



# General Certificate of Education

## Statistics 6380

*SS06 Statistics 6*

## Mark Scheme

*2006 examination – June series*

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

## Key To Mark Scheme And Abbreviations Used In Marking

|              |                                                                    |     |                            |
|--------------|--------------------------------------------------------------------|-----|----------------------------|
| M            | mark is for method                                                 |     |                            |
| m or dM      | mark is dependent on one or more M marks and is for method         |     |                            |
| A            | mark is dependent on M or m marks and is for accuracy              |     |                            |
| B            | mark is independent of M or m marks and is for method and accuracy |     |                            |
| E            | mark is for explanation                                            |     |                            |
| ✓ or ft or F | follow through from previous incorrect result                      | MC  | mis-copy                   |
| CAO          | correct answer only                                                | MR  | mis-read                   |
| CSO          | correct solution only                                              | RA  | required accuracy          |
| AWFW         | anything which falls within                                        | FW  | further work               |
| AWRT         | anything which rounds to                                           | ISW | ignore subsequent work     |
| ACF          | any correct form                                                   | FIW | from incorrect work        |
| AG           | answer given                                                       | BOD | given benefit of doubt     |
| SC           | special case                                                       | WR  | work replaced by candidate |
| OE           | or equivalent                                                      | FB  | formulae book              |
| A2,1         | 2 or 1 (or 0) accuracy marks                                       | NOS | not on scheme              |
| -x EE        | deduct x marks for each error                                      | G   | graph                      |
| NMS          | no method shown                                                    | c   | candidate                  |
| PI           | possibly implied                                                   | sf  | significant figure(s)      |
| SCA          | substantially correct approach                                     | dp  | decimal place(s)           |

### No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded. However, there are situations in some units where part marks would be appropriate, particularly when similar techniques are involved. Your Principal Examiner will alert you to these and details will be provided on the mark scheme.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

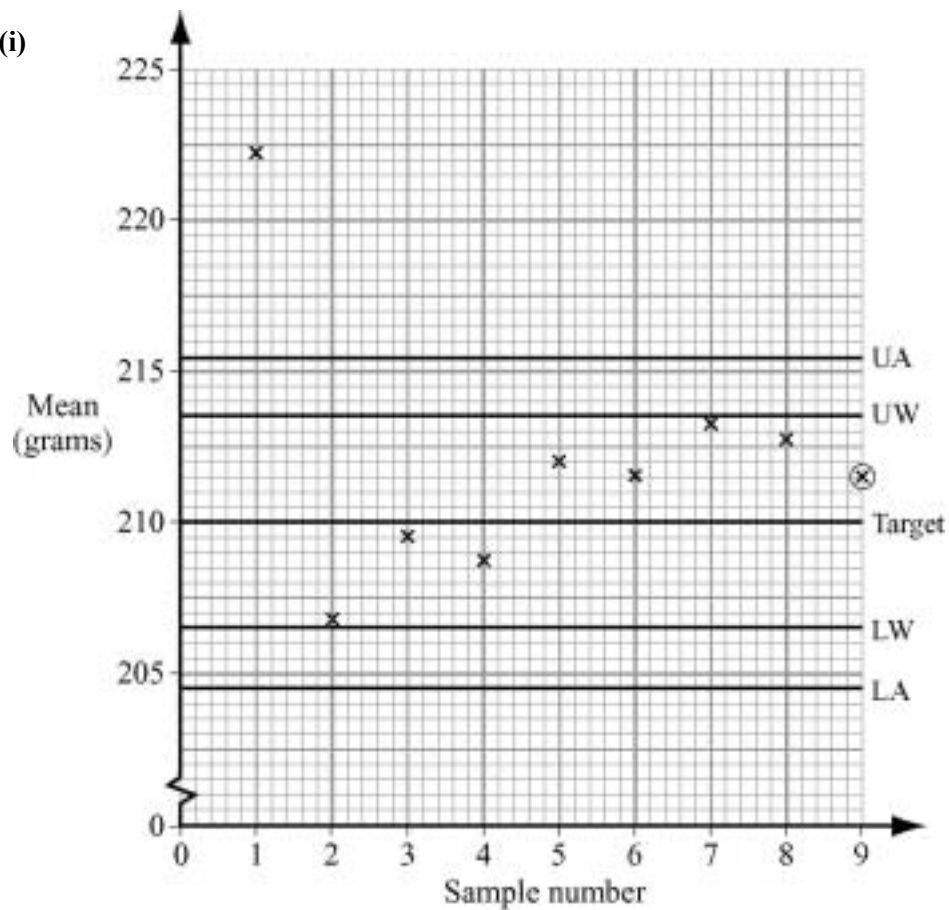
Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

