |
| | 2nd M1 for $(-2)^2 \times$ ( their Var($X$)) condone e.g. $-2^2$Var($X$) if it later becomes 4Var($X$) |
| | This can be awarded for the formula with Var($X$) not necessarily a value. |
| | If they state Var($X$) = E($X^2$) or 4.54 then M0M1 is possible. |
| | A1 for 14.92 (accept 14.9) |
| **ALT** | **Dist of $Y$** |

| $y$ | 7 | 5 | 3 | 1 | $-3$ |
|---|---|---|---|---|---|
| P($Y=y$) | 0.15 | $a$ | $b$ | $a$ | 0.4 |

1st M1 for E($Y$) = 6 "$a$" + 3 "$b$" – 0.15 or 1.2 **and** E($Y^2$) = 26 "$a$" + 9 "$b$" + 10.95 or 16.36

2nd M1 for Var($Y$) = "16.36" – ["1.2"]$^2$ allow ft of their E($Y$) $\neq$ their (a) and E($Y^2$) $\neq 4.54$ but E($Y^2$) > 0

| Question Number | | Scheme | Marks |
|---|---|---|---|
| 3. | (a) | $[W \sim \mathrm{N}(64, 8^2)]$ $\quad \mathrm{P}(W < 51) = \mathrm{P}\left(Z < \dfrac{51-64}{8}\right)$ <u>or</u> $\mathrm{P}(Z < -1.625)$ | M1 |
| | | $= 1 - 0.9484$ $\quad$ (calc. $1 - 0.9479187299\ldots$) | M1 |
| | | $=$ awrt **<u>0.052</u>** | A1 |
| | | | (3) |
| | (b) | Require: $\mathrm{P}(W > 49 \mid W < 51)$ | M1 |
| | | $= \dfrac{\mathrm{P}(49 < W < 51)}{\mathrm{P}(W < 51)}$ <u>or</u> $\dfrac{\mathrm{P}(-1.875 < Z < -1.625)}{\mathrm{P}(Z < -1.625)}$ | M1 |
| | | $= \dfrac{0.021684...}{\text{(a)}}$ | A1ft |
| | | $= 0.4163\ldots$ $\quad$ awrt **<u>0.42</u>** | A1 |
| | | | (4) |
| | (c) | $\left[\mathrm{P}(W > H) = 0.10 \Rightarrow\right]$ $\dfrac{H-64}{8} = 1.2816$ | M1B1 |
| | | $H = 74.2528\ldots$ $\quad$ awrt **<u>74.3</u>** | A1 |
| | | | (3) |
| | | | **[10 marks]** |

**Notes**

**(a)**
1st M1 for standardising with 51(or 77), 64 and 8 (allow $\pm$) Implied by $z$ = awrt $\pm$ 1.62/3
2nd M1 for $1 - p$ where $0.9 < p < 1$
A1 for awrt 0.052 (NB If they use $z = (\pm)$ 1.62 from correct standardising allow 0.053)
NB Calculator gives 0.0520812… [ans only of awrt 0.052 is 3/3]

**(b)**
1st M1 for a correctly stated conditional probability. May be implied by correct ratio.
2nd M1 for a correct ratio of probabilities in their $W$ or $Z$ (either version from scheme)
$\dfrac{\text{(a)} - \mathrm{P}(W < 49)}{\text{(a)}}$ <u>or</u> $1 - \dfrac{\mathrm{P}(W < 49)}{\text{(a)}}$ will score M1M1
1st A1ft for a correct ratio of probabilities with their (a) on denominator and numerator in the range [0.0215, 0.0219]. Num > Denom is A0
2nd A1 for a final answer of awrt 0.42 (dep on at least one other mark)
Final answer of $\frac{5}{12}$ will lose the final A1 unless awrt 0.42 is seen as well
**Ans only** For an answer of 0.416 or better award 4/4

