



# Mark Scheme (Final)

October 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
- $\square$  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.

**Special notes for marking Statistics exams (for AAs only)**

- If a method leads to "probabilities" which are greater than 1 or less than 0 then M0 should be awarded unless the mark scheme specifies otherwise.
- 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 gives multiple solutions we mark the last complete solution. If in doubt send to review.

| Question Number | Scheme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Marks                                      |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|
| 1(a)            | $[S_{xy} = ] = \underline{1818}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | B1<br>(1)                                  |
| (b)             | $b = \frac{1818}{1754} [=1.036 \text{ or } \frac{909}{877}]$ <b>ALT</b><br>$c = -1.036... \times \frac{5}{8}$ <b>or</b> $\bar{f} = 80 \times \frac{5}{8} + 3500$<br>$= -0.6478$ [ <b>or</b> $\frac{4545}{7016}$ ] <b>or</b> $\bar{h} = 4500$ and $\bar{f} = 3550$<br>$y = 1.04x - 0.6478...$ <b>or</b> eqn of form $h = ... + 1.04f$<br>$\frac{h-4500}{80} = 1.036 \times \frac{f-3500}{80} - 0.6479...$ <b>or</b> $4500 - "1.04" \times 3550 = (820.467...)$<br>$h = 820 + 1.04f$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | M1<br>M1<br>A1<br>A1ft<br>dM1<br>A1<br>(6) |
| (c)             | <p>On average for every <u>increase in area of 1</u> (m<sup>2</sup>) the annual heating <u>bill increases</u> by approximately (\$) <u>1.04</u></p> <p>The cost of heating is (\$) 820 even if there is no floor space (no building)</p> <p><u>or</u> the “standing charge” / “base rate” etc is (\$) 820</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | B1ft<br>B1ft<br>(2)                        |
| (d)             | $"820.46..." + "1.036..." \times 4600$<br>$= (\$) 5588.31... \text{ ans in range } (\underline{5560-5610})$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | M1<br>A1<br>(2)                            |
| <b>Total 11</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                            |
| <b>Notes</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                            |
| (b)             | <p>1<sup>st</sup> M1 for use of <math>\frac{S_{xy}}{S_{xx}}</math> ft their <math>S_{xy}</math> (allow correct use of <math>S_{fh}</math> etc )</p> <p>2<sup>nd</sup> M1 for <math>c = -(their\ b) \times \frac{5}{8}</math> <b>or ALT</b> for a correct expression for <math>\bar{f}</math></p> <p>1<sup>st</sup> A1 awrt <math>-0.648</math> <b>or ALT</b> for correct values for both <math>\bar{h}</math> and <math>\bar{f}</math></p> <p>2<sup>nd</sup> A1ft for equ'n in the form <math>y = c + bx</math> with their <math>c</math> and <math>b =</math> awrt 1.04 (dep on 1<sup>st</sup> M1 only) <b>or ALT</b> for <math>h = ... + (awrt\ 1.04)f</math> [ignore any intercept]</p> <p>3<sup>rd</sup> dM1 (dep on 2<sup>nd</sup> M1) for substituting <math>\frac{h-4500}{80}</math> and <math>\frac{f-3500}{80}</math> into their regression line of <math>y</math> on <math>x</math> <b>or ALT</b> for correct method for intercept in <math>h, f</math> equation – ft their 1.04</p> <p>3<sup>rd</sup> A1 for <math>h =</math> awrt <math>820 +</math> awrt <math>1.04f</math> [Do <b>not</b> allow fractions for this final mark]</p> |                                            |
| (c)             | <b>Must see correct words used, not just letters <math>f</math> and <math>h</math></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                            |
| (i)             | B1ft for correct interpretation need: “increase of area by 1” and “increase in bill by “1.04””<br>Can be other words giving same idea but must see their 1.04 (can ignore units)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                            |
| (ii)            | B1ft for a suitable explanation e.g. “cost if area is zero”<br>Must see “their 820” (which must be $> 0$ ) but can ignore units.<br>Accept reasonable alternatives to “standing charge”                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                            |
| (d)             | M1 for substituting 4600 into their regress' line of $h$ on $f$ (or use of $x = 13.75$ in $y, x$ equation)<br>A1 allow answers in range 5580 - 5610                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                            |

| Question Number | Scheme                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                            | Marks                    |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|--------------------------|
| 2(a)            | $10 \times 7.8 \div 1.2 / 10 \times 7.8 \times \frac{5}{6} / \frac{1}{6} \times 10 \times 39$                                                                                                                                                                                                                                                                                                                                     | $5 \times 3.6 \div 1.2 / 5 \times 3.6 \times \frac{5}{6} / \frac{1}{6} \times 5 \times 18$ | M1                       |
|                 | (Time 45-55 freq =) <b>65</b>                                                                                                                                                                                                                                                                                                                                                                                                     | (Time 55-60 freq =) <b>15</b>                                                              | A1                       |