**Otherwise we require evidence of a correct method for any marks to be awarded.**

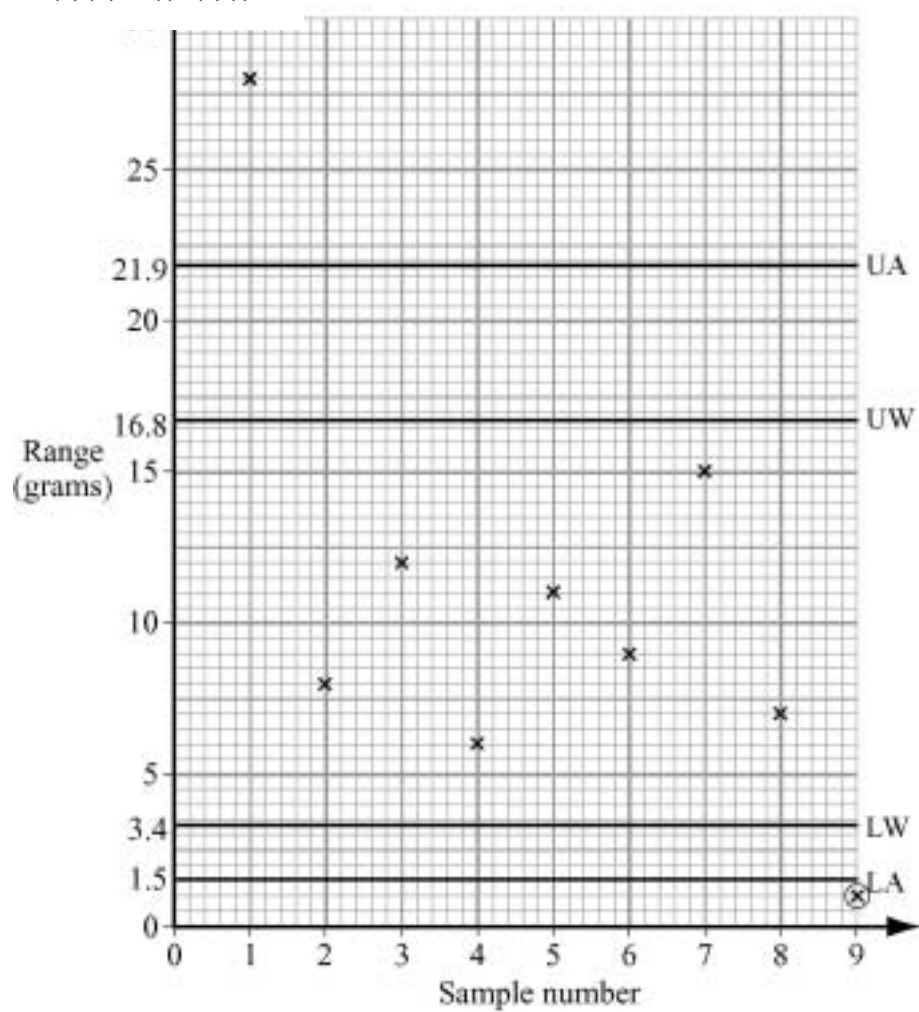
## SS06

| Q              | Solution                                                                                                                                                                                                                                                          | Marks                | Total    | Comments                                                                                                                                                                                    |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1(a)(i)</b> | Group treated with new ointment                                                                                                                                                                                                                                   | B1                   |          | CAO                                                                                                                                                                                         |
| <b>(ii)</b>    | Group treated with well established ointment                                                                                                                                                                                                                      | B1                   | 2        | CAO                                                                                                                                                                                         |
| <b>(b)</b>     | Neither patient nor medical staff administering the ointment know which is new and which is well established ointment. This is to ensure that any differences observed are due to the ointments and not due to expectations that the new ointment will be better. | E1                   |          | patients don't know                                                                                                                                                                         |
|                |                                                                                                                                                                                                                                                                   | E1                   |          | administrators of treatment don't know                                                                                                                                                      |
|                |                                                                                                                                                                                                                                                                   | E1                   | 3        | to ensure differences are due to ointments - allow to eliminate bias                                                                                                                        |
|                | <b>Total</b>                                                                                                                                                                                                                                                      |                      | <b>5</b> |                                                                                                                                                                                             |
| <b>2(a)(i)</b> | Chart for means<br>Warning limits $210 \pm 1.96 \times 4/\sqrt{5}$<br>$210 \pm 3.51$<br>$206.5 \sim 213.5$<br>Action limits $210 \pm 3.09 \times 4/\sqrt{5}$<br>$210 \pm 5.53$<br>$204.5 \sim 215.5$<br>+ limits on chart                                         | B1<br>M1<br>m1<br>A1 |          | 1.96 (1.96~2) and 3.09 (3~3.1)<br>use of their $z \times 4/\sqrt{5}$<br>method - their z - for all limits<br>206.5 (206~207),<br>213.5 (213 ~214)<br>204.5 (204~205) and<br>215.5 (215~216) |