**(c)**
M1 for standardising with $H$, 64 and 8 and setting equal to a $z$ value where $|z| > 1$
B1 for using $z = \pm 1.2816$ (or better e.g. calc: 1.2815515…) can be with $8^2$ instead of 8 etc
**NB** $\mathrm{P}\left(Z > \frac{H-64}{8}\right) = 1.2816$ can score M1B0 unless a correct answer implies 3/3
A1 for awrt 74.3 (calc gives 74.25241253…)
**$z$ = 1.28** award M1B0A1 for an answer of 74.24 or awrt 74.2 if B0 scored for $z = 1.28$
**Ans only** for an answer only of awrt 74.3 (can come from $z = 1.282$ etc) award M1B0A1
**Ans only** for an answer for $H$ in the range $74.252 \leqslant H \leqslant 74.253$ award M1B1A1

| Question Number | Scheme | Marks |
|---|---|---|
| **4.(a)** | Width: 15 minutes is 0.5 cm so 60 mins will be $4\times0.5$ = **2** (cm) | B1 |
| | Height: freq of 25 represented by $6\times0.5 = 3$ ($cm^2$) so freq of 24 is $\frac{24}{25}\times3$ | M1 |
| | So height = $\frac{1}{"2"}\times\frac{24}{25}\times3$ = **1.44** (cm) | A1 |
| | | (3) |
| **(b)** | $[Q_2 =]$ $\{30\}+\frac{(50-[25+17])}{28}\times30$ or e.g. $\frac{60-30}{70-42}=\frac{m-\{30\}}{50-42}$ | M1 |
| | = 38.571… awrt **38.6** | A1 |
| | | (2) |
| **(c)** | Use of midpoints to get $\sum fx = 5070$ (allow 5000 to 1 sf) | M1 |
| | $[\bar{t}$ or $\bar{x}] =$ **50.7** | A1 |
| | | (2) |
| **(d)** | $[\sigma]=\sqrt{\frac{455\,512.5}{100}-"50.7"^2}$ or $\sqrt{1984.635}$ | M1 |
| | = 44.5492… awrt **44.5** | A1 |
| | | (2) |
| **(e)** | $\bar{t}$ or $\bar{x} > Q_2$ [allow "50.7" > "38.6" or formula] so positive (skew) | B1 |
| | | (1) |
| **(f)(i)** | Median: **no change** | |
| | Since e.g. all 18 values or all changes are still below the median | B2/1/0 |
| **(ii)** | Mean: will be **smaller** | |
| | Since e.g. changes will reduce total of $x$ ($7\times7.5$ not $25\times7.5$ in 1st class) | B1 |
| **(iii)** | Standard deviation: will be **greater** | |
| | Since e.g. (18 zeros means) data more spread out | (3) |
| | | **[13 marks]** |

| | Notes |
|---|---|
| **(a)** | B1 for a width of 2 (cm)<br>M1 for some calc' linking area and frequency for both groups or their $w$ × their $h$ = 2.88<br>A1 for 1.44 (or exact equivalent e.g. $\frac{36}{25}$ ) |
| **(b)** | M1 for $+\frac{8}{28}\times30$ (o.e.) May work down e.g. $\{60\}-\frac{20}{28}\times30$ or if using ($n$ + 1) for $\frac{8.5}{28}\times30$<br>A1 for awrt 38.6 (accept $\frac{270}{7}$) or (if using ($n$ + 1) for 39.107.. or awrt 39.1) |
| **(c)** | M1 for $\sum fx$ = 5000 (to 1 sf) or a fully correct expression using midpoints<br>A1 for 50.7 or exact equivalent e.g. $\frac{5070}{100}$ |
| **(d)** | M1 for a correct expression including square root (ft their mean)<br>A1 for awrt 44.5 ( or 44.55) (allow use of $s$ = 44.77367… or awrt 44.8) |
| **(e)** | B1 for positive skew plus a suitable correct reason [allow use of values provided (c) > (b)]<br>Allow correct use of quartiles but must see $Q_1$ = 15 and $Q_3$ = 72.5 |
| **(f)(i)~(iii)** | B2 for all 3 correct statements B1 for only 2 correct statements (B1B0)<br>3rd B1 dep on B2 for at least one suitable reason. (Allow calculation of $\bar{x}$ or $\sigma$ or $s$)<br>Do not accept comments like "median not affected by extreme values" |
| **NB** | With 18 zeros $\Sigma fx$ = 4935, $\bar{x}$ =49.35, $\Sigma fx^2$ = 454 500, $\sigma$ = 45.930…, $s$ = 46.161… |

