



General Certificate of Education

Statistics 6380

SS05 Statistics unit 5

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.

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.

Further copies of this Mark Scheme are available to download from the AQA Website: www.aqa.org.uk

Copyright © 2007 AQA and its licensors. All rights reserved.

COPYRIGHT

AQA retains the copyright on all its publications. However, registered centres for AQA are permitted to copy material from this booklet for their own internal use, with the following important exception: AQA cannot give permission to centres to photocopy any material that is acknowledged to a third party even for internal use within the centre.

Set and published by the Assessment and Qualifications Alliance.

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.

SS05

| Q | Solution | Marks | Total | Comments |
|--------------|---|-------|----------|---|
| 1(a)(i) | $P(0.8 \leq X \leq 1.2) = \frac{1.2 - 0.8}{2 - 0}$ $= \frac{0.4}{2} = 0.2$ | M1 | 2 | probability raised to power of 3 CAO |
| | | A1 | | |
| (a)(ii) | $P(X = 1) = 0$ | B1 | 1 | |
| (b)(i) | $P(X \geq 0.6) = \frac{2 - 0.6}{2} = \frac{1.4}{2} = 0.7$ $P(\text{all three} \geq 0.6)$ $= (0.7)^3$ $= 0.343$ | B1 | 3 | |
| | | M1 | | |
| | | A1 | | |
| (ii) | $P(\text{remnant less than 1 metre long})$ $= \frac{1 - 0.6}{2 - 0.6} = \frac{0.4}{1.4}$ $= 0.286 \text{ (3 sf)}$ or $P(X < 1 X \geq 0.6)$ $= \frac{P(0.6 \leq X < 1)}{P(X \geq 0.6)} = \frac{0.2}{0.7}$ $= 0.286$ | M1 | 2 | |
| | | A1 | | |
| | | (M1) | (2) | |
| | | (A1) | | |
| Total | | | 8 | |

SS05 (cont)

| Q | Solution | Marks | Total | Comments |
|---------|---|----------------|-----------|--|
| 2(a)(i) | $v = 9$ | B1 | | here or in (ii) |
| | $t = \pm 2.262$ | B1 | | $S^2 \times \frac{10}{9}$: withhold last A mark in 1 part |
| | 95% confidence limits for mean are: $446.9 \pm 2.262 \times \frac{13.9}{\sqrt{10}}$ | M1 m1 | | use of formula standard error |
| | 95% confidence interval is: (437, 457) grams | A1 | 5 | (436.9 to 437, 456.8 to 457) |
| (ii) | $\chi^2 = 2.700, 19.023$ | B1 | | both |
| | 95% confidence limits for variance are: $\frac{9 \times 13.9^2}{19.023}, \frac{9 \times 13.9^2}{2.700}$ | M1 A1✓ | | correct values substituted ft on incorrect x^2 values |
| | (95% CI is (91.410, 644.03)) 95% CI for standard deviation is: $\left(\sqrt{\frac{9 \times 13.9^2}{19.023}}, \sqrt{\frac{9 \times 13.9^2}{2.700}} \right)$ = (9.56, 25.4) grams | M1 A1 | 5 | (9.5 to 9.6, 25.3 to 25.4) CAO |
| (b) | Damien's claim seems to be correct upper CL for mean is less than 460 | B1 E1 | 2 | must say above CI |
| (c) | taking lower CL for mean (437) and upper CL for SD (25.4) 350 is more than 3 SDs below mean making it plausible that Damien made a mistake | E1 E1 E1 | 3 | SC E1 for plausible because 350 well below CI for mean |
| | Total | | 15 | |

