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# Mark Scheme (Results)

## October 2021

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

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**General Marking Guidance**

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

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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.

- 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
- $\lfloor$ or d… The second mark is dependent on gaining the first mark

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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.

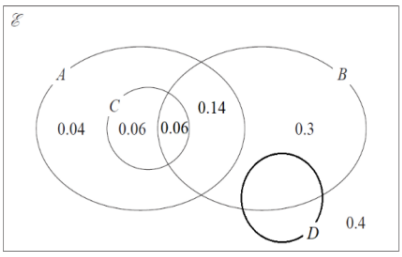
**Special notes for marking Statistics exams (for AAs only)**

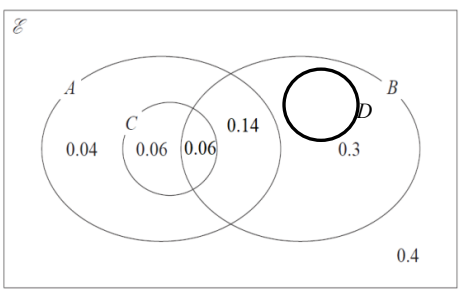
- If a method leads to "probabilities" which are greater than 1 or less than 0 then M0 should be awarded unless the mark scheme specifies otherwise.
- Any correct method should gain credit. If you cannot see how to apply the mark scheme but believe the method to be correct then please send to review.
- 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 is "hedging their bets" e.g. give Attempt 1…Attempt 2…etc then please send to review.

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| Question Number | Scheme | Marks |
|---|---|---|
| **1 (a)** | [Sum of probs = 1 gives $p + q = 0.2$ and] so P($B$) = **0.5** | B1 (1) |
| **(b)** | e.g. P($A$) = 0.3 or 0.1 + " their value for $p + q$", $P(A \cap B) = 0.2$ or "their value for $p + q$", **and** [P($A$) × P($B$) =]0.3 × "0.5" [="0.15"] | M1 |
| | 0.15 ≠ 0.2 so [$A$ and $B$ are] not independent | A1 (2) |
| **(c)** | [P($C$ \| $B$) = ] $\frac{p}{"0.5"} = p + 0.06$ (o.e.) | M1 |
| | [$2p = p + 0.06$ so ] **$p = 0.06$** | A1 |
| | [Use of $p + q = 0.2$ gives] **$q = 0.14$** | A1 (3) |
| **(d)** | Suitable event $D$ drawn. [See Venn diagrams below] | B1 (1) |
| | | **[7]** |

| | **Notes** |
|---|---|
| **(a)** | B1 for 0.5 or exact equivalent |
| **(b)** | M1 for sight of correct probabilities for P(A) and $P(A \cap B)$ **clearly labelled**, 0.3 × "0.5" seen or P($A$) × P($B$) = 0.15<br>Allow 0.04 + 0.06 + 0.2 for P($A$) if clearly labelled<br>$P(A \cap B)$ may be stated in part (a) P($B$) can ft from (a) eg P(A) = "0.5" – 0.3-0.2 |
| **ALT** | May see P($B$ \| $A$) = $\frac{2}{3}$ and compared with P($B$) **or** P($A$ \| $B$) = 0.4 and P($A$) = 0.3 |
| | A1 For all the correct probabilities and calculations, a comparison and correct conclusion. We need to see 0.15 but will accept $P(A \cap B) \neq P(A) \times P(B)$ instead of 0.15 ≠ 0.2 for comparison |
| | **SC** Allow M1A0for P($A$) = 0.1 + $p$ + $q$; $P(A \cap B) = p + q$ clearly labelled and $0.5 \times (0.1 + p + q)$ or $(p + q + 0.3)(0.1 + p + q)$ given. |
| **(c)** | M1 ft their P($B$) from part (a). For a correct equation in $p$ or $q$ based on the given statement. NB equation in terms of $q$ is $\frac{0.2 - q}{"0.5"} = 0.26 - q$ (o.e.) Allow $\frac{p}{0.3 + p + q} = p + 0.06$ |
| | 1st A1 for ($p$ = ) 0.06 |
| | 2nd A1 for ($q$ = ) 0.14 |
| **Ans only** | ($p$ = ) 0.06 and ($q$ = ) 0.14 3/3 |
| **(d)** | B1 for a suitable event $D$ drawn that has an intersection with $B$ but not with $A$. Condone if not labelled D |

