



General Certificate of Education

Statistics 6380

SS06 Statistics unit 6

Mark Scheme

2007 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.

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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 |
|--------------|---|---|-----------|---|
| 1(a) | mean range = $\frac{0.84}{8} = 0.105$ | M1 | 3 | attempt to find mean range |
| | estimated s.d. = 0.4299×0.105 | B1 | | 0.4299 |
| = 0.045 | A1 | 0.045 ag by any correct method (0.045~0.05) | | |
| (b)(i) | chart for means | B1 | 4 | 1.96 and 3.09 – allow 2 and 3 |
| | warning limits | M1 | | use of $\frac{0.045}{\sqrt{5}}$ |
| | $6.00 \pm 1.96 \times \frac{0.045}{\sqrt{5}}$ | M1 | | method – both limits, allow incorrect z-value, use of $\sqrt{8}$, disallow if not centred on 6.00 |
| | 5.961~6.039 | | | |
| | action limits | | | |
| | $6.00 \pm 3.09 \times \frac{0.045}{\sqrt{5}}$ | | | |
| | 5.938~6.062 | A1 | | 5.96(5.959~5.961) 6.04(6.039~6.041) 5.94(5.937~5.94) 6.06(6.06~6.063) |
| (ii) | chart for ranges | | 2 | |
| | LA $0.367 \times 0.045 = 0.017$ | M1 | | D $\times 0.045$ allow upper limits only allow any D |
| | LW $0.850 \times 0.045 = 0.038$ | | | |
| | UW $4.197 \times 0.045 = 0.189$ | | | |
| | UA $5.484 \times 0.045 = 0.247$ | A1 | | 0.017(0.016~0.017) 0.038(0.038~0.039) 0.189(0.1885~0.1895) 0.247(0.246~0.247) } allow one small slip |
| (c) | mean 6.056 range 0.20 | B1 | 3 | 6.056(6.05~6.06) and 0.2 CAO |
| | both between warning and action limits | E1✓ | | correct conclusion – their figures |
| | take another sample immediately – if mean or range on new sample outside warning limits take action | E1 | | take another sample immediately - based on all correct working |
| (d) | $z_1 = \frac{(6.15-6.06)}{0.045} = 2$ | M1 | 2 | method – allow z_1 only, allow proportion inside tolerances |
| | $z_2 = \frac{(5.85-6.06)}{0.045} = -4.67$ | | | |
| | proportion outside tolerances = $1 - 0.97725$ | | | |
| | = 0.02275 | A1 | | 0.02275(0.022~0.023) |
| Total | | | 14 | |

SS06 (cont)

| Q | Solution | Marks | Total | Comments |
|--------------|--|-------|-----------|---|
| 2(a) | In a blind trial the subject does not know whether they are being treated with an active ingredient or a placebo – which looks similar but contains no active ingredient. Purpose is to prevent outcome of the trial being affected by subjects' expectations. | E1 | 3 | subject does not know |
| | | E1 | | purpose |
| | | E1 | | complete answer |
| | | E1 | | nonsense |
| (b) | If any measurable benefit is claimed for a product it can be tested using a placebo. The reason for the product's effectiveness is irrelevant Statement nonsense. | E1 | 2 | explanation |
| | | E1 | | |
| Total | | | 5 | |
| 3(a) | <p>vol 1 2 3 4 5 6 7</p> <p>W – G 32 102 7 54 –4 44 91</p> <p>8 9 10 11 12</p> <p>6 47 48 18 –41</p> <p>$\bar{d}=33.6667$ $s=39.97575$</p> <p>$H_0: \mu_d = 0$ $H_1: \mu_d > 0$</p> <p>allow $H_0: \mu_G = \mu_w$ $H_1: \mu_G < \mu_w$</p> $t = \frac{(33.6667-0)}{\frac{(39.97575)}{\sqrt{12}}} = 2.92$ <p>c.v. $t_{11} = 1.1796$</p> <p>reject H_0, significant evidence that items can be collected more quickly, on average, at Guildford than at Woking</p> | M1 | 10 | method for differences – disallow all same sign (W – G or G – W) |
| | | B1 | | 33.67 (33.6~33.7) and 39.98 (39.9~40.0) |
| | | B1 | | both hypothesis consistent with their differences – needs population or μ |
| | | M1 | | use of $\frac{\text{their s.d.}}{\sqrt{12}}$ |
| | | m1 | | method for t – ignore sign – needs both previous M marks |
| | | A1 | | 2.92 (2.91~2.92) or –2.92 if G–W used |
| | | B1 | | 11 df |
| | | B1✓ | | 1.796 (1.79~1.8) ignore sign |
| | | A1✓ | | conclusion – must be compared with correct tail of t |
| | | A1✓ | | conclusion in context – needs previous A mark For sign test/Wilcoxon allow maximum M1 B0 B1 |
| (b) | All volunteers collected from Woking first then Guildford – possible learning effect. Could have 6 collect at Guildford first and the other 6 collect at Woking first. | E1 | 2 | source of possible bias – allow familiarity with store / particular items included in lists etc. |
| | | E1 | | method of removal |
| Total | | | 12 | |

