

# Mark Scheme (Results) January 2010

GCE

## Statistics S1 (6683)

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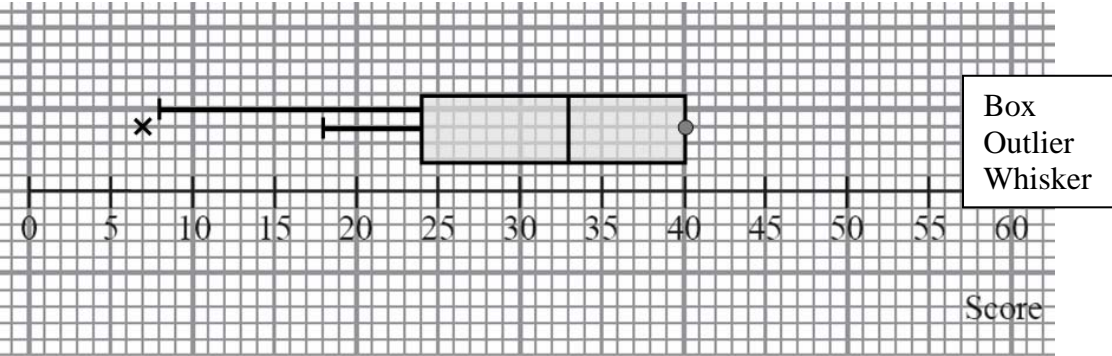
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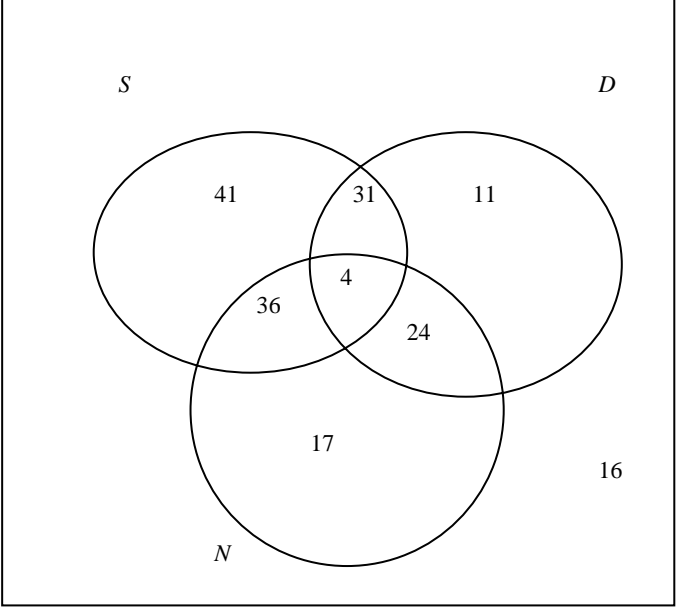
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January 2010  
6683 Statistics S1  
Mark Scheme

Question Number	Scheme	Marks
Q1 (a)		M1 A1 A1  (3)
(b)	<p>P(Blue bead and a green bead) = <math>\left(\frac{1}{4} \times \frac{1}{3}\right) + \left(\frac{1}{4} \times \frac{1}{3}\right) = \frac{1}{6}</math> (or any exact equivalent)</p>	M1 A1  (2) <b>Total [5]</b>
Q1 (a)	<p>M1 for shape and labels: 3 branches followed by 3,2,2 with some <i>R</i>, <i>B</i> and <i>G</i> seen Allow 3 branches followed by 3, 3, 3 if 0 probabilities are seen implying that 3, 2, 2 intended Allow blank branches if the other probabilities imply probability on blanks is zero Ignore further sets of branches</p> <p>1<sup>st</sup> A1 for correct probabilities and correct labels on 1<sup>st</sup> set of branches. 2<sup>nd</sup> A1 for correct probabilities and correct labels on 2<sup>nd</sup> set of branches. (accept 0.33, 0.67 etc or better here)</p>	
(b)	<p>M1 for identifying the 2 cases <i>BG</i> and <i>GB</i> and adding 2 products of probabilities. These cases may be identified by their probabilities e.g. <math>\left(\frac{1}{4} \times \frac{1}{3}\right) + \left(\frac{1}{4} \times \frac{1}{3}\right)</math> NB <math>\frac{1}{6}</math> (or exact equivalent) with no working scores 2/2</p>	
<b>Special Case</b>	<p><u>With Replacement</u> (This oversimplifies so do not apply Mis-Read: max mark 2/5)</p> <p>(a) B1 for 3 branches followed by 3, 3, 3 with correct labels and probabilities of <math>\frac{1}{2}, \frac{1}{4}, \frac{1}{4}</math> on each.</p> <p>(b) M1 for identifying 2, possibly correct cases and adding 2 products of probabilities but A0 for wrong answer  <math display="block">\left[\left(\frac{1}{4} \times \frac{1}{4}\right) + \left(\frac{1}{4} \times \frac{1}{4}\right)\right]</math>           will be sufficient for M1A0 here but <math>\frac{1}{4} \times \frac{1}{2} + \dots</math> would score M0</p>	