|                 | $260 - "65 + 180" = \underline{15}$                                                                                                                                                                                                                                                                                                                                                                                               | $260 - "15 + 180" = \underline{65}$                                                        | B1ft<br>(3)              |
| (b)(i)          | $\left[ \text{Mean} = \frac{11\,087.5}{260} \right] = 42.644\dots$ awrt <b>42.6</b>                                                                                                                                                                                                                                                                                                                                               |                                                                                            | B1<br>(1)                |
| (ii)            | Standard deviation = $\sqrt{\frac{505718.75}{260} - \left(\frac{11087.5}{260}\right)^2} = 11.249\dots (s = 11.27\dots)$ awrt <b>11.2</b>                                                                                                                                                                                                                                                                                          |                                                                                            | M1 A1<br>(2)             |
| (c)             | Median = $(30) + 15 \times \frac{130 - 20}{145}$ or $(45) - 15 \times \frac{(165 - 130)}{145}$<br>$= 41.379\dots$ awrt <b>41.4</b>                                                                                                                                                                                                                                                                                                |                                                                                            | M1<br>A1<br>(2)          |
| (d)             | Positive (skew) since the median is less than the mean<br>or Positive (skew) since the histogram has a “tail” on the right oe<br>(Allow use of quartiles if $Q_1 = [34.65\dots]$ and $Q_3 = [49.61\dots]$ are correct to 2sf)                                                                                                                                                                                                     |                                                                                            | B1<br>(1)                |
| (e)             | Number of people = $\frac{6}{15} \times 145 + 20$ [= 78]<br><br>Probability being less than 36 seconds = $\frac{78}{260} = 0.3$ o.e.<br><br>$\left(\frac{"78"}{260}\right) \times \left(\frac{"77"}{259}\right) \times \left(\frac{"76"}{258}\right); = \frac{209}{7955}$ or 0.02627... awrt <b>0.0263</b>                                                                                                                        |                                                                                            | M1<br>A1<br>M1;A1<br>(4) |
| Total 13        |                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                            |                          |
| Notes           |                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                            |                          |
| (a)             | M1 for a correct expression for one frequency<br>A1 for 65 or 15<br>B1 for 15 or 65 ft <u>one of</u> their incorrect frequency or their “180”                                                                                                                                                                                                                                                                                     | <b>Look in table in QP</b><br>If table and text disagree take table.                       |                          |
| (b)(i)          | B1 for awrt 42.6 [Beware use of units e.g. 42.6s which looks like 42.65] (Allow $\frac{4435}{104}$ )                                                                                                                                                                                                                                                                                                                              |                                                                                            |                          |
| (ii)            | M1 ft their mean. Must have the square root. [Allow use of their $\Sigma ft^2 > 300\,000$ here]<br>A1 for awrt 11.2 [but allow 11.25] (allow $s = 11.3$ ) [Answer only 2/2]                                                                                                                                                                                                                                                       |                                                                                            |                          |
| NB              | [Beware correct formula with mean = 42.64 gives $11.265 = 11.3$ (3sf) but scores M1A0]                                                                                                                                                                                                                                                                                                                                            |                                                                                            |                          |