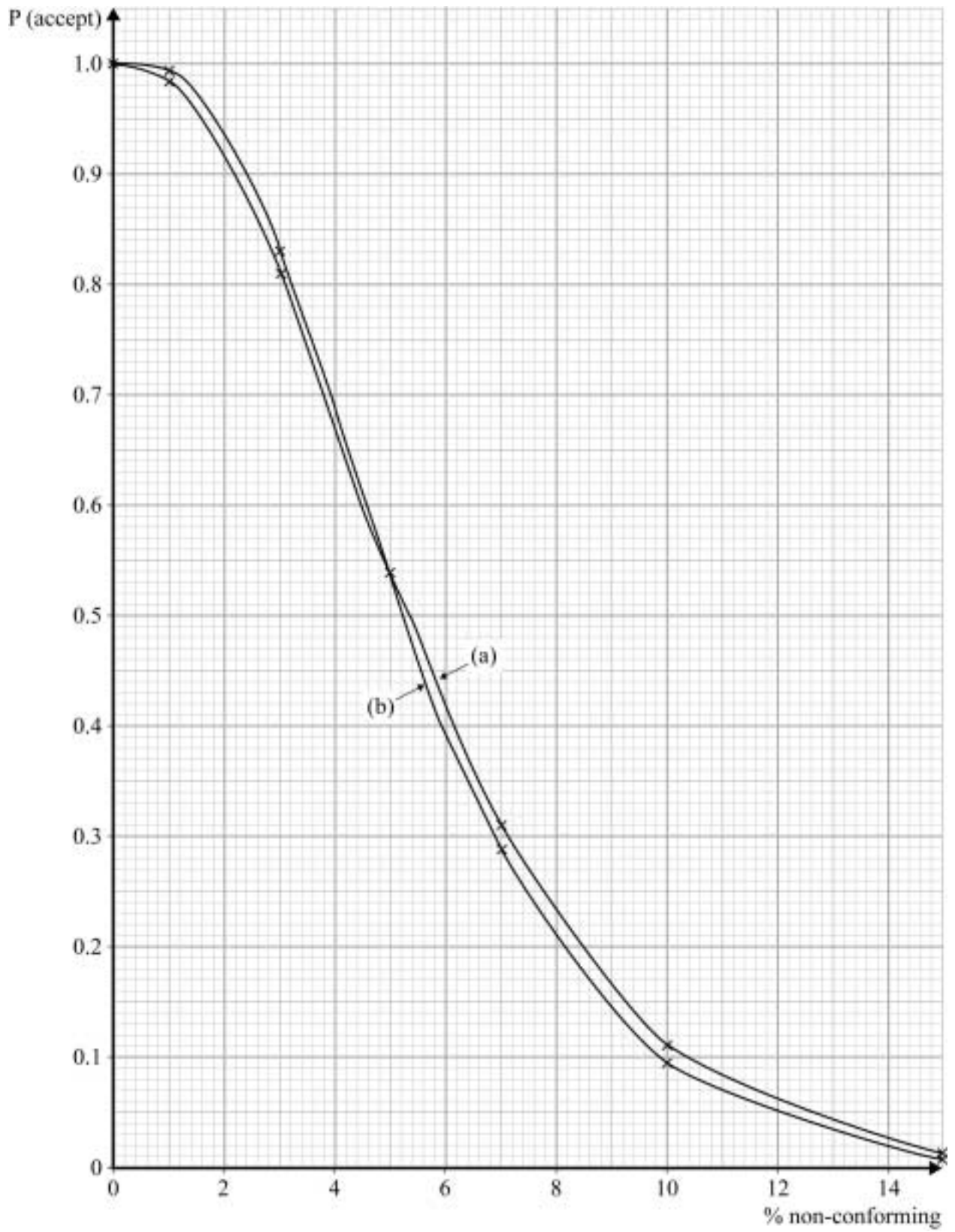
SS06 (cont)