Question Number	Scheme	Marks
Q2 (a)	Median is 33	B1 (1)
(b)	$Q_1 = 24, Q_3 = 40, \text{IQR} = 16$	B1 B1 B1ft (3)
(c)	$Q_1 - \text{IQR} = 24 - 16 = 8$ So 7 is only outlier	M1 A1ft (2)
(d)	 <p style="text-align: right;">(accept either whisker)</p>	B1ft B1 B1ft (3)  Total [9]
Q2 (b)	<p>1<sup>st</sup> B1 for <math>Q_1 = 24</math> and 2<sup>nd</sup> B1 for <math>Q_3 = 40</math>  3<sup>rd</sup> B1ft for their IQR based on their lower and upper quartile.  Calculation of range (<math>40 - 7 = 33</math>) is B0B0B0  <u>Answer only</u> of IQR = 16 scores 3/3. For any other answer we must see working in (b) or on stem and leaf diagram</p> <p>(c) M1 for evidence that <math>Q_1 - \text{IQR}</math> has been attempted, their “8” (&gt;7) seen or clearly attempted is sufficient  A1 ft must have seen their “8” and a suitable comment that only one person scored below this.</p> <p>(d) 1<sup>st</sup> B1ft for a clear box shape and ft their <math>Q_1, Q_2</math> and <math>Q_3</math> readable off the scale.  Allow this mark for a box shape even if <math>Q_3 = 40, Q_1 = 7</math> and <math>Q_2 = 33</math> are used  2<sup>nd</sup> B1 for only one outlier appropriately marked at 7  3<sup>rd</sup> B1ft for either lower whisker. If they choose the whisker to their lower limit for outliers then follow through their “8”.  (There should be no upper whisker unless their <math>Q_3 &lt; 40</math>, in which case there should be a whisker to 40)</p> <p>A typical error in (d) is to draw the lower whisker to 7, this can only score B1B0B0</p>	

Question Number	Scheme	Marks
Q3	<p>(a) 2.75 or <math>2\frac{3}{4}</math>, 5.5 or 5.50 or <math>5\frac{1}{2}</math></p> <p>(b) Mean birth weight = <math>\frac{4841}{1500} = 3.227\bar{3}</math> <b>awrt 3.23</b></p> <p>(c) Standard deviation = <math>\sqrt{\frac{15889.5}{1500} - \left(\frac{4841}{1500}\right)^2} = 0.421093\dots</math> or <math>s = 0.4212337\dots</math></p> <p>(d) <math>Q_2 = 3.00 + \frac{403}{820} \times 0.5 = 3.2457\dots</math> (allow 403.5..... <math>\rightarrow</math> 3.25)</p> <p>(e) Mean(3.23) &lt; Median(3.25) (or very close) Negative Skew (or symmetrical)</p>	<p>B1 B1 (2)</p> <p>M1 A1 (2)</p> <p>M1 A1ft A1 (3)</p> <p>M1 A1 (2)</p> <p>B1ft dB1ft (2)</p> <p><b>Total [11]</b></p>
Q3	<p>(b) M1 for a correct expression for mean. Answer only scores both.</p> <p>(c) M1 for a correct expression (ft their mean) for sd or variance. Condone mis-labelling eg sd=... with no square root or no labelling 1<sup>st</sup> A1ft for a correct expression (ft their mean) including square root and no mis-labelling Allow 1<sup>st</sup> A1 for <math>\sigma^2 = 0.177\dots \rightarrow \sigma = 0.42\dots</math> 2<sup>nd</sup> A1 for awrt 0.421. Answer only scores 3/3</p> <p>(d) M1 for a correct expression (allow 403.5 i.e. use of <math>n + 1</math>) but must have 3.00, 820 and 0.5 A1 for awrt 3.25 provided M1 is scored. NB 3.25 with no working scores 0/2 as some candidates think mode is 3.25.</p> <p>(e) 1<sup>st</sup> B1ft for a comparison of their mean and median (may be in a formula but if <math>\pm(\text{mean} - \text{median})</math> is calculated that's OK. We are not checking the <u>value</u> but the <u>sign</u> must be consistent.) Also allow for use of quartiles <u>provided correct values seen</u>: <math>Q_1 = 3.02, Q_3 = 3.47</math> [They should get <math>(0.22 =) Q_3 - Q_2 &lt; Q_2 - Q_1 (= 0.23)</math> and say (slight) negative skew or symmetric] 2<sup>nd</sup> dB1ft for a compatible comment based on their comparison. Dependent upon a suitable, correct comparison. Mention of "correlation" rather than "skewness" loses this mark.</p>	