| (c)             | M1 for correct use of linear interpolation to find the median ignore the end points (may be implied by correct answer). NB may work up or down and allow use of 130.5<br>A1 for awrt 41.4 (Use of 130.5 gives 41.43...) [Again beware of units 41.4s etc]                                                                                                                                                                         |                                                                                            |                          |
| (d)             | B1 positive (skew) with either reason[No ft for -ve skew if $Q_2 > \text{mean}$ ].<br>Ignore use of mode and condone “positive correlation”<br>If $ Q_2 - \bar{t}  < 1$ allow mean close to median so no skew or symmetric.                                                                                                                                                                                                       |                                                                                            |                          |
| (e)             | 1 <sup>st</sup> M1 for a correct method for finding the number of people. [Correct expression or 78]<br>1 <sup>st</sup> A1 for the correct probability of 0.3 or exact equivalent<br>2 <sup>nd</sup> M1 for use of <u>their</u> probability without replacement (condone with replacement)<br>Score this mark for $p^3$ where $p =$ their 0.3 from <u>any</u> method e.g. use of normal etc<br>2 <sup>nd</sup> A1 for awrt 0.0263 |                                                                                            |                          |

| Question Number | Scheme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Marks                                   |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| 3(a)            | $P(X < 40) = P\left(Z < \frac{40-42}{5}\right) = P(Z < -0.4)$ $= 1 - 0.6554$ $= 0.3446$                                                                                                                                                                                                                                                                                                                                                                                                                                                      | M1<br>M1<br>A1<br><b>(3)</b>            |
| (b)             | <p> <math>P(\text{Qualify}) = 1 - ("0.3446")^3</math>      <u>or</u><br/> <math>(1 - "0.3446") + ("0.3446")(1 - "0.3446") + ("0.3446")^2(1 - "0.3446")</math><br/> [ <math>q = 0.9590\dots</math>      full calc: 0.9590867...] </p> $P(X > 45) = P\left(Z > \frac{45-42}{5}\right) = P(Z > 0.6)$ $= 1 - 0.7257$ <u>or</u> 0.2743      allow 1 - awrt 0.726 <u>or</u> awrt 0.274                                                                                                                                                             | M1<br>A1<br>dM1<br><br>A1<br><b>(5)</b> |
|                 | <b>Notes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Total 8</b>                          |
| (a)             | 1 <sup>st</sup> M1      for standardising with 40, 42 and 5. Allow $\pm \frac{40-42}{5}$<br>2 <sup>nd</sup> M1      for $1 - p$ (where $p > 0.5$ )<br>A1      awrt 0.345      (NB Calc gives 0.3445783...)                                                                                                                                                                                                                                                                                                                                   |                                         |
| (b)             | 1 <sup>st</sup> M1      for identifying <u>all</u> the cases to qualify with correct ft probabilities<br>2 <sup>nd</sup> M1      for an attempt standardise with 45, 42 and 5 ie $\pm \frac{45-42}{5}$                                                                                                                                                                                                                                                                                                                                       |                                         |
| SC B1           | <p><b>Use <math>\mu = 40</math></b> Using <math>\mu = 40</math> to find <math>P(X &gt; 45)</math> will give 0.1587 and can award B1 if we see this <u>used</u> in an expression of the form <math>("0.3446")^2 \times 0.1587</math>. Score on open as 2<sup>nd</sup> M0 1<sup>st</sup> A1</p> <p>They may also be able to score 1<sup>st</sup> M1 and 3<sup>rd</sup> M1 as well</p>                                                                                                                                                          |                                         |
|                 | 1 <sup>st</sup> A1      for 1 - awrt 0.726      or      awrt 0.274      (sight of either of these scores 2 <sup>nd</sup> M1 and 1 <sup>st</sup> A1)<br><br>May be part of an expression such as $("0.3446")^2 \times 0.2743$<br>3 <sup>rd</sup> dM1 <b>dep on 1<sup>st</sup> M1</b> for $\frac{("their\ 0.3446")^2 \times "their\ 0.2743"}{their\ q}$<br><br>providing the numerator < denominator and num and denom are both probs<br>2 <sup>nd</sup> A1      for awrt 0.034      (NB numerator is awrt 0.033 so <u>must</u> be awrt 0.034) |                                         |