| Q | Solution | Marks | Total | Comments |
|--------------|--|-------|----------|---|
| 4(a)(i) | $z = \frac{(25.2-24.6)}{\left(\frac{0.65}{\sqrt{10}}\right)}$ $= 2.919$ <p>P (reject) = 0.998 >0.9 or 2.92 > 1.2816 condition met</p> | M1 | 4 | method for z – ignore sign |
| | | m1 | | method for P(reject) – both method marks may be earned in (a)(ii) |
| | | A1 | | 0.998(0.998~0.9985) |
| | | A1✓ | | condition met |
| (ii) | $z = \frac{(25.2-25.7)}{\left(\frac{0.65}{\sqrt{10}}\right)}$ $= -2.433$ <p>P (accept) = 0.993 > 0.95 or -2.433 < -1.6449 condition met</p> | A1 | 2 | 0.993(0.992~0.993) |
| | | A1✓ | | condition met |
| | | (b) | | Since both conditions are easily met, it is likely that the sample size could be reduced and the conditions still met. can imply A1✓ A1✓ in (a) |
| Total | | | 8 | |

SS06 (cont)

| Q | Solution | Marks | Total | Comments |
|--------------|--|----------------|-----------|--|
| 5(a)(i) | % n-c 1 3 5 7 10 15 P(accept) 0.986 0.811 0.541 0.311 0.112 0.014 | B1 M1 A1 | 3 | use of binomial $n = 50$ method all values ± 0.001 |
| | (ii) on next page | M1 A1 | 2 | method – points must be joined accurate plot – allow 1 small slip – must go through (0,1) |
| (b)(i) | accept 1st 0 1 2 2 3 2nd 0 1 0 | M1 m1 B1 | | reasonable attempt to enumerate ways of accepting or rejecting correct enumeration use of B (40,0.05) |
| | B (40,0.05) P(accept) = $P(0 \text{ or } 1) + P(2) \times P(0 \text{ or } 1) + P(3) \times P(0)$ $= 0.3991 + 0.2776 \times 0.3991 + 0.1852 \times 0.1285$ $= 0.534$ | m1 A1 | 5 | correct method 0.534(0.533~0.534) |
| (ii) | on next page | M1 A1 | 2 | method for given data – points must be joined accurate plot – allow one small slip – don't penalise omission of (0,1) twice |
| (c) | Double sampling plans more likely to accept good (low % n-c) batches and to reject bad (high % n-c) batches. More complicated to operate. All acceptance sampling plans will reject some good batches and accept some bad batches. | E1 | | double sampling plan 'better' |
| | | E1 | | double sampling plan more complicated |
| | | E1 | 3 | all acceptance sampling plans will reject some good batches |
| Total | | | 15 | |

SS06 (cont)



SS06 (cont)