Question Number	Scheme	Marks
4 (a)	<div style="display: flex; align-items: center;">  <div style="margin-left: 20px;"> <p>3 closed curves and 4 in centre Evidence of subtraction</p> <p>31,36,24 41,17,11 Labels on loops, 16 and box</p> </div> </div>	<p>M1 M1 A1 A1 B1</p> <p style="text-align: right;">(5)</p>
(b)	$P(\text{None of the 3 options}) = \frac{16}{180} = \frac{4}{45}$	<p>B1ft (1)</p>
(c)	$P(\text{Networking only}) = \frac{17}{180}$	<p>B1ft (1)</p>
(d)	$P(\text{All 3 options/technician}) = \frac{4}{40} = \frac{1}{10}$	<p>M1 A1 (2) <b>Total [9]</b></p>
4 (a)	<p>2<sup>nd</sup> M1 There may be evidence of subtraction in “outer” portions, so with 4 in the centre then 35, 40 28 (instead of 31,36,24) along with 33, 9, 3 can score this mark but A0A0 N.B. This is a common error and their “16” becomes 28 but still scores B0 in part (a)</p> <p>(b) B1ft for <math>\frac{16}{180}</math> or any exact equivalent. Can fit their “16” from their box. If there is no value for their “16” in the box only allow this mark if they have <u>shown</u> some working.</p> <p>(c) B1ft ft their “17”. Accept any exact equivalent</p> <p>(d) If a probability greater than 1 is found in part (d) score M0A0 M1 for clear sight of <math>\frac{P(S \cap D \cap N)}{P(S \cap N)}</math> and an attempt at one of the probabilities, ft their values. Allow <math>P(\text{all 3}   S \cap N) = \frac{4}{36}</math> or <math>\frac{1}{9}</math> to score M1 A0. Allow a correct ft from their diagram to score M1A0 e.g. in 33,3,9 case in (a): <math>\frac{4}{44}</math> or <math>\frac{1}{11}</math> is M1A0 A ratio of probabilities with a <u>product</u> of probabilities on top is M0, even with a correct formula.</p> <p>A1 for <math>\frac{4}{40}</math> or <math>\frac{1}{10}</math> or an exact equivalent Allow <math>\frac{4}{40}</math> or <math>\frac{1}{10}</math> to score both marks if this follows from their diagram, otherwise some explanation (method) is required.</p>	

