



National  
Qualifications  
2016

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# **2016 Statistics**

## **Advanced Higher**

### **Finalised Marking Instructions**

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## General Marking Principles for Advanced Higher Statistics

*This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this Paper. These principles must be read in conjunction with the detailed marking instructions, which identify the key features required in candidate responses.*

*For each question the marking instructions are generally in two sections, namely Illustrative Scheme and Generic Scheme. The Illustrative Scheme covers methods which are commonly seen throughout the marking. The Generic Scheme indicates the rationale for which each mark is awarded. In general, markers should use the Illustrative Scheme and only use the Generic Scheme where a candidate has used a method not covered in the Illustrative Scheme.*

- (a) Marks for each candidate response must always be assigned in line with these General Marking Principles and the Detailed Marking Instructions for this assessment.
- (b) Marking should always be positive. This means that, for each candidate response, marks are accumulated for the demonstration of relevant skills, knowledge and understanding: they are not deducted from a maximum on the basis of errors or omissions.
- (c) If a specific candidate response does not seem to be covered by either the principles or detailed Marking Instructions, and you are uncertain how to assess it, you must seek guidance from your Team Leader.
- (d) Credit must be assigned in accordance with the specific assessment guidelines.
- (e) One mark is available for each •. There are no half marks.
- (f) Working subsequent to an error must be **followed through**, with possible credit for the subsequent working, provided that the level of difficulty involved is approximately similar. Where, subsequent to an error, the working for a follow through mark has been eased, the follow through mark cannot be awarded.
- (g) As indicated on the front of the question paper, full credit should only be given where the solution contains appropriate working. Unless specifically mentioned in the marking instructions, a correct answer with no working receives no credit.
- (h) Candidates may use any mathematically correct method to answer questions except in cases where a particular method is specified or excluded.
- (i) As a consequence of an error perceived to be trivial, casual or insignificant, eg  $6 \times 6 = 12$  candidates lose the opportunity of gaining a mark. However, note the second example in comment (j).

- (j) Where a transcription error (paper to script or within script) occurs, the candidate should normally lose the opportunity to be awarded the next process mark, eg

This is a transcription error and so the mark is not awarded.	$x^2 + 5x + 7 = 9x + 4$
Eased as no longer a solution of a quadratic equation so mark is not awarded.	$x - 4x + 3 = 0$ $x = 1$
Exceptionally this error is not treated as a transcription error as the candidate deals with the intended quadratic equation. The candidate has been given the benefit of the doubt and all marks awarded.	$x^2 + 5x + 7 = 9x + 4$ $x - 4x + 3 = 0$ $(x-3)(x-1) = 0$ $x = 1 \text{ or } 3$

- (k) **Horizontal/vertical** **marking**

Where a question results in two pairs of solutions, this technique should be applied, but only if indicated in the detailed marking instructions for the question.

Example:

$$\begin{array}{cc} \bullet^5 & \bullet^6 \\ \bullet^5 x = 2 & x = -4 \\ \bullet^6 y = 5 & y = -7 \end{array}$$

Horizontal:  $\bullet^5 x = 2$  and  $x = -4$       Vertical:  $\bullet^5 x = 2$  and  $y = 5$   
 $\bullet^6 y = 5$  and  $y = -7$                        $\bullet^6 x = -4$  and  $y = -7$

Markers should choose whichever method benefits the candidate, but **not** a combination of both.

- (l) In final answers, unless specifically mentioned in the detailed marking instructions, numerical values should be simplified as far as possible, eg:

$$\begin{array}{ll} \frac{15}{12} \text{ must be simplified to } \frac{5}{4} \text{ or } 1\frac{1}{4} & \frac{43}{1} \text{ must be simplified to } 43 \\ \frac{15}{0.3} \text{ must be simplified to } 50 & \frac{4/5}{3} \text{ must be simplified to } \frac{4}{15} \\ \sqrt{64} \text{ must be simplified to } 8^* & \end{array}$$

\*The square root of perfect squares up to and including 100 must be known.

- (m) Commonly Observed Responses (COR) are shown in the marking instructions to help mark common and/or non-routine solutions. CORs may also be used as a guide when marking similar non-routine candidate responses.