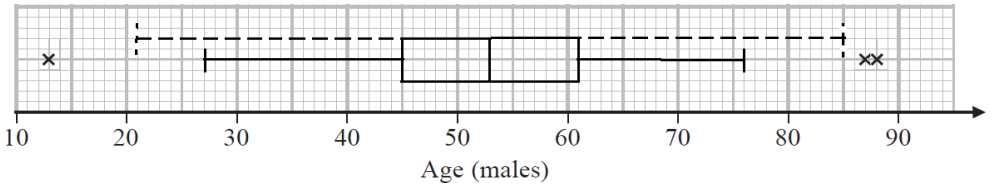


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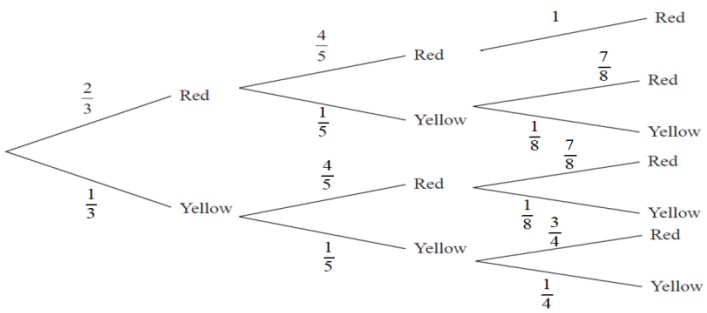
| Question Number | Scheme | Marks |
|---|---|---|
| **2 (a)** | $\left[S_{xp} =\right] 2347 - \frac{93\times 273}{12}$ or $2347 - \frac{25\,389}{12}$ $\left[=231.25\right]$ (*) | B1cso (1) |
| **(b)** | $\left[S_{pp} =\right] 6602.72 - \frac{273^2}{12} = \left[391.97\right]$ | M1 |
| | $\left[r =\right] \frac{231.25}{\sqrt{148.25\times "391.97"}}$ | M1 |
| | = 0.959307… awrt **<u>0.959</u>** | A1 (3) |
| **(c)** | $\left[b = \frac{S_{xp}}{S_{xx}} = \right] \frac{231.25}{148.25} \left[=1.559865...\right]$ | M1 |
| | $a = \frac{273}{12} - "1.56"\times \frac{93}{12}$ or $22.75 - "1.56"\times 7.75$ $\left[=10.66...\right]$ | M1 |
| | $b$ = awrt 1.6 **or** $a$ = awrt 11 | A1 |
| | ***<u>p = 10.7 + 1.56x</u>*** | A1 (4) |
| **(d)** | e.g. each extra **employee** costs the company (on average)[$"]156" a year in **paper** | B1 (1) |
| **(e)** | [New $p$ = ] $0.8\times "10.66..." + \frac{"1.559..."}{2}\times \frac{93}{12}$ [=14.573…] | M1 |
| | [compared with $\overline{p} = 22.75$ ] so percentage saving is $\frac{22.75 - 14.573...}{22.75}\left[\times 100\right]$ | M1 |
| | = 35.94… awrt **<u>36[%]</u>** | A1 (3) |
| | **Notes** | **[12]** |
| **(a)** | B1 for either correct expression [don't need = 231.25] | |
| **(b)** | 1st M1 for attempt at correct expression for $S_{pp}$ Allow one transcription error e.g. 6620.72 May be seen in part (a)<br>If no correct expression seen allow $S_{pp}$ = awrt 392 or correctly placed in formula for $r$<br>2nd M1 for a correct expression for $r$, ft their $S_{pp}$<br>A1 for awrt 0.959 | |
| **(c)** | 1st M1 for a correct expression for $b$ (may be implied by a correct value of awrt 1.56)<br>2nd M1 for a correct expression for $a$ ft their value for $b$. May be implied by awrt 10.7<br>1st A1 for $b$ = awrt 1.6 **or** $a$ = awrt 11<br>2nd A1 for correct equation in $p$ and $x$ with $b$ = awrt 1.56 and $a$ = awrt 10.7 | |
| **(d)** | B1 for a suitable contextual comment that mentions their value of $b$<br>Allow multiples eg every extra 100 employees costs the company "$15600". Condone missing $ sign or use of £. Do not allow " $1.56" for 1 person unless indicates in 100's | |
| **(e)** | 1st M1 for a correct expression for average value of $p$ using new model [ft their $a$ and $b$]<br>2nd M1 for correct percentage saving calculation using 22.75 (e.g. $\frac{14.573...}{22.75}\left[\times 100\right]$ ) Allow use of $"10.7" + 1.56"\times \frac{93}{12}\left[\approx 22.79\right]$ for 22.75 May be implied by correct answer.<br>A1 for awrt 36<br>**SC** use of 93 throughout part (e) rather than 7.75 leading to awrt 48 or 0.48 (they will need to use the regression line from part(c) to calculate the original value) gains M0M1A0<br>**SC** use of 93 in part(c) Answer of 36% gains M1M1A1, 64% or 0.64 gains M1M1A0. | |