|                |                                                                                                                                                                                                                                                                   | B1                   | 5        | limits correctly plotted<br>- disallow 206,214 etc<br>allow omission of target line                                                                                                         |
| <b>(ii)</b>    | Chart for ranges<br>Lower Action $0.367 \times 4 = 1.5$<br>Lower Warning $0.850 \times 4 = 3.4$<br>Upper Warning $4.197 \times 4 = 16.8$<br>Upper Action $5.484 \times 4 = 21.9$<br>+ limits on chart                                                             | B1<br>M1             |          | 4.197 (or 4.20), and 5.484<br>(or 5.48)<br>their factors $\times 4$ - allow wrong<br>sample size, use of E and/or<br>upper limits only                                                      |
|                |                                                                                                                                                                                                                                                                   | A1                   |          | all four limits $\pm 0.1$                                                                                                                                                                   |
| <b>(b)(i)</b>  | on graph                                                                                                                                                                                                                                                          | B1                   | 4        | limits correctly plotted                                                                                                                                                                    |
|                |                                                                                                                                                                                                                                                                   | B1                   | 2        | means correct - by eye<br>ranges correct - by eye                                                                                                                                           |
| <b>(ii)</b>    | First sample out of control on both mean and range chart.                                                                                                                                                                                                         | E1✓                  |          | first sample outside action limits                                                                                                                                                          |
|                | Action appears to have been taken successfully as all other points within warning limits.                                                                                                                                                                         | E1                   |          | other points within warning limits                                                                                                                                                          |
|                | Mean appears to be drifting upwards                                                                                                                                                                                                                               | E1                   | 3        | mean appears to be increasing                                                                                                                                                               |

2(a)(i), b(i), (c)(i)



2(a)(ii), b(i), (c)(i)