| Question Number | Scheme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Marks                 |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
|                 | <b>If any part, especially (a) or (b), is missing send to review</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |
| 4(a)            | 0.72                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | B1<br>(1)             |
| (b)             | $C$ (is most likely to be the 100 metre junior champion)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | B1<br>(1)             |
| (c) (i)         | $S_{xx} = 3445.26 - \frac{164.4^2}{8} \left[ = 66.84 \text{ or } \frac{1671}{25} \right]$ $r = \frac{60.85}{\sqrt{66.84 \times 67.52}}$ $= 0.90578\dots \quad \text{awrt } \underline{0.906}$                                                                                                                                                                                                                                                                                                                                                                                                                                                            | M1<br>M1<br>A1<br>(3) |
| (ii)            | The faster boys are in the the 100 metres, the faster they are in the 200 metres                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | B1<br>(1)             |
|                 | <b>Notes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Total 6</b>        |
| (c) (i)         | <p>1<sup>st</sup> M1 for a correct expression, allow the use of <math>n = 10</math>, ie <math>S_{xx} = 3445.26 - \frac{164.4^2}{10} [= 742.524]</math></p> <p>Condone one slip e.g. 3445.6 instead of 3445.26 etc</p> <p>2<sup>nd</sup> M1 for an attempt at a correct formula for <math>r</math> using <math>S_{yy}</math> and <math>S_{xy}</math> and their <math>S_{xx}</math></p> <p>Condone one slip e.g. 60.84 or 66.48 miscopied for 66.84</p> <p>A1 for awrt 0.906</p> <p>NB Use of <math>S_{xx} = 742.524</math> gives <math>r = 0.272</math> and can score M1M1A0 provided expressions are seen for <math>S_{xx}</math> and <math>r</math></p> |                       |
| (ii)            | <p><b>NB on open this is an A1 mark but we are treating it as a B1 It does not depend on M1 in (c)(i)</b></p> <p>B1 allow equivalent statements e.g. on average boys that are faster/slower in the 100 metres are also faster/slower in the 200 metres</p> <p>Comment must be: (1) a comparison of <u>time</u> e.g. faster, quicker, slower etc (not “higher”)</p> <p><b>and</b> (2) mention <u>100 metres</u> or <u>200 metres</u> (and imply the other)</p>                                                                                                                                                                                            |                       |

| Question Number | Scheme                                                                                                                                                                                                                                                                                                                              | Marks           |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 5(a)(i)         | $P(D) = \frac{200}{320} = \frac{5}{8}$ (or exact equivalent e.g. 0.625)                                                                                                                                                                                                                                                             | B1<br>(1)       |
| (ii)            | $P(D \cap X') = \frac{1}{2}$ oe                                                                                                                                                                                                                                                                                                     | B1<br>(1)       |
| (iii)           | $P(D' \cup Z') = \frac{320-88}{320}; = \frac{29}{40} = 0.725$ o.e.                                                                                                                                                                                                                                                                  | M1; A1<br>(2)   |
| (b)             | $P(Z D) = \frac{\frac{88}{320}}{\frac{200}{320}}; = \frac{88}{200}$ or $\frac{11}{25}$ or 0.44 oe                                                                                                                                                                                                                                   | M1; A1<br>(2)   |
| (c)             | $X$ and $Y$ or $X$ and $Z$ or $Y$ and $Z$ (Allow $X, Y$ etc)                                                                                                                                                                                                                                                                        | B1<br>(1)       |
| (d)             | $P(D) \times P(X) = 0.625 \times 0.2$ or $\frac{5}{8} \times \frac{64}{320} = 0.125 = P(D \cap X)$ or<br>$P(D X) = \frac{40}{64} = 0.625 = P(D)$ or $P(X D) = \frac{40}{200} = \frac{1}{5} = P(X) = \frac{24+40}{320}$<br>So yes they are independent                                                                               | M1<br>A1<br>(2) |
| (e)(i)          | A house that does not have a driveway but has exactly two cars                                                                                                                                                                                                                                                                      | B1<br>(1)       |