(n) Unless specifically mentioned in the marking instructions, the following should not be penalised:

- Working subsequent to a correct answer
- Correct working in the wrong part of a question
- Legitimate variations in numerical answers/algebraic expressions, eg angles in degrees rounded to nearest degree
- Omission of units
- Bad form (bad form only becomes bad form if subsequent working is correct), eg  $(x^3 + 2x^2 + 3x + 2)(2x + 1)$  written as  $(x^3 + 2x^2 + 3x + 2) \times 2x + 1$

$2x^4 + 4x^3 + 6x^2 + 4x + x^3 + 2x^2 + 3x + 2$  written as  $2x^4 + 5x^3 + 8x^2 + 7x + 2$  gains full credit

- Repeated error within a question, but not between questions or papers
- (o) In any 'Show that...' question, where the candidate has to arrive at a required result, the last mark of that part is not available as a follow-through from a previous error unless specified in the detailed marking instructions.
- (p) All working should be carefully checked, even where a fundamental misunderstanding is apparent early in the candidate's response. Marks may still be available later in the question so reference must be made continually to the marking instructions. The appearance of the correct answer does not necessarily indicate that the candidate has gained all the available marks.
- (q) Scored-out working which has not been replaced should be marked where still legible. However, if the scored out working has been replaced, only the work which has not been scored out should be marked.
- (r) Where a candidate has made multiple attempts using the same strategy and not identified their final answer, mark all attempts and award the lowest mark.

For example:

Strategy 1 attempt 1 is worth 3 marks.	Strategy 2 attempt 1 is worth 1 mark.
Strategy 1 attempt 2 is worth 4 marks.	Strategy 2 attempt 2 is worth 5 marks.
From the attempts using strategy 1, the resultant mark would be 3.	From the attempts using strategy 2, the resultant mark would be 1.

In this case, award 3 marks.

Detailed Marking Instructions for each question

Question		Generic Scheme	Illustrative Scheme	Max Mark
1	(a)	<ul style="list-style-type: none"> <li>•<sup>1</sup> appropriate diagram</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> dotplot, stem-and-leaf or boxplot</li> </ul>	1
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				
	(b)	<ul style="list-style-type: none"> <li>•<sup>2</sup> correct quartiles</li> <li>•<sup>3</sup> calculate upper fence</li> <li>•<sup>4</sup> appropriate comment</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>2</sup> 16.5 and 27.5</li> <li>•<sup>3</sup> <math>27.5 + 1.5 \times 11 = 44</math></li> <li>•<sup>4</sup> 48 is an outlier</li> </ul>	3
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				
2	(a)	<ul style="list-style-type: none"> <li>•<sup>1</sup> appropriate comment</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> eg surgeons may not be sampled in the same proportions as operations performed</li> </ul>	1
<b>Notes:</b>				
1. another valid comment is that some surgeons may not be represented at all				
<b>Commonly Observed Responses:</b>				
	(b)	<ul style="list-style-type: none"> <li>•<sup>2</sup> appropriate strategy</li> <li>•<sup>3</sup> correct sampling method</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>2</sup> determine the proportion of operations performed by each surgeon and sample the 100 patients in the same proportion</li> <li>•<sup>3</sup> stratified sampling</li> </ul>	2
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				
	(c)	<ul style="list-style-type: none"> <li>•<sup>4</sup> appropriate comment</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>4</sup> eg waiting time for the operation, recovery time after the operation, quality of hospital care</li> </ul>	1
<b>Notes:</b>				
1. other appropriate comments are acceptable				
<b>Commonly Observed Responses:</b>				