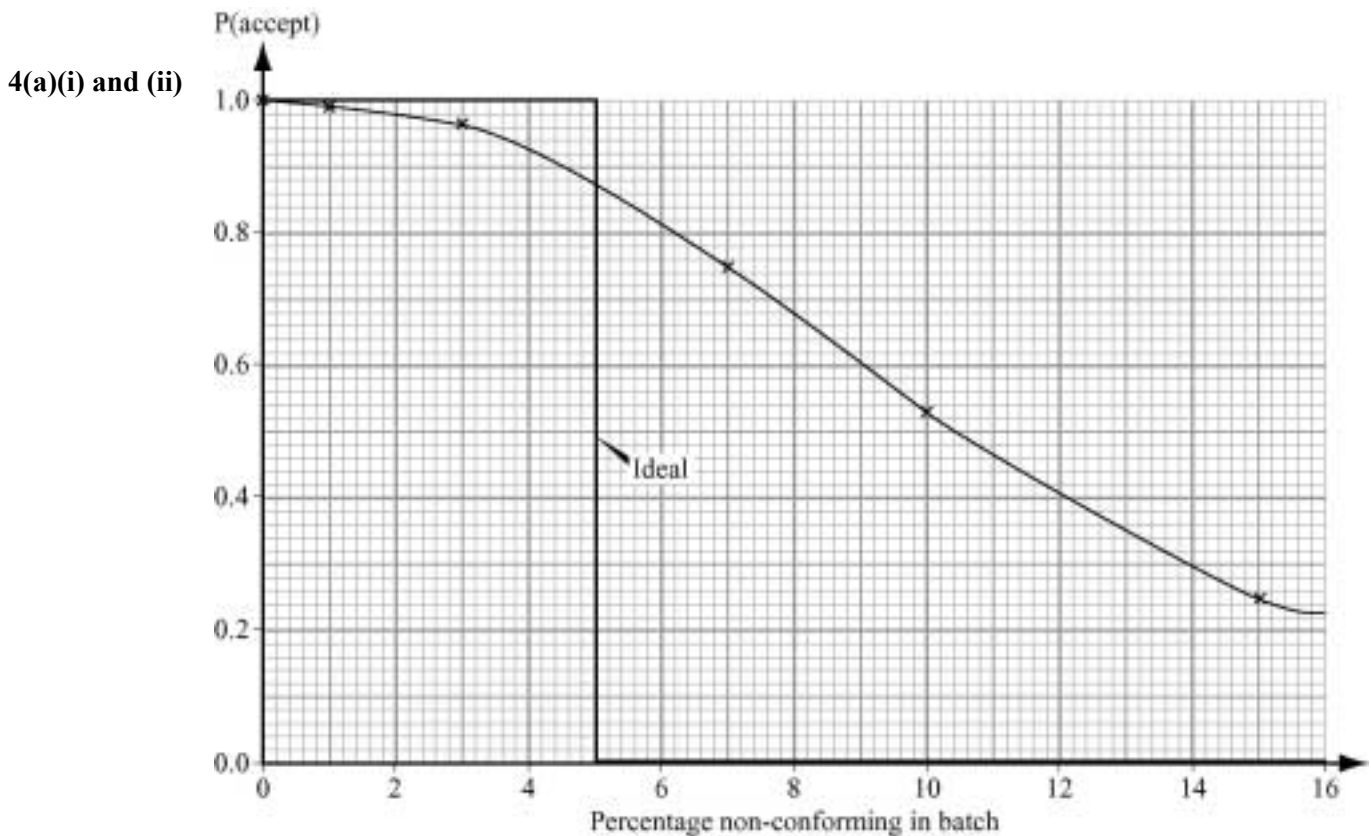


## SS06 (cont)

| Q              | Solution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Marks                                                                          | Total     | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>2(c)(i)</b> | mean 211.6<br>range 1<br>+ points on graph                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | M1<br>M1<br>A1                                                                 | 3         | method for calc and plot mean<br>method for calc and plot range<br>both points correct                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>(ii)</b>    | Mean between warning limits, range below lower action limit. No action/ investigate apparent improvement in order to maintain/ check readings are correct                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | E1√<br><br>E1                                                                  | 2         | recommended action consistent with their points and limits<br><br>correct action based on correct points and limits                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                | <b>19</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>3(a)</b>    | <p><math>H_0: \mu_{\text{diff}} = 0</math><br/><math>H_1: \mu_{\text{diff}} &gt; 0</math></p> <p>Pair    1    2    3    4    5    6<br/>B - A   7   35   9 -12 12 22</p> <p><math>\bar{x} = 12.167</math>    <math>s = 15.741</math></p> <p><math>t = (12.167 - 0)/(15.741/\sqrt{6}) = 1.89</math></p> <p>cv <math>t_5</math> is 1.476<br/>reject <math>H_0</math>: significant evidence that older girls score more points on average.</p> <p><b>Alternative</b><br/>s.c. confidence interval<br/><math>12.167 \pm 1.476 \times 15.741/\sqrt{6}</math><br/><math>2.68 \sim 21.65</math><br/><math>2.68 &gt; 0</math></p> <p>s.c critical value<br/><math>1.476 \times 15.741/\sqrt{6} = 9.49</math><br/><math>9.49 &lt; 12.167</math></p> <p>s.c unpaired t used<br/>allow maximum<br/>B1 M0M0m0A0 B1B1 A0A0</p> <p>s.c. all differences same sign<br/>allow maximum<br/>B1 M0M1m0A0B1B1A1A1√</p> | <p>B1</p> <p>M1</p> <p>M1<br/>m1</p> <p>A1<br/>B1<br/>B1<br/>A1</p> <p>A1√</p> | 9         | <p>both hypotheses - must use <math>\mu</math> or population - allow <math>\mu_A = \mu_B</math> <math>H_1</math>: must be consistent with differences<br/>method for differences</p> <p>use of their s.d./√6<br/>method for <math>t</math> - ignore sign</p> <p>1.89 ( 1.89 to 1.9) or – 1.89 if A-B used 5df<br/>1.476 or 1.48 - ignore sign<br/>reject <math>H_0</math> - must be compared with correct tail of <math>t</math><br/>conclusion in context - requires previous A1</p> <p>2.68 (2.65 to 2.7)</p> <p>9.49 (9.48 to 9.5)</p> <p>B1 hypotheses<br/>B1 10df<br/>B1 1.372 or 1.37</p> |

## SS06 (cont)

| Q       | Solution                                                                                                             | Marks          | Total     | Comments                                                                                                      |
|---------|----------------------------------------------------------------------------------------------------------------------|----------------|-----------|---------------------------------------------------------------------------------------------------------------|