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| Question Number | Scheme | Marks |
|---|---|---|
| **3. (a)** | [Median =] **53** | B1 (1) |
| **(b)** | $Q_1 = 45$ $Q_3 = 61$ | M1 |
| | [IQR =] 61 – 45 = **16** (*) | A1cso (2) |
| **(c)** | $Q_1 - 1.5\times(\text{IQR}) = 45 - 1.5\times16$ [= **21**] or $Q_3 + 1.5\times(\text{IQR}) = 61 + 1.5\times16$ [=**85**] | M1 |
| | Outliers are < **21** or > **85** | A1ft |
| | So there are three outliers at **13, 87 and 88** | A1 (3) |
| **(d)** |   | M1 A1ft A1 A1 (4) |
| **(e)** | e.g. the females are generally older than the men as median is higher (67 > 53) | B1 (1) |
| **(f)(i)** | No change to box plot means one in each section so granddaughter **[34~56]** | B1 |
| **(ii)** | Eldest daughter in range [67~72] **or** Anja's age [72~93] | M1 |
| | Since Anja 23 years older than eldest daughter Anja in range **[90~93]** | A1 (3) |

| | **Notes** **[14]** |
|---|---|
| **(a)** | B1 for 53 |
| **(b)** | M1 for an attempt at both **and** at least one correct. No need to be labelled. |
| | A1cso for both correct quartiles seen **and** 61 – 45 leading to 16 |
| **(c)** | M1 for attempting at least one of the limits. Can ft their quartiles. May be implied by 85 or 21 |
| | 1st A1ft for both outlier limits correct or correct ft using their quartiles |
| | 2nd A1 for identifying the three outliers at 13, 87, 88 (dep on seeing both correct limits) |
| **(d)** | M1 for drawing a box with only two whiskers one at each end |
| | 1st A1ft for $Q_1, Q_2$ and $Q_3$ as a correctly drawn box (ft their values for $Q_1, Q_2$ and $Q_3$) |
| | 2nd A1 for upper whisker ending at 76 (or 85) **and** lower whisker ending at 27 (or 21) **NB Must be correctly paired.** |
| | 3rd A1 for the **3** outliers correctly shown (accuracy - half a small square throughout) |
| | SC fully correct but with both whiskers correct on each side. M0A1A0A1 |
| **(e)** | B1 for a correct comment, **referring to ages**, with reference to a **correctly named statistic.** Must **include the figures** compared. |
| | eg Females older than men and comparison of median, upper quartile or lower quartile, allow $Q_1, Q_2$ and $Q_3$ with their figures which must agree with the statement . |
| | eg Males ages more spread out than female and comparison of ranges with males = 75 and females = 73 |
| | eg Females older than males since Males are symmetrical [Q3 – Q2 : Q2 – Q1] 8 : 8 Female are negative **skew** 5 : 11 |
| | **NB** use of mean/ IQR/ minimum/ maximum is B0. Ignore incorrect comments. |
| **(f)(i)** | B1 for deducing granddaughter is at or below lower quartile but not below 34 |
| | Allow any reasonable adjustment for her mother's age, {34 to $x$} where 35 □ $x$ □ 56 |
| **(ii)** | M1 Suitable range for eldest daughter or Anja above upper quartile. Ignore any incorrect upper limit. May be implied by a correct range. |
| | A1 for a range of [90~93] for Anja's age |