Question Number	Scheme	Marks
Q5 (a)	$k + 4k + 9k = 1$ $14k = 1$ $k = \frac{1}{14} \quad \text{**given**}$	M1 A1 (2)
(b)	$P(X \geq 2) = 1 - P(X = 1) \quad \text{or} \quad P(X = 2) + P(X = 3)$ $= 1 - k = \frac{13}{14} \quad \text{or} \quad 0.92857\dots$	M1 A1 (2)
(c)	$E(X) = 1 \times k + 2 \times k \times 4 + 3 \times k \times 9 \quad \text{or} \quad 36k$ $= \frac{36}{14} = \frac{18}{7} \quad \text{or} \quad 2\frac{4}{7} \quad \text{(or exact equivalent)}$	M1 A1 (2)
(d)	$\text{Var}(X) = 1 \times k + 4 \times k \times 4 + 9 \times k \times 9 - \left(\frac{18}{7}\right)^2$ $\text{Var}(1 - X) = \text{Var}(X)$ $= \frac{19}{49} \quad \text{or} \quad 0.387755\dots$	M1 M1 M1 A1 (4) <b>Total [10]</b>
Q5 (a)	<p>M1 for clear attempt to use <math>\sum p(x) = 1</math>, full expression needed and the “1” must be clearly seen. This may be seen in a table.</p> <p>A1cso for no incorrect working seen. The sum and “= 1” must be explicitly seen somewhere.</p> <p>A verification approach to (a) must show addition for M1 and have a suitable comment e.g. “therefore <math>k = \frac{1}{14}</math>” for A1 cso</p>	
(b)	<p>M1 for <math>1 - P(X \leq 1)</math> or <math>P(X = 2) + P(X = 3)</math></p> <p>A1 for awrt 0.929. Answer only scores 2/2</p>	
(c)	<p>M1 for a full expression for <math>E(X)</math> with at least two terms correct. NB If there is evidence of division (usually by 3) then score M0</p> <p>A1 for any exact equivalent - answer only scores 2/2</p>	
(d)	<p>1<sup>st</sup> M1 for clear attempt at <math>E(X^2)</math>, need at least 2 terms correct in <math>1 \times k + 4 \times 4k + 9 \times 9k</math> or <math>E(X^2) = 7</math></p> <p>2<sup>nd</sup> M1 for their <math>E(X^2) - (\text{their } \mu)^2</math></p> <p>3<sup>rd</sup> M1 for clearly stating that <math>\text{Var}(1 - X) = \text{Var}(X)</math>, wherever seen</p> <p>A1 accept awrt 0.388. All 3 M marks are required. Allow 4/4 for correct answer only but must be for <math>\text{Var}(1 - X)</math>.</p>	

Question Number	Scheme	Marks
Q6 (a)	$S_{pp} = 106397 - \frac{833^2}{7} = 7270$ $S_{tp} = 42948 - \frac{341 \times 833}{7} = 2369, \quad S_{tt} = 18181 - \frac{341^2}{7} = 1569.42857... \quad \text{or} \quad \frac{10986}{7}$	M1 A1
(b)	$r = \frac{2369}{\sqrt{7270 \times 1569.42857..}} = 0.7013375$	A1 A1 (4) M1 A1ft A1 (3)
(c)	(Pmcc shows positive correlation.) Older patients have higher blood pressure	B1 (1)
(d)	(d) Points plotted correctly on graph: -1 each error or omission (within one square of correct position)	B2
(f)	* see diagram below for correct points	
(f)	Line drawn with correct intercept, and gradient	B1ft B1 (2+2)
(e)	$b = \frac{2369}{1569.42857..} = 1.509466...$ $a = \frac{833}{7} - b \times \frac{341}{7} = 45.467413...$ $p = 45.5 + 1.51t$	M1 A1 M1 A1 (4)
(g)	$t = 40, p = 105.84...$ from equation or graph.	awrt 106 M1 A1 (2) Total [18]
Q6 (a)	M1 for at least one correct expression $1^{\text{st}}$ A1 for $S_{pp} = 7270$ , $2^{\text{nd}}$ A1 for $S_{tp} = 2369$ or $2370$ , $3^{\text{rd}}$ A1 for $S_{tt} =$ awrt 1570	
(b)	M1 for attempt at correct formula and at least one correct value (or correct ft) M0 for $\frac{42948}{\sqrt{106397 \times 18181}}$ A1ft All values correct or correct ft. Allow for an answer of 0.7 or 0.70 <u>Answer only:</u> awrt 0.701 is 3/3, answer of 0.7 or 0.70 is 2/3	
(c)	B1 for comment in context that <u>interprets</u> the fact that correlation is positive, as in scheme. Must mention age and blood pressure in words, not just “ $t$ ” and “ $p$ ”.	
(d)	Record 1 point incorrect as B1B0 on open. [NB overlay for (60, 135) is slightly wrong]	
(e)	$1^{\text{st}}$ M1 for use of the correct formula for $b$ , ft their values from (a) $1^{\text{st}}$ A1 allow 1.5 or better $2^{\text{nd}}$ M1 for use of $\bar{y} - b\bar{x}$ with their values $2^{\text{nd}}$ A1 for full equation with $a =$ awrt 45.5 and $b =$ awrt 1.51. Must be $p$ in terms of $t$ , not $x$ and $y$ .	
(f)	$1^{\text{st}}$ B1ft ft their intercept (within one square). You may have to extend their line. $2^{\text{nd}}$ B1 for correct gradient i.e. parallel to given line (Allow 1 square out when $t = 80$ )	
(g)	M1 for clear use of their equation with $t = 40$ or correct value from their graph. A1 for awrt 106. Correct answer only (2/2) otherwise look for evidence on graph to award M1	

