



**General Certificate of Education**

**Mathematics 6360**  
**Statistics 6380**

**MS/SS1B/W Statistics 1B**

**Mark Scheme**

*2009 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.**

## MS/SS1B/W

| Q            | Solution  | Marks                        | Total                         | Comments   |
|--------------|---|------------------------------|-------------------------------|--|
| <b>1(a)</b>  |   |                              |                               | <b>In (a), ratios (eg 100:160) are only penalised by 1 mark at first correct answer</b>  |
| <b>(i)</b>   | $P(P) = 100/160 = 50/80 = 25/40 = 10/16$ $= 5/8 = 0.625$  | B1                           | 1                             | CAO  |
| <b>(ii)</b>  | $P(S') = 1 - \frac{32}{160} \quad \text{or} \quad P(S) = \frac{32}{160}$ $= 128/160 = 64/80 = 32/40 = 16/20 = 8/10$ $= 4/5 = 0.8$   | M1<br><br>A1                 | <br><br>2                     | Or equivalent<br>Ignore labels of $S'$ & $S$<br>Can be implied by <b>correct</b> answer<br><br>CAO   |
| <b>(iii)</b> | $P(S \text{ or } H) = P(S \cup H) =$ $\frac{60+32-18}{160} \quad \text{or} \quad \frac{60+14}{160} \quad \text{or} \quad \frac{32+8+16+18}{160}$ $= 74/160 = 37/80 = 0.462 \text{ to } 0.463$ | M1<br><br>A1                 | <br><br>2                     | Or equivalent<br>Can be implied by <b>correct</b> answer<br><br>CAO/AFWW (0.4625)  |
| <b>(iv)</b>  | $P(T P) = \frac{30/160}{(i)}$ $= 3/100 = 3/10 = 0.3$  | M1<br><br>A1                 | <br><br>2                     | Or equivalent<br>Can be implied by <b>correct</b> answer<br>But watch for $18/160$ or $48/160$<br><br>CAO  |
| <b>(b)</b>   | $P(1C \text{ \& } 1R \text{ \& } 1S) =$ $\frac{24}{160} \times \frac{56}{159} \times \frac{32}{158}$ $(0.15 \times 0.35220 \times 0.20253)$ $\times 6$ $= 0.064 \text{ to } 0.0644$           | M1<br>M1<br><br>M1<br><br>A1 | <br><br><br><br><br><br><br>4 | Multiplication of any 3 different given subject totals<br>Multiplication of 160, 159 & 158<br><br>Accept 3dp accuracy<br>Award for $3 \leq \text{multiplier} \leq 6$<br><br>AWFW (0.0642)<br>Do not accept a fraction as answer<br>A <b>correct</b> answer can imply 4 marks |
|              | <b>Special Case:</b><br>(Any given subject total) $\div$ 160<br>seen anywhere in (b)  | (M1)                         | 4                             | Can award if no marks scored in (b)<br>Accept a decimal equivalent   |
|              |   | <b>Total</b>                 | <b>11</b>                     |  |

## MS/SS1B/W (cont)

| Q             | Solution  | Marks        | Total     | Comments   |
|---------------|---|--------------|-----------|--|
| <b>2(a)</b>   | $r = 0.893$ to 0.8933   | B3           |           | AWFW (0.89319)   |
|               | $r = 0.89$ to 0.896   | (B2)         |           | AWFW   |
|               | $r = 0.8$ to 0.95   | (B1)         |           | AWFW   |
|               | <b>or</b>   |              |           |  |
|               | Attempt at $\sum x$ $\sum x^2$ $\sum y$ $\sum y^2$ & $\sum xy$  |              |           | 561 30667 671 42613 & <b>35882</b> (all 5 attempted)   |
| <b>or</b>     |   | (M1)         |           | 2056 1682 & <b>1661</b> (all 3 attempted)  |
|               | Attempt at $S_{xx}$ $S_{yy}$ & $S_{xy}$   |              |           |  |
|               | Attempt at <b>correct</b> corresponding formula for $r$   | (m1)         |           |  |
|               | $r = 0.893$ to 0.8933   | (A1)         | 3         | AWFW   |
| <b>(b)</b>    | Fairly strong / strong / very strong positive (linear) correlation / relationship / association / link (but not trend) between <b>length and weight</b> of adult snakes | B1dep        |           | Or equivalent; must qualify strength and indicate positive Dependant on $0.8 \leq r \leq 0.95$<br>B0 for some/average/medium/etc   |
| <b>(c)</b>    | Figure 1: 5 correct labelled points<br>4 or 3 correct labelled points   | B2<br>(B1)   | 2         | Deduct 1 mark if points not labelled   |
| <b>(d)(i)</b> | D and G   | B1           | 1         | Both CAO   |
| <b>(ii)</b>   | $r = 0.25$ to 0.75  | B1           |           | AWFW (0.48790)<br>No penalty for calculation<br>Accept a range only if whole of it falls within 0.25 to 0.75   |
|               | Fairly weak / weak / some / moderate positive (linear) correlation / relationship / association / link  | B1dep        | 2         | Or equivalent; must qualify strength and indicate positive Dependant on $0.25 \leq r \leq 0.75$<br>B0 for very weak/little/slight/hardly any/fair/average/medium/anything involving strong/etc |
|               | Do not accept comparison with value in (a) or statement in (b)  |              |           |  |
|               |   | <b>Total</b> | <b>10</b> |  |