| Question Number | Scheme | Marks |
|---|---|---|
| **5.(a)** | $\left[\bar{x} = \frac{96}{80} = \right]$ **1.2** | B1 (1) |
| **(b)** | P($S = 2$) = $3 \times 0.4^2 \times 0.6$ | M1 |
| | = **0.288** | A1 (2) |
| **(c)** | P(S = 0) = 1 – (0.496 + "0.288") or $0.6^3$ = **0.216** | B1ft (1) |
| **(d)(i)** | $p_1 = 0.25$ and $p_2 = 0.4$ and $p_3 = 0.55$ | M1 |
| | P($T = 3$) = $p_1 \times p_2 \times p_3 = 0.25 \times 0.4 \times 0.55 =$ 0.055 (*) | A1cso |
| **(ii)** | P($T = 1$) = $0.25 \times 0.6 \times 0.45 + 0.75 \times 0.4 \times 0.45 + 0.75 \times 0.6 \times 0.55$ | M1A1 |
| | or = 0.0675 + 0.135 + 0.2475 | |
| | = 0.45 (*) | A1 cso (5) |
| **(e)** | P($T = 0$) = $0.75 \times 0.6 \times 0.45$ (or equivalent expression for P($T = 2$)) | M1 |
| | = **0.2025** (Allow $\frac{81}{400}$) | A1 |
| | P($T = 2$) = 1 – (0.505 + "0.2025") = **0.2925** (Allow $\frac{117}{400}$) | A1ft (3) |
| **(f)** | Estimate probs from the data: (or frequencies for $S$ and $T$) | M1 |
| | Ting's model is always closer | A1 |
| | So **choose Ting's** model | A1 (3) |
| | **[15 marks]** | |

| $x$ | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| f/80 | **0.2** | **0.45** | **0.3** | **0.05** |
| P($S$=$x$) | *0.216* | 0.432 | *0.288* | 0.064 |
| P($T$=$x$) | *0.2025* | 0.45 | *0.2925* | 0.055 |
| f | 16 | 36 | 24 | 4 |
| $S$(f) | **17.28** | **34.56** | **23.04** | **5.12** |
| $T$(f) | **16.2** | **36** | **23.4** | **4.4** |

**Notes**

**(a)** B1 for 1.2 or any exact equivalent

**Mark (b) and (c) together (M1 is for a full method for P($S$ = 2))**

**(b)** M1 for $k \times 0.4^2 \times 0.6$ (including $k = 1$) where $k \in \mathbb{Z}^+$ or $3 \times p^2 \times (1-p)$ for some $p \in (0, 1)$

A1 for 0.288 or an exact equivalent e.g. $\frac{36}{125}$

**Correct answers in table can score all marks in (b) and (c). Table takes preference.**

**(c)** B1ft for P($S = 0$) based on sum of probabilities = 1 i.e. 0.216 or 1 – (0.496 + their 0.288) or $0.6^3$

**(d)** 1st M1 for a correct attempt to find all 3 $p_i$ values. Implied by the correct product expr'

1st A1 for a correct numerical product and no incorrect working seen for P($T = 3$)

2nd M1 for at least 1 correct product in P($T = 1$) (ft their $p_i$ probabilities)

2nd A1 for at least 2 correct products seen

3rd A1cso for all 3 correct products seen and no incorrect working seen

Beware: $(1 - p_3) = 0.45$ is 2nd M0

**Correct answers in table can score all marks in (e). Table takes preference.**

**(e)** M1 for a correct product for P($T = 0$) or all 3 correct products for P($T = 2$) (ft their $p_i$)

1st A1 for either correct probability (correctly labelled or placed in the table)

2nd A1ft for a correct 4th probability or a 4th probability that makes the sum = 1

**(f)** M1 for attempt at calculating probs from the data or freqs $S$(f) **and** $T$(f) (at least 3 correct)

1st A1 for all figs correct(2sf) and comparison of probs (or frequencies) for the 2 models

2nd A1 for clearly choosing Ting's model (dependent on M1A1 scored)

e.g. "Ting's is best because probabilities (or frequencies) are always closer" scores A1A1