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| Question Number | Scheme | Marks |
|---|---|---|
| **4. (a)** |  | B1<br>B1<br>B1<br>(3) |
| **(b)** | [Cases $RYY$ or $YRY$ or $YYR$] Prob $= \frac{2}{3}\times\frac{1}{5}\times\frac{1}{8} + \frac{1}{3}\times\frac{4}{5}\times\frac{1}{8} + \frac{1}{3}\times\frac{1}{5}\times\frac{6}{8}$ | M1 A1ft |
| | $[=\frac{1}{120}(2+4+6)$ or $(0.0166...+0.033...+0.05)] = \frac{12}{120}$ or $\underline{\underline{\frac{1}{10}}}$ (*) | A1*cso<br>(3) |
| **(c)** | [P($RYY \mid RYY$ or $YRY$ or $YYR$) = ] $\frac{"\frac{2}{3}\times\frac{1}{5}\times\frac{1}{8}"}{\frac{1}{10}}$ | M1 |
| | $= \underline{\underline{\frac{1}{6}}}$ | A1<br>(2) |
| **(d)** | $x$ \| 0 \| 1 \| 2 \| 3<br>P($X=x$) \| $\frac{64}{120}$ or $\frac{8}{15}$ \| $\frac{42}{120}$ or $\frac{7}{20}$ \| $\left[\frac{1}{10}\right]$ \| $\frac{2}{120}$ or $\frac{1}{60}$ | B1<br>M1<br>A1<br>(3) |
| **(e)** | [E($X$) = ] $\frac{1}{120}(0 + "42" + "2\times12" + "3\times2")$ | M1 |
| | $= \frac{72}{120}$ or **<u>0.6</u>** | A1<br>(2)<br>**[13]** |

| | Notes |
|---|---|
| **(a)** | 1st B1 completing the structure of branches: 2, 4 then 7 or 8 and suitable labels e.g. *Y* or *R'*<br>2nd B1 correct probabilities for at least bag **A** and bag **B.** Allow exact decimals<br>3rd B1 for a fully correct tree diagram. Condone missing 0 as probability. Allow exact decimals |
| **(b)** | 1st M1 for at least one correct product of 3 probabilities (ft their tree diagram)<br>1st A1ft for all 3 products of 3 probabilities added ( no extras) (ft their tree diag.)<br>2nd A1*cso for fully correct solution with no incorrect statements seen |
| **(c)** | M1 for a ratio of probabilities with denominator of 0.1 and numerator $\frac{1}{60}$ oe or the product of 3 probabilities **seen** from their tree diagram representing P($RYY$) provided num < 0.1<br>A1 for $\frac{1}{6}$ or exact equivalent |
| **(d)** | B1 for a correct sample space i.e. { 0, 1, 2, 3} Allow extras if they have a probability of 0.<br>M1 for at least 1 correct value of $x$ and associated probability (excluding $x$ = 2) [ft their tree]<br>A1 for a fully correct probability distribution |
| **(e)** | M1 for attempt at a correct expression (at least 2 correct ft part(d) non-zero products)<br>A1 for 0.6 or any exact equivalent |