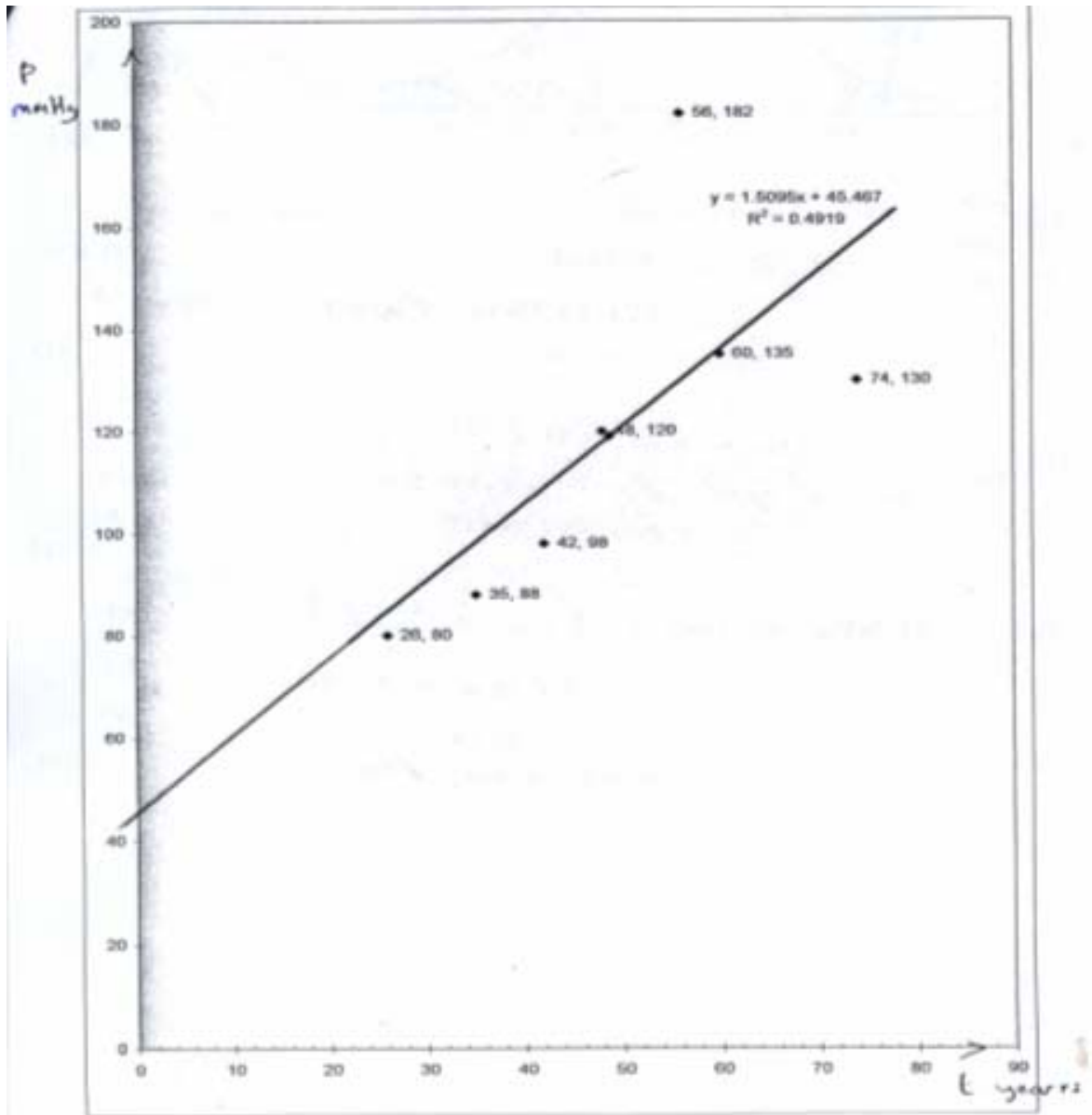


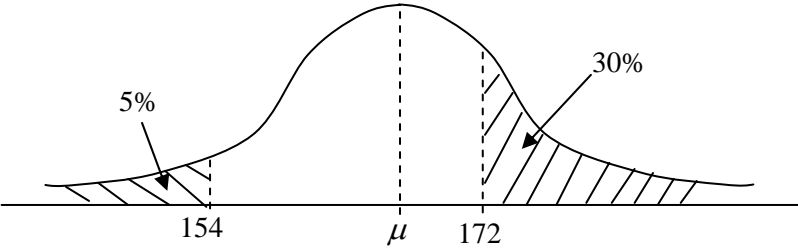
Question Number

Scheme

Diagram for Q6 (d) + (f)