| (ii)            | A house that has a driveway<br>(with) fewer than two cars (oe)                                                                                                                                                                                                                                                                      | B1<br>B1<br>(2) |
| <b>Total 12</b> |                                                                                                                                                                                                                                                                                                                                     |                 |
| <b>Notes</b>    |                                                                                                                                                                                                                                                                                                                                     |                 |
| (a)(iii)        | <b>If any part(s) of this question are missing please send to review</b><br>M1 for identifying the correct 7 values: 24, 40, 35, 37, 32, 44 and 20 or sum of 232<br>A1 for $\frac{29}{40}$ or exact equivalent e.g. 0.725                                                                                                           |                 |
| (b)             | M1 for a ratio of probabilities with numerator of $\frac{88}{320}$ and denominator of their (a)(i)<br>A1 for 0.44 or exact equivalent                                                                                                                                                                                               |                 |
| (c)             | B1 for at least one correct pair and no incorrect ones. Do not allow e.g. $P(Y \cap Z)[=0]$ etc                                                                                                                                                                                                                                     |                 |
| (d)             | M1 for a correct test with all required probs (labels and values) stated or implied - ft $P(D)$<br>A1 for a correct conclusion – allow “yes they are” but must be events not probabilities<br>e.g. a conclusion that $P(D)$ and $P(X)$ are independent is A0                                                                        |                 |
| (e)(ii)         | 1 <sup>st</sup> B1 for a house that has a driveway<br>2 <sup>nd</sup> B1 for fewer than two cars (Allow 0 or 1 but must not include both no car and 1 car)<br>e.g. “has a driveway with 1 car <u>and</u> has a driveway with no car” is B1B0 <b>but</b><br>“has a driveway with 1 car <u>or</u> has a driveway with no car” is B1B1 |                 |

| Question Number | Scheme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Marks                                                           |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| 6 (a)           | $\frac{3.968 - \mu}{\sigma} = -1.2816 \quad \text{or} \quad \frac{4.026 - \mu}{\sigma} = 1.0364$ $\mu - 1.2816\sigma = 3.968 \quad (\text{Calc: } -1.28155156\dots)$ $\mu + 1.0364\sigma = 4.026 \quad (\text{Calc: } 1.03643338\dots)$ $2.318\sigma = 0.058$ $\sigma = 0.0250\dots \quad \mu = 4.00\dots \quad \text{awrt } \underline{\mathbf{0.025 \text{ and } 4}}$                                                                                                                                                                                                                                                                                                                                                                                                    | M1A1A1<br><br>dM1<br>A1<br><b>(5)</b>                           |
| (b)             | $Q_3 = \text{awrt } 30.3 \text{ (calc: } 30.337\dots) \text{ or } Q_3 - Q_1 = \text{awrt } 0.6 \text{ oe (calc: } 0.6744\dots)$ $30.3 + 1.5("30.3" - 29.7)[= 31.2] \quad \text{or} \quad 29.7 - 1.5("30.3" - 29.7)[= 28.8]$ $P(L > "31.2") = P\left(Z > \frac{"31.2" - 30}{0.5}\right) \quad \text{or} \quad P(L < "28.8") = P\left(Z < \frac{"28.8" - 30}{0.5}\right)$ $= 0.0082$ $\text{Probability it is an outlier} = 2 \times 0.0082$ $= 0.0164 \quad \text{answer in range } \underline{\mathbf{0.006 \sim 0.017}}$                                                                                                                                                                                                                                                  | B1<br>M1<br>M1<br><br>M1<br>A1<br><b>(5)</b><br><b>Total 10</b> |
| <b>Notes</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                 |
| (a)             | 1 <sup>st</sup> M1 for standardising with $\mu$ and $\sigma$ and forming an equation in $\mu$ and $\sigma$ with $ z  > 1$<br>1 <sup>st</sup> A1 for one correct equation in any form with $z$ value as given or better<br>2 <sup>nd</sup> A1 for a 2 <sup>nd</sup> correct equation in any form allow 2dp or better for the $z$ value<br>2 <sup>nd</sup> dM1 (dep on 1 <sup>st</sup> M1) for correct method to solve* their 2 linear, simultaneous equations.<br>Can be implied by both correct answers.<br>[*Must see correct substitution or correct addition/subtraction of all 3 terms]<br>2 <sup>nd</sup> A1 for both $\mu = \text{awrt } 4$ and $\sigma = \text{awrt } 0.025$ [Check it follows from their working.]<br>NB Could score M1A0A1M1A1 or M1A1A0M1A1 here |                                                                 |