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| Question Number | Scheme | Marks |
|---|---|---|
| **5. (a)** | [By symmetry E($Y$) ] = **$\underline{0}$** | B1 (1) |
| **(b)** | $q+r+u=\frac{19}{30}$ | M1 |
| | $2(q+r)+u=1$ [and attempt to solve e.g. $q+r=\ldots$] | M1 |
| | $u=\frac{8}{30}=\underline{\underline{\frac{4}{15}}}$ **(*)** | A1*cso (3) |
| **(c)** | $\mathrm{E}(Y^2)=(-9)^2\times q + (-5)^2\times r + 5^2\times r + 9^2 q$ **or** $162q+50r$ | M1 |
| | Var($Y$) = 37 = $\mathrm{E}(Y^2)-"0"^2 \Rightarrow 37=162q+50r$ oe | dM1 |
| | Solving with $q+r=\frac{11}{30}$ oe e.g. $(162-50)q=37-\frac{55}{3}$ or | M1 |
| | $q=\underline{\underline{\frac{1}{6}}}$ **and** $r=\underline{\underline{\frac{1}{5}}}$ | A1 (4) |
| **(d)** | $Y=0\Rightarrow D=12$ , $D=\sqrt{12^2+Y^2}$; $Y=\pm5\Rightarrow D=13$ $\underline{\text{or}}$ $Y=\pm9\Rightarrow D=15$ | B1, M1;A1 |
| | $d$ \| 12 \| 13 \| 15 | |
| | P($D=d$) \| $\frac{4}{15}$ \| $\frac{6}{15}$ or $\frac{2}{5}$ \| $\frac{5}{15}$ or $\frac{1}{3}$ | M1A1ftA1ft (6) |
| | | **[14]** |

| | Notes |
|---|---|
| **(a)** | B1 for 0 |
| **(b)** | 1st M1 for a correct equation in $q$, $r$ and $u$ using F(0)<br>2nd M1 for a second equation clearly based on sum of probs = 1 and an attempt to solve these 2 equations<br>A1* cso correct value for $u$ found with no incorrect working |
| **(c)** | 1st M1 for an attempt at E($Y^2$) with at least 3 correct products seen. The negative numbers do not need to be in brackets<br>2nd dM1 for attempt at correct equation in $q$ and $r$ using Var($Y$) [ft their E($Y$) and E($Y^2$)] Condone missing subtraction of $0^2$ if 0 in part(a)<br>3rd M1 using $q+r=11/30$ (awrt 0.37) to attempt to solve two linear equations in $q$ and $r$ leading to equation in one variable. May be implied by correct answers.<br>A1 for $q=\frac{1}{6}$ and $r=\frac{1}{5}$ or exact equivalents |
| **(d)** | B1 for $D=12$<br>1st M1 for use of Pythagoras to work out $D$ = 13 $\underline{\text{or}}$ 15<br>1st A1 for $D$ = 13 $\underline{\text{and}}$ 15<br>2nd M1 for a correct value of $D$ and an associated probability. Allow two occurrences (for 15 and 13) which add to the appropriate probability.<br>2ndA1ft for two correct values of $D$ and associated probs ft their +ve $q$ and $r$ if $q+r=\frac{11}{30}$ Allow two occurrences (for 15 and 13) which add to the appropriate probability.<br>3rd A1ft for a fully correct probability distribution ft their +ve $q$ and $r$ if $q+r=\frac{11}{30}$ |

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| Question Number | Scheme | Marks |
|---|---|---|
| **6. (a)** | $H \sim N(25.1, 5.5^2)$ | |
| | $P(H > 30.8) = P\left(Z > \frac{30.8-25.1}{5.5}\right)$ or $P(Z > 1.03636\ldots)$ | M1 |
| | $= 1 - 0.8508$ | M1 |
| | $= 0.1492$ or better (calc: 0.1500…) | A1cso |
| | | (3) |
| **(b)** | [$P(H < y) = 0.05$ implies] $\frac{y-25.1}{5.5} = -1.6449$ | M1B1 |
| | $y = 16.053\ldots$ so range is awrt **16.1** ~ **30.8** | A1 |
| | | (3) |
| **(c)(i)** | $P(H < d) = 0.05 + 0.2 + 0.3$ [= 0.55] | M1 |
| | $\frac{d-25.1}{5.5} = 0.13$ (Calc 0.12566) | M1 |
| | $d = 0.13 \times 5.5 + 25.1 = 25.815$ (25.791… calc) | A1cso |
| | | (3) |
| **(ii)** | $P(H < m) = 0.05 + 0.2$ [= 0.25] | M1 |
| | $\frac{m-25.1}{5.5} = -0.67$ (Calc 0.674489) | M1M1 |
| | $m$ = awrt **21.4** | A1 |
| | | (4) |
| **(d)** | Height = $2 \times$ "$m$" $+ 3 \times 25.8 + 3 \times 30.8$ [+8] | M1 |
| | = 220.6 awrt **221** (cm) | A1 |
| | | (2) |
| | | **[15]** |