| 3(b)    | Differences may be regarded as a random sample from the population and are normally distributed                      | E1             | 2         | random                                                                                                        |
| (c)     | Boys would introduce an additional source of experimental error and make any effect of age more difficult to detect. | E1             |           | normal                                                                                                        |
| (d)(i)  | rankings also unreliable - Wilcoxon signed-rank test unsuitable.                                                     | E1             | 1         | explanation                                                                                                   |
|         |                                                                                                                      | E1             |           | rankings unreliable                                                                                           |
| (ii)    | sign test valid but unlikely to detect a difference with such a small sample.                                        | E1             | 3         | Wilcoxon unsuitable                                                                                           |
|         |                                                                                                                      | E1             |           | sign test valid                                                                                               |
|         |                                                                                                                      |                |           | sample too small for sign test to be effective.                                                               |
|         |                                                                                                                      |                |           | maximum 3                                                                                                     |
|         |                                                                                                                      |                | <b>15</b> |                                                                                                               |
| 4(a)(i) | % non-conf 1 3 5 7 10 15<br>P(Accept) 0.998 0.962 0.873 0.747 0.537 0.254                                            | B1<br>M1<br>A1 | 3         | Use of Binomial $n = 25$<br>method for P(Accept) at least two points<br>all correct 3dp -allow one small slip |
| (ii)    | on graph below                                                                                                       | M1<br>A1       |           | points plotted<br>accurate plot - points joined - passes through (0,1)                                        |
| (iii)   | on graph below                                                                                                       | M1<br>A1       | 2         | shape of ideal OC<br>accurate plot - line above 5% not necessarily visible                                    |