Question		Generic Scheme	Illustrative Scheme	Max Mark	
3	(a)	<ul style="list-style-type: none"> <li>•<sup>1</sup> correct test statistic</li> <li>•<sup>2</sup> correct value of <math>t</math></li> <li>•<sup>3</sup> appropriate critical value and inequality</li> <li>•<sup>4</sup> appropriate conclusion</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> <math>t = \frac{\bar{x} - \mu}{s/\sqrt{n}}</math></li> <li>•<sup>2</sup> <math>= \frac{147.8 - 150}{2.379/\sqrt{12}} = -3.203</math></li> <li>•<sup>3</sup> 1% cv is <math>t_{11,0.99} = -2.718 &gt; -3.203</math></li> <li>•<sup>4</sup> furnishing strong evidence that the population mean content weight is less than 150 g</li> </ul>	4	
<b>Notes:</b> 1. a formal test is not required and so neither are formal hypotheses 2. the alternative (and acceptable) $p$ -value approach (hereafter the PvA) would record that $P(t_{11} < -3.203) = 0.0042 < 0.01$ etc 3. constructing an appropriate confidence interval would also be acceptable					
<b>Commonly Observed Responses:</b>					
	(b)	• <sup>5</sup> appropriate comment	• <sup>5</sup> the population variance is unknown	1	
<b>Notes:</b>					
<b>Commonly Observed Responses:</b>					
4	(a)	(i)	• <sup>1</sup> appropriate comment	• <sup>1</sup> distribution is skewed	1
		(ii)	• <sup>2</sup> correct statistics	• <sup>2</sup> $\bar{x} = 7.1$ and $s = 2.43$	1
<b>Notes:</b>					
<b>Commonly Observed Responses:</b>					
	(b)	<ul style="list-style-type: none"> <li>•<sup>3</sup> appropriate strategy</li> <li>•<sup>4</sup> calculate parameters</li> <li>•<sup>5</sup> calculate <math>z</math></li> <li>•<sup>6</sup> calculate probability</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>3</sup> <math>\bar{X} \approx N</math></li> <li>•<sup>4</sup> <math>\left( 7.1, \frac{5.893}{20} \right)</math></li> <li>•<sup>5</sup> <math>z = \frac{8.1 - 7.1}{\sqrt{\frac{5.893}{20}}} = 1.84</math></li> <li>•<sup>6</sup> <math>p = 0.0329</math></li> </ul>	4	
<b>Notes:</b> 1. it is a requirement to record that normality is approximate					
<b>Commonly Observed Responses:</b>					

Question			Generic Scheme	Illustrative Scheme	Max Marks
5	(a)	(i)	<ul style="list-style-type: none"> <li>•<sup>1</sup> appropriate strategy</li> <li>•<sup>2</sup> correct <math>\bar{x}</math> and <math>s</math></li> <li>•<sup>3</sup> correct <math>t</math></li> <li>•<sup>4</sup> calculate interval</li> <li>•<sup>5</sup> appropriate assumption</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> <math>\mu = \bar{x} \pm t_{v, 1-\alpha/2} \frac{s}{\sqrt{n}}</math></li> <li>•<sup>2</sup> <math>\bar{x} = 4.9</math> and <math>s = 0.462</math></li> <li>•<sup>3</sup> <math>t_{8, 0.95} = 1.86</math></li> <li>•<sup>4</sup> (4.61, 5.19)</li> <li>•<sup>5</sup> the yield of tomatoes is normally distributed</li> </ul>	5
<b>Notes:</b> 1. another valid assumption is that the plants are chosen at random					
<b>Commonly Observed Responses:</b>					
		(ii)	<ul style="list-style-type: none"> <li>•<sup>6</sup> interpret <math>t</math> interval</li> <li>•<sup>7</sup> appropriate comment</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>6</sup> 4.75 lies within calculated interval</li> <li>•<sup>7</sup> so no evidence, at the 10% level of significance, that the mean yield has changed, by watering plants once a week</li> </ul>	2
<b>Notes:</b>					
<b>Commonly Observed Responses:</b>					
	(b)		<ul style="list-style-type: none"> <li>•<sup>8</sup> appropriate comment</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>8</sup> eg temperature, soil type, application of fertiliser, hours of sunshine</li> </ul>	1
<b>Notes:</b>					
<b>Commonly Observed Responses:</b>					

Question		Generic Scheme	Illustrative Scheme	Max Mark
6	(a)	<ul style="list-style-type: none"> <li>•<sup>1</sup> identify correct WECO rule</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> 8 consecutive points lie above the centre line</li> </ul>	1
<b>Notes:</b>				
1. reference to a WECO rule should be made				
<b>Commonly Observed Responses:</b>				
	(b)	<ul style="list-style-type: none"> <li>•<sup>2</sup> use binomial distribution</li> <li>•<sup>3</sup> appropriate strategy</li> <li>•<sup>4</sup> calculate probability</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>2</sup> <math>X \sim B\left(14, \frac{1}{2}\right)</math></li> <li>•<sup>3</sup> <math>2 P(X = 12)</math></li> <li>•<sup>4</sup> 0.0111</li> </ul>	3
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				
	(c)	<ul style="list-style-type: none"> <li>•<sup>5</sup> correct months</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>5</sup> 14 and 15</li> </ul>	1
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				
	(d)	<ul style="list-style-type: none"> <li>•<sup>6,7</sup> appropriate strategy</li> <li>•<sup>8</sup> appropriate simplification</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>6,7</sup> <math display="block">0.04 = 0.025 + 3\sqrt{\frac{0.025 \times 0.975}{n}}</math> </li> <li>•<sup>8</sup> <math>n = \frac{9 \times 0.025 \times 0.975}{0.015^2} = 975</math></li> </ul>	3
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				
	(e)	<ul style="list-style-type: none"> <li>•<sup>9</sup> appropriate values</li> <li>•<sup>10</sup> appropriate comment</li> <li>•<sup>11</sup> correct strategy</li> <li>•<sup>12</sup> calculate percentage</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>9</sup> <math>np = 24.375</math> and <math>nq = 950.625</math></li> <li>•<sup>10</sup> since both <math>np</math> and <math>nq &gt; 5</math> it might be appropriate to use a normal approximation to the binomial distribution</li> <li>•<sup>11</sup> <math>p(Z &gt; 1) =</math></li> <li>•<sup>12</sup> 16%</li> </ul>	4
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				