| | Notes |
|---|---|
| **(a)** | 1st M1 for standardising 30.8 with 25.1 and 5.5 (allow ±) Allow use of $z = 1.04$<br>2nd M1 for $1 - p$ (where $0.84 < p < 0.86$)<br>A1cso for an answer of 0.1492… or better(calc: 0.1500…) with evidence of both M's seen |
| **(b)** | M1 for standardising their letter $y$ with 25.1 and 5.5 and setting equal to $z$ value $1 < \lvert z \rvert < 2$<br>B1 for use of $z = \pm 1.6449$ or better (calc 1.6448536…) with the correct standardisation.<br>A1 for awrt 16.1 (ISW)(calc 16.053305….) or range [16.1, 30.8](Allow 30.8 – 16.1 = 14.7[5])<br>**Ans only** [awrt 16.05 scores 3/3 16.1 scores M1B0A1 unless 1.6449 or better is seen] |
| **(c)(i)** | 1st M1 for a correct method to calculate $P(H < d)$ implied by $z$ = awrt 0.13<br>Allow 0.05 + awrt 0.200 + awrt 0.300[=0.5505]<br>2nd M1 for a correct standardisation $= z$ where $0.125 \leq \lvert z \rvert \leq 0.13$<br>A1cso both method marks awarded, no errors seen **and** awrt 25.82 or awrt 25.79<br>or $d$ = awrt $0.13 \times 5.5 + 25.1$ = awrt 25.8 |
| **ALT** | Verification 2nd M1 allow $\frac{25.8-25.1}{5.5} = 0.127...$ or 0.13<br>A1 for 0.55 and 0.5517 (calc 0.5506 or better) seen |
| **(ii)** | 1st M1 correct method for $P(H < m)$ Allow 0.05 + awrt 0.200 implied by $\lvert z \rvert$ = [0.67 − 0.68]<br>2nd M1 for standardising $m$ with 25.1 and 5.5 and setting equal to $z$ value ($0.65 \leq \lvert z \rvert \leq 0.69$)<br>3rd M1 for standardising $m$ with 25.1 and 5.5 and setting equal to awrt −0.67 oe<br>A1 for $m$ = awrt 21.4 (use of $z = 0.67$ gives 21.415… and $z = 0.68$ gives 21.36…)<br>No need for 3rd M1 to be awarded<br>Answer only 21.4 gets M1M1M0A1. 21.39 gets 4/4 |
| **(d)** | M1 for $2 \times$ "$m$" $+ 3 \times 25.8 + 3 \times 30.8$ [ + $n$ ] where $n$ is an integer $\neq 0$ Allow $m$ or ft their $m$<br>A1 for awrt 221 (cm) |

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| Question Number | Scheme | Marks |
|---|---|---|
| **ALT 1 (c)(i)** | e.g. $P(H > 25.8 \mid \text{"16.1"} < H < 30.8)$ **or** $\dfrac{P(25.8 < H < 30.8)}{1-(0.15+0.05)}$<br>$= \dfrac{0.8508-0.5517}{0.8}$ (tables) **or** $\dfrac{0.299345...}{0.8}$ (calc) $\approx \dfrac{3}{8}$ | M1<br>M1 A1cso<br>(3) |
| | **Notes** | |
| **(c)(i)** | 1st M1 for a correct conditional probability statement ft their answer to (b) i.e. their $y$<br>2nd M1 for a ratio of probs of the form $\dfrac{q}{0.8}$ where $q = 0.3$ to 1sf<br>A1 for probability of approx $\frac{3}{8}$ | |

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