| (b)             | B1 awrt 30.3 or IQR = awrt 0.6 or awrt 0.67<br>1 <sup>st</sup> M1 correct method for finding 1 outlier limit – ft their $Q_3$ or their IQR<br>2 <sup>nd</sup> M1 standardising with their limit, 30 and 0.5 allow $\pm$ leading to a probability $< 0.05$<br>Can be implied by a correct probability statement e.g. $P(L < 28.8) = 0.0082$<br>3 <sup>rd</sup> M1 multiplying their probability by 2 (or adding their two probs both $< 0.05$ )<br>A1 (dependent on all 3 M marks) for an answer in the range $0.006 \sim 0.017$                                                                                                                                                                                                                                            |                                                                 |
| Calc            | <b>Use of full calc values:</b> If they use a calculator the lower limit is 28.651...upper limit is 31.3489 and probability comes to $2 \times 0.00348835\dots = \text{awrt } 0.00698$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                 |

| Question Number | Scheme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Marks                        |                |                 |                |   |   |     |    |     |     |     |     |            |                |                |                |                 |                |                    |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------|-----------------|----------------|---|---|-----|----|-----|-----|-----|-----|------------|----------------|----------------|----------------|-----------------|----------------|--------------------|
| 7(a)(i)         | $2a + 2b = 0.5$ oe ; $5a + 11b = 1.55$ oe (any unsimplified form)<br>e.g. $5a + 11(0.25 - a) = 1.55$ [implies $6a = 1.2$ oe]<br>$a = 0.2^*$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | B1; B1<br>M1<br>A1 cso<br>B1 |                |                 |                |   |   |     |    |     |     |     |     |            |                |                |                |                 |                |                    |
| (ii)            | $b = \underline{\underline{0.05}}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | (5)                          |                |                 |                |   |   |     |    |     |     |     |     |            |                |                |                |                 |                |                    |
| (b)             | $[E(X^2) = ]1^2 \times 0.35 + 2^2 \times 0.2 + 3^2 \times 0.2 + 4^2 \times 0.15 + 5^2 \times 0.05 + 6^2 \times 0.05$ [=8.4]<br>$\text{Var}(X) = "8.4" - 2.5^2 = [2.15]$<br>$\text{Var}(4X + 3) = 16 \text{Var}(X)$<br>$= \underline{\underline{34.4}}$                                                                                                                                                                                                                                                                                                                                                                                                                                               | M1<br>M1<br>M1<br>A1         |                |                 |                |   |   |     |    |     |     |     |     |            |                |                |                |                 |                |                    |
| (c)             | Expected profit = $2.5 \times 60$ or $2.5 \times 80 - 2.5 \times 20$ oe<br>$= \underline{\underline{150}}$ (cents) or \$1.50 per customer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | M1<br>A1                     |                |                 |                |   |   |     |    |     |     |     |     |            |                |                |                |                 |                |                    |
| (d)             | Let $W$ be the profit, in cents per customer<br><table><tr><td><math>y</math></td><td>1</td><td>2</td><td>3</td><td>5</td><td>6</td></tr><tr><td><math>w</math></td><td>60</td><td>120</td><td>180</td><td>220</td><td>280</td></tr><tr><td><math>P(Y = y)</math></td><td><math>\frac{3}{40}</math></td><td><math>\frac{4}{40}</math></td><td><math>\frac{3}{40}</math></td><td><math>\frac{22}{40}</math></td><td><math>\frac{8}{40}</math></td></tr></table> $[E(W)] = \frac{1}{40}(60 \times 3 + 120 \times 4 + 180 \times 3 + 220 \times 22 + 280 \times 8)$<br>$= \underline{\underline{207}}$ cents per customer<br>[May work in dollars e.g. \$2.67 or \$2.27 scores B1B0M1A0 and \$2.07 4/4] | $y$                          | 1              | 2               | 3              | 5 | 6 | $w$ | 60 | 120 | 180 | 220 | 280 | $P(Y = y)$ | $\frac{3}{40}$ | $\frac{4}{40}$ | $\frac{3}{40}$ | $\frac{22}{40}$ | $\frac{8}{40}$ | B1; B1<br>M1<br>A1 |
| $y$             | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 2                            | 3              | 5               | 6              |   |   |     |    |     |     |     |     |            |                |                |                |                 |                |                    |
| $w$             | 60                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 120                          | 180            | 220             | 280            |   |   |     |    |     |     |     |     |            |                |                |                |                 |                |                    |
| $P(Y = y)$      | $\frac{3}{40}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | $\frac{4}{40}$               | $\frac{3}{40}$ | $\frac{22}{40}$ | $\frac{8}{40}$ |   |   |     |    |     |     |     |     |            |                |                |                |                 |                |                    |