## SS06 (cont)

| Q              | Solution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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| 4(b)           | % non-conforming      3      15<br>P(Accept)      0.983      0.112                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | B1        | 1         | 0.983 ( 0.9825 to 0.9835) and 0.112 (0.1115 to 0.1125) |   |     |   |    |    |    |    |   |    |    |    |    |   |    |    |    |    |   |    |    |    |    |     |     |     |    |     |               |           |           |           |               |        |   |       |                |        |   |        |              |        |   |       |              |        |    |  |                                                        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| (c)(i)         | More chance of accepting batch with low % non-conforming                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | E1        |           | advantage (b) compared to (a)                          |   |     |   |    |    |    |    |   |    |    |    |    |   |    |    |    |    |   |    |    |    |    |     |     |     |    |     |               |           |           |           |               |        |   |       |                |        |   |        |              |        |   |       |              |        |    |  |                                                        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|                | Less chance of accepting batch with high % non-conforming                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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| (ii)           | Requires more components to be tested                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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|                | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          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| 5(a)(i)        | <table><tr><td></td><td>O</td><td>M</td><td>R</td><td>Tot</td></tr><tr><td>A</td><td>42</td><td>29</td><td>19</td><td>90</td></tr><tr><td>B</td><td>37</td><td>33</td><td>24</td><td>94</td></tr><tr><td>C</td><td>24</td><td>29</td><td>18</td><td>71</td></tr><tr><td>D</td><td>25</td><td>22</td><td>13</td><td>60</td></tr><tr><td>Tot</td><td>128</td><td>113</td><td>74</td><td>315</td></tr></table> <p><math>\Sigma x^2 = 9019</math></p> <p>Between Models SS<br/><math>\left( \frac{90^2 + 94^2 + 71^2 + 60^2}{3} \right) - \frac{315^2}{12} = 256.92</math></p> <p>Between Campers SS<br/><math>\left( \frac{128^2 + 113^2 + 74^2}{4} \right) - \frac{315^2}{12} = 388.5</math></p> <p>Total SS = <math>9019 - \frac{315^2}{12} = 750.25</math></p> <table><tr><td><b>Source</b></td><td><b>SS</b></td><td><b>DF</b></td><td><b>MS</b></td></tr><tr><td><b>Models</b></td><td>256.92</td><td>3</td><td>85.64</td></tr><tr><td><b>Campers</b></td><td>388.50</td><td>2</td><td>194.25</td></tr><tr><td><b>Error</b></td><td>104.83</td><td>6</td><td>17.47</td></tr><tr><td><b>Total</b></td><td>750.25</td><td>11</td><td></td></tr></table> <p><math>H_0</math>: no difference between models<br/>F = 85.64/17.47 = 4.90<br/>cv <math>F_{[3,6]}</math> is 4.757 reject <math>H_0</math> - not all models take same time to pitch on average</p> <p><math>H_0</math>: no difference between campers<br/>F = 194.25/17.47 = 11.1<br/>cv <math>F_{[2,6]}</math> is 5.143 reject <math>H_0</math> - not all campers take same time to pitch a tent on average</p> |           | O         | M                                                      | R | Tot | A | 42 | 29 | 19 | 90 | B | 37 | 33 | 24 | 94 | C | 24 | 29 | 18 | 71 | D | 25 | 22 | 13 | 60 | Tot | 128 | 113 | 74 | 315 | <b>Source</b> | <b>SS</b> | <b>DF</b> | <b>MS</b> | <b>Models</b> | 256.92 | 3 | 85.64 | <b>Campers</b> | 388.50 | 2 | 194.25 | <b>Error</b> | 104.83 | 6 | 17.47 | <b>Total</b> | 750.25 | 11 |  | M1<br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><b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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>DF</b> | <b>MS</b> |                                                        |   |     |   |    |    |    |    |   |    |    |    |    |   |    |    |    |    |   |    |    |    |    |     |     |     |    |     |               |           |           |           |               |        |   |       |                |        |   |        |              |        |   |       |              |        |    |  |                                                        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| <b>Models</b>  | 256.92                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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| <b>Campers</b> | 388.50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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| <b>Error</b>   | 104.83                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 6         | 17.47     |                                                        |   |     |   |    |    |    |    |   |    |    |    |    |   |    |    |    |    |   |    |    |    |    |     |     |     |    |     |               |           |           |           |               |        |   |       |                |        |   |        |              |        |   |       |              |        |    |  |                                                        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| <b>Total</b>   | 750.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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## SS06 (cont)