Question		Generic Scheme	Illustrative Scheme	Max Mark
7	(a)	<ul style="list-style-type: none"> <li>•<sup>1</sup> correct probability</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> <math>\frac{1}{3}</math></li> </ul>	1
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				
	(b)	<ul style="list-style-type: none"> <li>•<sup>2</sup> correct probabilities</li> <li>•<sup>3</sup> calculate probability</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>2</sup> <math>\frac{50}{150} \times \frac{49}{149} \times \frac{48}{148}</math></li> <li>•<sup>3</sup> 0.0356</li> </ul>	2
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				
	(c) (i)	<ul style="list-style-type: none"> <li>•<sup>4</sup> appropriate strategy</li> <li>•<sup>5</sup> continue strategy</li> <li>•<sup>6</sup> complete strategy</li> <li>•<sup>7</sup> calculate probability</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>4</sup> eg create tree diagram</li> <li>•<sup>5</sup> annotate clearly</li> </ul> <ul style="list-style-type: none"> <li>•<sup>6</sup> <math>\frac{1}{3} \cdot 0.94 + \frac{2}{3} \cdot 0.07 =</math></li> <li>•<sup>7</sup> = 0.36</li> </ul>	4
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				
	(ii)	<ul style="list-style-type: none"> <li>•<sup>8</sup> appropriate strategy</li> <li>•<sup>9</sup> substitute probabilities</li> <li>•<sup>10</sup> calculate probability</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>8</sup> <math>P(V +) = \frac{P(V \cap +)}{P(+)}</math></li> <li>•<sup>9</sup> <math>= \frac{0.94/3}{0.36}</math></li> <li>•<sup>10</sup> = 0.8704</li> </ul>	3
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				

Question		Generic Scheme	Illustrative Scheme	Max Mark
8	(a)	<ul style="list-style-type: none"> <li>•<sup>1</sup> appropriate hypotheses</li> <li>•<sup>2</sup> correct test statistic</li> <li>•<sup>3</sup> correct <math>p</math></li> <li>•<sup>4</sup> calculate <math>z</math></li> <li>•<sup>5</sup> correct critical value</li> <li>•<sup>6</sup> deal with <math>H_0</math></li> <li>•<sup>7</sup> appropriate conclusion</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> <math>H_0: p_d = p_c \quad H_1: p_d &gt; p_c</math></li> <li>•<sup>2</sup> <math>Z = \frac{P_d - P_c}{\sqrt{pq \left( \frac{1}{n_d} + \frac{1}{n_c} \right)}}</math></li> <li>•<sup>3</sup> <math>p = \frac{75 + 65}{200} = 0.7</math></li> <li>•<sup>4</sup> <math>z = \frac{0.75 - 0.65}{\sqrt{0.7 \cdot 0.3 \left( \frac{1}{100} + \frac{1}{100} \right)}} = 1.54</math></li> <li>•<sup>5</sup> the 5% cv is 1.64</li> <li>•<sup>6</sup> <math>1.54 &lt; 1.64</math> so we cannot reject <math>H_0</math> at the 5% level of significance</li> <li>•<sup>7</sup> and conclude that there is no evidence that the new drug is effective</li> </ul>	7
<b>Notes:</b> 1. the PvA would record that $P(Z > 1.54) = 0.0614 > 0.05$ etc				
<b>Commonly Observed Responses:</b>				
	(b)	<ul style="list-style-type: none"> <li>•<sup>8</sup> appropriate comment</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>8</sup> the new drug may have reduced the recovery rate</li> </ul>	1
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				