| Q | Solution | Marks | Total | Comments | | | | | | | | | | | | | | | | | | | | |
|---|--|---|--|---|----|----------------|---------|------|------|----------|---------|------|--------|-------|----------|------|---|----------|-------|-----------------------------------|----|--|----------|--|
| 6(a) | group 1 2 3 total 622 660 860 $\Sigma x=2142$ $\Sigma x^2=411620$ total SS = $411620 - \frac{2142^2}{12} = 29273$ | M1 | | method for total SS disallow negative SS | | | | | | | | | | | | | | | | | | | | |
| | between groups SS = $\frac{622^2}{4} + \frac{660^2}{4} + \frac{860^2}{4} - \frac{2142^2}{12} = 8174$ | M1 | | method for between groups SS | | | | | | | | | | | | | | | | | | | | |
| | <table border="1"> <thead> <tr> <th>source</th> <th>SS</th> <th>DF</th> <th>MS</th> </tr> </thead> <tbody> <tr> <td>between groups</td> <td>8174</td> <td>2</td> <td>4087</td> </tr> <tr> <td>residual</td> <td>21099</td> <td>9</td> <td>2344.3</td> </tr> <tr> <td>total</td> <td>29273</td> <td>11</td> <td></td> </tr> </tbody> </table> | source | SS | DF | MS | between groups | 8174 | 2 | 4087 | residual | 21099 | 9 | 2344.3 | total | 29273 | 11 | | B1 M1 | | df 2, 9 method for residual SS | | | | |
| | source | SS | DF | MS | | | | | | | | | | | | | | | | | | | | |
| | between groups | 8174 | 2 | 4087 | | | | | | | | | | | | | | | | | | | | |
| | residual | 21099 | 9 | 2344.3 | | | | | | | | | | | | | | | | | | | | |
| | total | 29273 | 11 | | | | | | | | | | | | | | | | | | | | | |
| | H_0 : no difference between groups H_1 : not all group means equal | B1 | | hypotheses – population not essential | | | | | | | | | | | | | | | | | | | | |
| | $F = \frac{4087}{2344.3} = 1.74$ | M1 A1 | | method for F – their figures 1.74(1.73~1.75) | | | | | | | | | | | | | | | | | | | | |
| | c.v. $F_{[2,9]} = 4.256$ | B1 | | 4.256(4.25~4.26) | | | | | | | | | | | | | | | | | | | | |
| | accept H_0 : no significant evidence of differences in mean times to complete Sudoku for groups drinking different quantities of alcohol | A1✓ A1✓ | 11 | their figures – must be compared with upper tail of F – needs previous M only in context – requires previous A mark | | | | | | | | | | | | | | | | | | | | |
| | 6(b) | <table border="1"> <thead> <tr> <th>source</th> <th>SS</th> <th>DF</th> <th>MS</th> </tr> </thead> <tbody> <tr> <td>alcohol</td> <td>9348</td> <td>2</td> <td>4674</td> </tr> <tr> <td>weights</td> <td>7980</td> <td>3</td> <td>2660</td> </tr> <tr> <td>residual</td> <td>3214</td> <td>6</td> <td>535.67</td> </tr> <tr> <td>total</td> <td>20542</td> <td>11</td> <td></td> </tr> </tbody> </table> | source | SS | DF | MS | alcohol | 9348 | 2 | 4674 | weights | 7980 | 3 | 2660 | residual | 3214 | 6 | 535.67 | total | 20542 | 11 | | B1 M1 | |
| source | | SS | DF | MS | | | | | | | | | | | | | | | | | | | | |
| alcohol | | 9348 | 2 | 4674 | | | | | | | | | | | | | | | | | | | | |
| weights | | 7980 | 3 | 2660 | | | | | | | | | | | | | | | | | | | | |
| residual | | 3214 | 6 | 535.67 | | | | | | | | | | | | | | | | | | | | |
| total | | 20542 | 11 | | | | | | | | | | | | | | | | | | | | | |
| H_0 : no difference between amounts of alcohol | | | | | | | | | | | | | | | | | | | | | | | | |
| $F = \frac{4674}{535.67} = 8.73$ | | m1 | | method for F (either) – their figures | | | | | | | | | | | | | | | | | | | | |
| reject H_0 : significant evidence differences in mean times to do Sudoku between groups drinking different amounts of alcohol | | | | | | | | | | | | | | | | | | | | | | | | |
| H_0 : no difference between weights | | | | | | | | | | | | | | | | | | | | | | | | |
| $F = \frac{2660}{535.67} = 4.97$ | A1 | | 8.73(8.72~8.73) and 4.97(4.96~4.97) | | | | | | | | | | | | | | | | | | | | | |
| c.v. $F_{[3,6]} = 4.757$ | B1 | | 5.143(5.14~5.15) and 4.757(4.75~4.76) | | | | | | | | | | | | | | | | | | | | | |
| reject H_0 : significant evidence differences in mean times to do Sudoku between groups of different weights | A1✓ | 6 | both conclusions – their figures – must be compared with upper tail of F | | | | | | | | | | | | | | | | | | | | | |

SS06 (cont)

| Q | Solution | Marks | Total | Comments |
|-------------|---|--------------|--------------|------------------------|
| 6(c) | The design in (b) has greatly reduced the residual MS, thus making it more likely to detect a difference if one exists. Design successful. | E1 | 2 | design effective |
| | | E1 | | reason |
| (d) | No interaction means that drinking alcohol has the same effect (in terms of time to do Sudoku) on a light person as on a heavy person. | E1 | 2 | meaning of interaction |
| | | E1 | | in context |
| | Total | | 21 | |
| | TOTAL | | 75 | |