**SC (A0A0)** B1 choose Ting because probs improve or lack of independence etc (M0A1A0 or M1A1A0)

| Question Number | Scheme | Marks |
|---|---|---|
| **6.(a)** | Mean, median, average, marks, results score: on P2 ($y$) is lower than P1($x$) o.e.<br>Spread , dispersion, range, st. dev, var(iance) : on P2 is more than P1 o.e | B1<br>B1<br>(2) |
| **(b)(i)** | e.g. (38, 0) doesn't follow the pattern/trend <u>or</u> out of range of other points<br><u>or</u> far from (best fit) line / other points (o.e.) | B1 |
| **(ii)** | The student was absent when paper 2 was taken (o.e.) | B1<br>(2) |
| **(c)** | New $\bar{x} = \dfrac{35.75\times16-38}{15}$ <u>or</u> $\dfrac{534}{15}$ , = **<u>35.6</u>** | M1, A1 |
| | New $\bar{y} = \dfrac{25.75\times16}{15} = 27.4\dot{6}$ awrt **<u>27.5</u>** (allow $\dfrac{412}{15}$) | B1<br>(3) |
| **(d)(i)** | New $\sum xy = 15\,837 - 38\times0$ so no change | B1 |
| **(ii)** | $S_{xy} = 15\,837 - \dfrac{(35.75\times16-38)\times(25.75\times16)}{15}$ <u>or</u> $-\dfrac{"534"\times"412"}{15}$ <u>or</u> $-\dfrac{220008}{15}$ | M1 |
| | = <u>1169.8</u> (*) | A1cso<br>(3) |
| **(e)** | $r = \dfrac{1169.8}{\sqrt{965.6\times1561.7}}$ , = 0.9526079… awrt **<u>0.953</u>** | M1, A1<br>(2) |
| **(f)** | $b = \dfrac{1169.8}{965.6}$ [= 1.21147…], $a$ = "27.5" – "$b$"×"35.6" [= – 15.6618..] | M1, M1 |
| | **<u>$y$ = – 15.6/7 + 1.2$x$</u>** $b$ = awrt **<u>1.2</u>**, $a$ = awrt **<u>– 15.6 or – 15.7</u>** | A1, A1<br>(4) |
| **(g)** | (Value of $r$ increased from 0.746 to 0.953) so <u>points</u> lie <u>closer to</u> a st. <u>line</u> | B1 (1) |
| **(h)** | $y$ = "1.21..."×38 – "15.66..." <u>or</u> awrt **<u>30</u>** | B1ft (1) |
| | | **[18 marks]** |

**Notes**

**(a)** for a correct comment on 1st B1: mean etc 2nd B1: spread etc, one of these 5 terms seen

**(b)** 1st B1 for a suitable explanation (saying an "extreme point" is B0)
2nd B1 for a suitable comment e.g. teacher didn't mark it, wrongly recorded/plotted (o.e.)

**(c)** M1 for a correct method to find $\bar{x}$ (a list requires $\Sigma x = 534$ and ÷15 or correct ans)
A1 for 35.6 or e.g. $35\frac{3}{5}$ B1 for awrt 27.5

**(d)(i)** B1 for explanation with sight of "38×0" (o.e.) e.g. for (38, 0) <u>or</u> omitted point, $xy = 0$
**(ii)** M1 for a correct expression (can ft their 534 and their 412 if they are stated in (c))
A1cso dependent on M1 with no incorrect working seen. [May be seen in (e)]

**(e)** M1 for a correct method (implied by ans = awrt 0.95) A1 for awrt 0.953

**(f)** 1st M1 for a correct expression for $b$ 2nd M1 for a correct expr' seen for $a$ ( ft means in (c))
1st A1 for $b$ = awrt 1.2 2nd A1 for $a$ = awrt – 15.6 or – 15.7 <u>$a$ and $b$ must be in an $x$, $y$ eq'n</u>

**(g)** B1 for a suitable comment e.g. <u>linear</u> relationship <u>stronger</u> **or** <u>stronger linear</u> correlation

**(h)** B1ft for awrt 30 or ft expression using $x$ = 38 in their equation (need not be evaluated)

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