SS05 (cont)

| Q | Solution | Marks | Total | Comments | | | |
|---|--|--------------------------|-----------|---|----|---|---|
| 3(a) | Morning: $s_x^2 = 12.136$ or $s_x = 3.48$ | B1 | 9 | 12.1 to 12.2; AWRT 35.0 to 35.1; AWRT } or equivalent 2.86 to 2.89 (0.344 to 0.349) ft on sample variances both, either way round accept 0.368 (0.271 to 0.272) if used H_1 with \neq must have $F = 4.823$ ft on variance ratio and CV | | | |
| | Evening: $s_y^2 = 35.045$ or $s_y = 5.92$ | B1 | | | | | |
| | $H_0: \sigma_x^2 = \sigma_y^2$ | B1 | | | | | |
| | $H_1: \sigma_x^2 < \sigma_y^2$ | B1 | | | | | |
| | Ratio of variances = $\frac{35.045}{12.136}$ | M1 | | | | | |
| | = 2.89 (or 0.346) | A1✓ | | | | | |
| | $\nu_1 = 9; \nu_2 = 7$ | B1 | | | | | |
| | Critical value of $F = 3.677$ | B1 | | | | | |
| | (or $\frac{1}{3.677} = 0.272$) | | | | | | |
| | $2.89 < 3.677$ (or $0.346 > 0.272$) | | | | | | |
| | There is not sufficient evidence at the 5% level to support Sandeep's belief | A1✓ | | | | | |
| | (b) | $H_0: \mu_M - \mu_A = 1$ | | | B1 | 7 | } μ_M, μ_A reversed, lose first B1 and last A1 } or equivalent If $H_1 \neq$ must have 1.96 accept 1.64, 1.645 or $P(Z > 1.94) = 0.2619$ difference of means over sd correct form of sd CAO; AWRT ft on sample value and CV |
| | | $H_1: \mu_M - \mu_A > 1$ | | | B1 | | |
| | | CV of $z = 1.6449$ | | | B1 | | |
| sample value of $z = \frac{(61.7 - 58.9) - 1}{2.1 \sqrt{\frac{1}{9} + \frac{1}{12}}}$ | | M1 m1 | | | | | |
| = 1.94 | | A1 | | | | | |
| $1.94 > 1.6449$ so reject H_0 . There is sufficient evidence at the 5% level to support the trainer's claim | | A1✓ | | | | | |
| Total | | | 16 | | | | |

SS05 (cont)

| Q | Solution | Marks | Total | Comments |
|---------|---|------------------------------|----------|---------------------------|
| 4(a)(i) | $P(X < 2) = 1 - e^{-0.4 \times 2}$ $= 1 - e^{-0.8} = 0.551$ | M1 A1 | 2 | or by integration AWRT |
| | (ii) $P(2 \leq X \leq 5) = F(5) - F(2)$ $= (1 - e^{-2}) - (1 - e^{-0.8})$ $= 0.314$ | M1 A1 | | 2 |
| (b) | for median m , $F(m) = 0.5 (= 1 - F(m))$ | B1 | 4 | may be implied |
| | $F(1.7) = 1 - e^{-0.68} = 0.493$ $(e^{-0.68} = 0.507)$ | B1 | | |
| | $F(1.8) = 1 - e^{-0.72} = 0.513$ $(e^{-0.72} = 0.487)$ | B1 | | |
| | 0.5 lies between 0.493 and 0.513 so median lies between 1.7 and 1.8 | E1 | | |
| | or $e^{-0.4m} = 0.5$ $-0.4m = \ln(0.5)$ $m = \frac{0.693}{0.4} = 1.73$ so median lies between 1.7 and 1.8 | (M1) (m1) (A1) (E1) | | |
| | Total | | 8 | |

SS05 (cont)