Q6 (d)  
+  
(f)



Question Number	Scheme	Marks
Q7 (a)	 <p style="text-align: right;">bell shaped, must have inflexions 154,172 on axis 5% and 30%</p>	<p>B1 B1 B1 (3)</p>
(b)	$P(X < 154) = 0.05$ $\frac{154 - \mu}{\sigma} = -1.6449 \quad \text{or} \quad \frac{\mu - 154}{\sigma} = 1.6449$ $\mu = 154 + 1.6449\sigma \quad \text{**given**}$	<p>M1 B1 A1 cso (3)</p>
(c)	$172 - \mu = 0.5244\sigma \quad \text{or} \quad \frac{172 - \mu}{\sigma} = 0.5244$ <p style="text-align: right;">(allow <math>z = 0.52</math> or better here but must be in an equation)</p> <p>Solving gives <math>\sigma = 8.2976075</math> (<b>awrt 8.30</b>) and <math>\mu = 167.64873</math> (<b>awrt 168</b>)</p>	<p>B1 M1 A1 A1 (4)</p>
(d)	$P(\text{Taller than 160cm}) = P\left(Z > \frac{160 - \mu}{\sigma}\right)$ $= P(Z < 0.9217994)$ $= 0.8212$ <p style="text-align: right;"><b>awrt 0.82</b></p>	<p>M1 B1 A1 (3) <b>Total [13]</b></p>
(a)	<p>2<sup>nd</sup> B1 for 154 and 172 marked but 154 must be <math>&lt; \mu</math> and <math>172 &gt; \mu</math>. But <math>\mu</math> need not be marked. Allow for <math>\frac{154 - \mu}{\sigma}</math> and <math>\frac{172 - \mu}{\sigma}</math> marked on appropriate sides of the peak.</p> <p>3<sup>rd</sup> B1 the 5% and 30% should be clearly indicated in the correct regions i.e. LH tail and RH tail.</p>	
(b)	<p>M1 for <math>\pm \frac{(154 - \mu)}{\sigma} = z</math> value (<math>z</math> must be recognizable e.g. 1.64, 1.65, 1.96 but NOT 0.5199 etc)</p> <p>B1 for <math>\pm 1.6449</math> seen in a line before the final answer.</p> <p>A1cso for no incorrect statements (in <math>\mu</math>, <math>\sigma</math>) equating a <math>z</math> value and a probability or incorrect signs e.g. <math>\frac{154 - \mu}{\sigma} = 0.05</math> or <math>\frac{154 - \mu}{\sigma} = 1.6449</math> or <math>P(Z &lt; \frac{\mu - 154}{\sigma}) = 1.6449</math></p>	
(c)	<p>B1 for a correct 2<sup>nd</sup> equation (NB <math>172 - \mu = 0.525\sigma</math> is B0, since <math>z</math> is incorrect)</p> <p>M1 for solving their two linear equations leading to <math>\mu = \dots</math> or <math>\sigma = \dots</math></p> <p>1<sup>st</sup> A1 for <math>\sigma =</math> awrt 8.30, 2<sup>nd</sup> A1 for <math>\mu =</math> awrt 168 [NB the 168 can come from false working. These A marks require use of correct equation from (b), and a <math>z</math> value for “0.5244” in (c)] NB use of <math>z = 0.52</math> will typically get <math>\sigma = 8.31</math> and <math>\mu = 167.67\dots</math> and score B1M1A0A1 <u>No working</u> and both correct scores 4/4, only one correct scores 0/4 Provided the M1 is scored the A1s can be scored even with B0 (e.g. for <math>z = 0.525</math>)</p>	
(d)	<p>M1 for attempt to standardise with 160, their <math>\mu</math> and their <math>\sigma (&gt; 0)</math>. Even allow with symbols <math>\mu</math> and <math>\sigma</math>.</p> <p>B1 for <math>z =</math> awrt <math>\pm 0.92</math> <u>No working</u> and a correct answer can score 3/3 provided <math>\sigma</math> and <math>\mu</math> are correct to 2sf.</p>	



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