Question		Generic Scheme	Illustrative Scheme	Max Marks
9	(a)	<ul style="list-style-type: none"> <li>•<sup>1</sup> appropriate assumption</li> <li>•<sup>2</sup> appropriate assumption</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> the sporting injuries are all random/independent of each other.</li> <li>•<sup>2</sup> the injuries occur at a constant mean rate of 4 per week.</li> </ul>	2
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				
	(b)	<ul style="list-style-type: none"> <li>•<sup>3</sup> correct standard deviation</li> <li>•<sup>4</sup> appropriate probability</li> <li>•<sup>5</sup> calculate probability</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>3</sup> <math>\sqrt{4} = 2</math></li> <li>•<sup>4</sup> <math>P(X &gt; 8) =</math></li> <li>•<sup>5</sup> 0.0214</li> </ul>	3
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				
	(c)	<ul style="list-style-type: none"> <li>•<sup>6</sup> correct strategy</li> <li>•<sup>7</sup> correct approximation</li> <li>•<sup>8</sup> correct strategy</li> <li>•<sup>9</sup> continuity correction</li> <li>•<sup>10</sup> calculate probability</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>6</sup> <math>Y \sim \text{Po}(152)</math></li> <li>•<sup>7</sup> <math>Y \approx N(152, 152)</math></li> <li>•<sup>8 &amp; 9</sup> <math>P(Y &lt; 140) = P\left(Z &lt; \frac{139.5 - 152}{\sqrt{152}}\right)</math></li> <li>•<sup>10</sup> 0.1562</li> </ul>	5
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				
	(d)	<ul style="list-style-type: none"> <li>•<sup>11</sup> appropriate comment</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>11</sup> team sports may result in injuries which are not independent.</li> </ul>	1
<b>Notes:</b>				
1. another valid comment would record the fact that most contact sports do not take place throughout the year				
<b>Commonly Observed Responses:</b>				

Question		Generic Scheme	Illustrative Scheme	Max Mark						
10	(a)	<ul style="list-style-type: none"> <li>•<sup>1</sup> appropriate strategy</li> <li>•<sup>2</sup> correct probability</li> <li>•<sup>3</sup> tabulate pd</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> <math>1p + 2(1-p) = \frac{7}{4}</math></li> <li>•<sup>2</sup> <math>p = \frac{1}{4}</math></li> <li>•<sup>3</sup> <table border="1" style="margin-left: 20px;"> <tr> <td><math>x</math></td> <td>1</td> <td>2</td> </tr> <tr> <td><math>p(x)</math></td> <td>1/4</td> <td>3/4</td> </tr> </table> </li> </ul>	$x$	1	2	$p(x)$	1/4	3/4	3
$x$	1	2								
$p(x)$	1/4	3/4								
<b>Notes:</b>										
<b>Commonly Observed Responses:</b>										
	(b)	<ul style="list-style-type: none"> <li>•<sup>4</sup> correct <math>E(Y)</math></li> <li>•<sup>5</sup> calculate <math>V(Y)</math></li> </ul>	<ul style="list-style-type: none"> <li>•<sup>4</sup> <math>\frac{8}{5}(1.6)</math></li> <li>•<sup>5</sup> <math>\frac{6}{25}(0.24)</math></li> </ul>	2						
<b>Notes:</b>										
<b>Commonly Observed Responses:</b>										
	(c)	<ul style="list-style-type: none"> <li>•<sup>6</sup> calculate <math>E(Z)</math></li> <li>•<sup>7</sup> correct strategy</li> <li>•<sup>8</sup> calculate <math>V(Z)</math></li> </ul>	<ul style="list-style-type: none"> <li>•<sup>6</sup> <math>\frac{73}{20}(3.65)</math></li> <li>•<sup>7</sup> <math>3^2 V(X) + V(Y)</math></li> <li>•<sup>8</sup> <math>= \frac{771}{400}(1.9275)</math></li> </ul>	3						
<b>Notes:</b>										
<b>Commonly Observed Responses:</b>										