| Q        | Solution                                                                                                                                                                                                                                                                                                    | Marks  | Total | Comments                               |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------|----------------------------------------|-------|-------|---|--------|-------|---|-------|-------|---|-------|-------|---|-------|--------|----|----|--|-----------------------------------------|
| 5(a)(ii) | D appears to take least time to pitch but this could be because it is always pitched last after practice on other models.                                                                                                                                                                                   | B1     |       | D CAO                                  |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
| (b)(i)   |                                                                                                                                                                                                                                                                                                             | E1     |       | because always pitched last            |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
|          | <table><tr><td>Source</td><td>SS</td><td>DF</td></tr><tr><td>Order</td><td>577.5</td><td>3</td></tr><tr><td>Camper</td><td>198.5</td><td>3</td></tr><tr><td>Model</td><td>611.5</td><td>3</td></tr><tr><td>Error</td><td>134.5</td><td>6</td></tr><tr><td>Total</td><td>1522.0</td><td>15</td></tr></table> | Source | SS    | DF                                     | Order | 577.5 | 3 | Camper | 198.5 | 3 | Model | 611.5 | 3 | Error | 134.5 | 6 | Total | 1522.0 | 15 | B1 |  | df correct - allow omission of total df |
|          | Source                                                                                                                                                                                                                                                                                                      | SS     | DF    |                                        |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
|          | Order                                                                                                                                                                                                                                                                                                       | 577.5  | 3     |                                        |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
|          | Camper                                                                                                                                                                                                                                                                                                      | 198.5  | 3     |                                        |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
|          | Model                                                                                                                                                                                                                                                                                                       | 611.5  | 3     |                                        |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
| Error    | 134.5                                                                                                                                                                                                                                                                                                       | 6      |       |                                        |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
| Total    | 1522.0                                                                                                                                                                                                                                                                                                      | 15     |       |                                        |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
|          |                                                                                                                                                                                                                                                                                                             | B1     | 2     | 134.5 ( 134 to 135)                    |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
| (ii)     | H <sub>0</sub> : no difference between models                                                                                                                                                                                                                                                               |        |       |                                        |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
|          | F = (611.5/3)/(134.5/6)                                                                                                                                                                                                                                                                                     | M1     |       | method for F - their df and SS         |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
|          | = 203.83/22.417 = 9.09                                                                                                                                                                                                                                                                                      | A1     |       | 9.09 (9 ~ 9.15)                        |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
|          | cv F <sub>[3,6]</sub> 4.757                                                                                                                                                                                                                                                                                 | B1     |       | 4.757 (4.75 ~ 4.76)                    |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
|          | Reject H <sub>0</sub> - there is evidence of a difference between models.                                                                                                                                                                                                                                   | A1✓    | 4     | conclusion - requires cv from F tables |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
| (iii)    | Totals    A - 128                                                                                                                                                                                                                                                                                           |        |       |                                        |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
|          | B - 93                                                                                                                                                                                                                                                                                                      |        |       |                                        |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
|          | C - 137                                                                                                                                                                                                                                                                                                     |        |       |                                        |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
|          | D - 162                                                                                                                                                                                                                                                                                                     | B1     |       | B                                      |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
|          | model B appears to take the least time to pitch.                                                                                                                                                                                                                                                            | E1     | 2     | comparison of totals or means          |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
| (iv)     | Latin Square enables 3-factors at n levels to be examined using only n <sup>2</sup> trials. If a Latin Square is to be used and there are only 4 models to be compared then only 4 campers can be included.                                                                                                 | E1     |       | cannot be more campers than models     |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
|          |                                                                                                                                                                                                                                                                                                             | E1     | 2     | comment on advantages of Latin Squares |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
|          | Total                                                                                                                                                                                                                                                                                                       |        | 25    |                                        |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |
|          | TOTAL                                                                                                                                                                                                                                                                                                       |        | 75    |                                        |       |       |   |        |       |   |       |       |   |       |       |   |       |        |    |    |  |                                         |