| Q | Solution | Marks | Total | Comments | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|------|---|-----------------------|-----------|--|----|-------|---------------------|---|------|------|----|------|------|----|-------|------|----|-------|------|----|-------|------|----|-------|------|---|------|------|---|------|------|--|--|------|--|--|--|
| 5(a) | $P(X < 304) = \Phi\left(\frac{304-310}{4}\right)$ $a = \Phi(-1.5) = 0.0668 \text{ (or 0.0667)}$ $b = 0.0918 \text{ (or 0.0919)}$ $c = 0.0918 \text{ (or 0.0919)}$ $d = 0.0668 \text{ (or 0.0667)}$ | M1 | 4 | attempt to find a probability | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | A1 | | one missing value found | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | B1 | | second value found by any method | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | B1 | | remaining values correct | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | (b) | | <table border="1"> <thead> <tr> <th>O</th> <th>E</th> <th>$\frac{(O-E)^2}{E}$</th> </tr> </thead> <tbody> <tr> <td>5</td> <td>6.68</td> <td>0.42</td> </tr> <tr> <td>13</td> <td>9.19</td> <td>1.58</td> </tr> <tr> <td>10</td> <td>14.99</td> <td>1.66</td> </tr> <tr> <td>18</td> <td>19.15</td> <td>0.07</td> </tr> <tr> <td>25</td> <td>19.15</td> <td>1.79</td> </tr> <tr> <td>20</td> <td>14.99</td> <td>1.68</td> </tr> <tr> <td>5</td> <td>9.19</td> <td>1.91</td> </tr> <tr> <td>4</td> <td>6.68</td> <td>1.08</td> </tr> <tr> <td></td> <td></td> <td>10.2</td> </tr> </tbody> </table> | O | E | $\frac{(O-E)^2}{E}$ | 5 | 6.68 | 0.42 | 13 | 9.19 | 1.58 | 10 | 14.99 | 1.66 | 18 | 19.15 | 0.07 | 25 | 19.15 | 1.79 | 20 | 14.99 | 1.68 | 5 | 9.19 | 1.91 | 4 | 6.68 | 1.08 | | | 10.2 | | | If $E = 12.5$ throughout, just second M1 available |
| | | | | | O | E | $\frac{(O-E)^2}{E}$ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | 5 | 6.68 | 0.42 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | 13 | 9.19 | 1.58 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | 10 | 14.99 | 1.66 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | 18 | 19.15 | 0.07 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 25 | 19.15 | | 1.79 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | 14.99 | 1.68 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | 9.19 | 1.91 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 6.68 | 1.08 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 10.2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| M1 | probabilities $\times 100$ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| M1 | use of formula | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A1 | at least 4 values correct (AWRT) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A1 | $\sum E \neq 100$: lose this and final A1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | total correct; AWRT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | H_0 : can be modelled by $N(310, 4^2)$ H_1 : Not H_0 $v = 8 - 1 = 7$ $\chi_{10\%}^2 = 12.017$ $10.2 < 12.017$ Accept H_0 at 10% level. There is not sufficient evidence to reject the model | B1 B1 B1 A1✓ | 8 | both any grouping of categories: lose final A1 fit on calculated value and cv | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (c) | (1) Reasonable claim as model has mean 310. (Does not say much about one punnet) (2) Looks a safe claim. Only 5 punnets in sample < 304 g; shape of normal distribution suggests few, if any, will be < 300 g (3) At least 5 punnets in sample < 305 g and shape suggests claim could be wrong for about 10% of punnets | E1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | E1 | | reference to relevant figure from sample in (2) or (3) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | E1 | | reference to property of normal in (2) or (3) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | E1 | 4 | appropriate assessment of possibilities must use data and model for E4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Total | | 16 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

SS05 (cont)

| Q | Solution | Marks | Total | Comments |
|---|--|--|-----------|--|
| 6 | <p>assume weights selected by Amy and Ben are normally distributed with common variance independence between samples } $H_0: \mu_A = \mu_B$ $H_1: \mu_A \neq \mu_B$ pooled estimate of variance $= \frac{(10 \times 3.24^2) + (8 \times 2.71^2)}{10 + 8}$ $= 9.096$ $\nu = 18$ $t = \pm 2.878$ sample statistic = $\frac{41.6 - 38.4}{\sqrt{9.096 \left(\frac{1}{11} + \frac{1}{9} \right)}}$ $= 2.36$ $2.36 < 2.878$ so accept H_0 There is not enough evidence at the 1% level to say that the earlier assessment was wrong</p> | <p>B1 B1 M1 B1 M1 A1 B1 B1 M1 A1 A1✓ A1✓</p> | <p>12</p> | <p>any two attempt to use t-test for difference of means both accept 9.09 to 9.10 correct values substituted ft on standard error; AWRT ft on sample statistic and t depends on first and last M1</p> |
| | Total | | 12 | |
| | TOTAL | | 75 | |