Question		Generic Scheme	Illustrative Scheme	Max Marks
11	(a)	<ul style="list-style-type: none"> <li>•<sup>1</sup> appropriate hypotheses</li> <li>•<sup>2</sup> correct statistics</li> <li>•<sup>3</sup> correct test statistic</li> <li>•<sup>4</sup> calculate <math>t</math></li> <li>•<sup>5</sup> correct critical value</li> <li>•<sup>6</sup> deal with <math>H_0</math></li> <li>•<sup>7</sup> appropriate conclusion</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> <math>H_0: \mu_d = 0 \quad H_1: \mu_d &gt; 0</math></li> <li>•<sup>2</sup> <math>\bar{x}_d = 1.175</math> and <math>s_d = 4.272</math></li> <li>•<sup>3</sup> <math>t_{n-1} = \frac{\bar{x}_d \sqrt{n}}{s_d}</math></li> <li>•<sup>4</sup> <math>= \frac{1.175\sqrt{12}}{4.272} = 0.9528</math></li> <li>•<sup>5</sup> 5% cv is <math>t_{11,0.950} = 1.796</math></li> <li>•<sup>6</sup> <math>0.9528 &lt; 1.796</math> so we cannot reject <math>H_0</math> at the 5% significance level</li> <li>•<sup>7</sup> and conclude that there is no evidence to support Darwin</li> </ul>	7
<b>Notes:</b> 1. the PvA would record that $P(t_{11} > 0.9528) = 0.1806 > 0.05$ etc 2. a maximum of 5 marks is available for performing the wrong test and the use of a non-parametric test or a test for independent samples receives little credit				
<b>Commonly Observed Responses:</b>				
	(b)	<ul style="list-style-type: none"> <li>•<sup>8</sup> appropriate test</li> <li>•<sup>9</sup> appropriate assumption</li> <li>•<sup>10</sup> deal with the zero difference</li> <li>•<sup>11</sup> correct statistics</li> <li>•<sup>12</sup> correct critical value</li> <li>•<sup>13</sup> appropriate conclusion</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>8</sup> Wilcoxon signed-rank test</li> <li>•<sup>9</sup> assumes that the distribution of height differences is symmetrical</li> <li>•<sup>10</sup> discard the zero difference</li> <li>•<sup>11</sup> <math>n = 11, W_- = 20, W_+ = 46</math></li> <li>•<sup>12</sup> 5% cv is 13</li> <li>•<sup>13</sup> same conclusion - no evidence to support Darwin</li> </ul>	6
<b>Notes:</b> 1. for • <sup>11</sup> the only requirement is $W_- = 20$ 2. the use of a parametric test or a test for independent samples receives little credit				
<b>Commonly Observed Responses:</b>				
	(c)	<ul style="list-style-type: none"> <li>•<sup>14</sup> appropriate comment</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>14</sup> the pairing of data helps to reduce the effect of other variables, apart from method of pollination</li> </ul>	1
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				

Question		Generic Scheme	Illustrative Scheme	Max Marks
12	(a)	<ul style="list-style-type: none"> <li>•<sup>1</sup> appropriate comment</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> there appears to be a weak linear association between attractiveness and performance</li> </ul>	1
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				
	(b)	<ul style="list-style-type: none"> <li>•<sup>2</sup> correct strategy</li> <li>•<sup>3</sup> correct <math>r</math></li> <li>•<sup>4</sup> appropriate comment</li> <li>•<sup>5</sup> appropriate comment</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>2</sup> <math>r = \frac{S_{xy}}{\sqrt{S_{xx}S_{yy}}}</math></li> <li>•<sup>3</sup> <math>= 0.4001</math></li> <li>•<sup>4</sup> measuring the strength of the linear association between <math>x</math> and <math>y</math></li> <li>•<sup>5</sup> the association is weak</li> </ul>	4
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				
	(c)	<ul style="list-style-type: none"> <li>•<sup>6</sup> correct <math>t</math></li> <li>•<sup>7</sup> appropriate explanation</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>6</sup> <math>t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} = 3.6</math></li> <li>•<sup>7</sup> 5% cv is <math>t_{68,0.975} = 1.96 &lt; 3.6</math> so there is evidence that the pmcc is significantly different from 0</li> </ul>	2
<b>Notes:</b>				
1. the PvA would record that $2P(t_{68} > 3.6) = 0.0006 < 0.05$ etc				
<b>Commonly Observed Responses:</b>				
	(d)	<ul style="list-style-type: none"> <li>•<sup>8</sup> appropriate comment</li> <li>•<sup>9</sup> appropriate conclusion</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>8</sup> with a large enough sample even a weak correlation may be significant</li> <li>•<sup>9</sup> the association between attractiveness and performance is weak, but statistically significant</li> </ul>	2
<b>Notes:</b>				
<b>Commonly Observed Responses:</b>				
	(e)	<ul style="list-style-type: none"> <li>•<sup>10</sup> appropriate reason</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>10</sup> low correlation means a linear relationship is questionable so a linear regression model would have a poor fit</li> </ul>	1
<b>Notes:</b>				
1. another valid reason would be concerned with the fact that predictability would be unreliable due to the low pmcc				
<b>Commonly Observed Responses:</b>				

[END OF MARKING INSTRUCTIONS]