|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | (4)                          |                |                 |                |   |   |     |    |     |     |     |     |            |                |                |                |                 |                |                    |
|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Total 15</b>              |                |                 |                |   |   |     |    |     |     |     |     |            |                |                |                |                 |                |                    |
| <b>Notes</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                              |                |                 |                |   |   |     |    |     |     |     |     |            |                |                |                |                 |                |                    |
| (a)(i)          | <b>Mark (a)(i) and (a)(ii) together</b><br>1 <sup>st</sup> B1 for a correct equation using $\Sigma \text{prob} = 1$<br>2 <sup>nd</sup> B1 for a correct equation using $E(X) = 2.5$<br>M1 dep on at least B1 for <u>eliminating</u> $a$ or $b$ leading to a linear equation in $a$ or $b$ only<br>A1cso for $a = 0.2$ <u>correctly</u> shown. Dependent on M1 scored and two correct equations seen.                                                                                                                                                                                                                                                                                                 |                              |                |                 |                |   |   |     |    |     |     |     |     |            |                |                |                |                 |                |                    |
| (ii)            | B1 for $b = 0.05$ (or exact equivalent) Independent of other marks in (a)(i). <b>Look by table</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                              |                |                 |                |   |   |     |    |     |     |     |     |            |                |                |                |                 |                |                    |
| (b)             | 1 <sup>st</sup> M1 for an attempt at $E(X^2)$ with at least 3 correct products. Allow ft of their value of $b$<br>Allow expression even if labelled $\text{Var}(X)$ but label of $\text{Var}(X)$ loses 2 <sup>nd</sup> M1 but can get 3 <sup>rd</sup> M1<br>2 <sup>nd</sup> M1 for use of $E(X^2) - [E(X)]^2$ ft their value of $E(X^2)$<br>3 <sup>rd</sup> M1 for seeing $16 \text{Var}(X)$ [Allow this mark if clearly stated $\text{Var}(X) = E(X^2) = 8.4$ ]<br>A1 for 34.4 or exact equivalent e.g. $\frac{172}{5}$                                                                                                                                                                             |                              |                |                 |                |   |   |     |    |     |     |     |     |            |                |                |                |                 |                |                    |
| (c)             | M1 for $2.5 \times 60$ or any other fully correct equivalent expression (allow $2.5 \times 0.6$ )<br>A1 for 150 or accept \$1.5 (working with dollars requires units)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                              |                |                 |                |   |   |     |    |     |     |     |     |            |                |                |                |                 |                |                    |
| (d)             | 1 <sup>st</sup> B1 for 1 <sup>st</sup> 3 values of $W$ (can allow in an expression for $E(W)$ )   <b>Look by table</b> but must<br>2 <sup>nd</sup> B1 for last 2 values for $W$   be in part (d)<br>M1 for attempt at $E(W)$ ft their $W$ values but at least 3 correct ft products<br>Dependent on at least one of the first two B1 marks<br>A1 for 207                                                                                                                                                                                                                                                                                                                                             |                              |                |                 |                |   |   |     |    |     |     |     |     |            |                |                |                |                 |                |                    |
| ALT             | <b>Use of E(Y)</b> [= 4.45] with at least 3 correct products seen <b>and</b> $E(W) = pE(Y) - q$<br>1 <sup>st</sup> B1 for $p = 60$ and 2 <sup>nd</sup> B1 for $q = \left(\frac{22}{40} + \frac{8}{40}\right) \times 80$ (or 60)<br>M1 for $E(W)$ expression of the form above and dep on at least one B mark scored                                                                                                                                                                                                                                                                                                                                                                                  |                              |                |                 |                |   |   |     |    |     |     |     |     |            |                |                |                |                 |                |                    |