## MS/SS1B/W (cont)

| Q     | Solution  | Marks                            | Total     | Comments   |
|-------|---|----------------------------------|-----------|--|
| 3(a)  | $X \sim N(253, 5^2)$  |                                  |           |  |
| (i)   | $P(X < 250) = P\left(Z < \frac{250-253}{5}\right) =$ $P(Z < -0.6) = 1 - P(Z < 0.6)$ $= 1 - 0.72575$ $= 0.274 \text{ to } 0.275$     | M1<br>m1<br>A1                   | 3         | Standardising (249.5, 250 or 250.5) with 253 and ( $\sqrt{5}$ , 5 or $5^2$ ) and/or (253 - x)<br><br>Area change; may be implied<br><br>AWFW (0.27425)<br>(1 - answer) $\Rightarrow$ M1 max                                    |
| (ii)  | $P(245 < X < 250) = [C's(a)(i)] - P(X < 245)$ $= (i) - P(Z < -1.6) = 0.27425 - 0.0548$ $= 0.219 \text{ to } 0.22(0)$                | M1<br><br>A1                     | 2         | Or equivalent; must be clear correct method if answer incorrect and answer > 0<br><br>AWFW (0.21945)<br>M1 A0 for [1 - (i)] - 0.0548 = 0.67095<br>M0 A0 for 0.9452 - [(i)] = 0.67095<br>M1 A1 for 0.9452 - [1 - (i)] = 0.21945 |
| (iii) | $P(X = 245) = 0$ or zero or impossible  | B1                               | 1         | Ignore any working<br>B0 for 'for impossible to calculate'   |
| (b)   | $98\% (0.98) \Rightarrow z = -2.05 \text{ to } -2.06$ $z = \frac{245 - 253}{\sigma}$ $= -2.0537$ $\sigma = 3.88 \text{ to } 3.9(0)$ | B1<br><br>M1<br><br>A1<br><br>A1 |           | AWFW; ignore sign (-2.0537)<br><br>Standardising 245 with 253 and $\sigma$ ; allow (253 - 245)<br><br>Only allow: $\pm 2.05$ to $\pm 2.06$<br>$\pm 2.32$ to $\pm 2.33$<br><br>AWFW (3.8954)                                    |
|       | <b>Note:</b><br>$\frac{245 - 253}{\sigma} = 2.0537 \Rightarrow \sigma = 3.8954$ $\Rightarrow \text{B1 M1 A1 A0}$                    |                                  | 4         | Or equivalent inconsistent signs   |
|       |   | <b>Total</b>                     | <b>10</b> |  |

## MS/SS1B/W (cont)

| Q                                       | Solution  | Marks  | Total   | Comments  |  |
|---|---|--------|---|---|--|
| 4(a)                                    | $b$ (gradient) = $-0.5485$ to $-0.5475$   | B2     | 4   | AWFW ( $-0.54814$ )   |  |
|   | $b$ (gradient) = $-0.55$ to $-0.54$   | (B1)   |   | AWFW  |  |
|   | Omission of $-ve$ sign  | (B0)   |   |   |  |
|   | $a$ (intercept) = $49.7$ to $49.9$  | B2     |   | AWFW ( $49.7982$ )  |  |
|   | $a$ (intercept) = $49$ to $50$  | (B1)   |   | AWFW  |  |
|   | <b>or</b>   |        |   |   |  |
|   | Attempt at $\sum x$ $\sum x^2$ $\sum y$ & $\sum xy$ ( $\sum y^2$ )  |        |   | 305 14975 281 & <b>6980</b> (10173)<br>(all 4 attempted)  |  |
|   | <b>or</b>   | (M1)   |   |   |  |
|   | Attempt at $S_{xx}$ & $S_{xy}$  |        |   | 4638.89 & <b>-2542.78</b><br>(both attempted)   |  |
|   | Attempt at <b>correct</b> formula for $b$ (gradient)  | (m1)   |   |   |  |
| $b$ (gradient) = $-0.5485$ to $-0.5475$ | (A1)  | AWFW   |   |   |  |
| $a$ (intercept) = $49.7$ to $49.9$      | (A1)  | AWFW   |   |   |  |
|   | Accept $a$ & $b$ interchanged only if identified correctly by a <b>clearly shown equation</b> (stated answers are not sufficient) in (b) or (c) |        | If $a$ and $b$ not identified anywhere in question, then:<br>$-0.5485$ to $-0.5475 \Rightarrow$ B1<br>$49.7$ to $49.9 \Rightarrow$ B1 |   |  |
| (b)                                     | C's value of intercept from (a) providing $> 47$  | B1F    | 1   | Accept value rounded to nearest integer (50)  |  |
|   | <b>or</b><br>Value 50 stated even if (a) incorrect or not attempted   |        |   |   |  |
| (c)                                     | 13 weeks $\Rightarrow$ 91 days  | B1     |   | Stated or used<br>Accept a descriptive answer that includes 91 and a value in range<br>AWFW ( $-0.08254$ )                      |  |
|   | $y = -1.1$ to $+ 1.1$   | B1     |   |   |  |
|   | <b>or</b>   |        |   |   |  |
|   | $y = 0 \Rightarrow x = 89$ to $93$  | (B1)   |   |   | AWFW (90.84942)<br>Accept a descriptive answer that includes a value in range and 13 |
|   | $\Rightarrow$ 13 weeks (approximately)  | (B1)   |   |   | Stated   |
|   | <b>Note:</b><br>B1 B1 or (B1) (B1) are available even if (a) not attempted  |        |   |   |  |
|   | Thus claim appears <b>justified</b>   | B1 dep |   | Or equivalent; ignore reasoning unless contradictory<br>Dependent upon 2 <sup>nd</sup> B1 in (c) or 2 <sup>nd</sup> (B1) in (c) |  |
| <b>or</b>                               | Thus tablet likely to have <b>dissolved</b>   |        |   |   |  |
|   | <b>or</b>   |        |   |   |  |
|   | Extrapolation required so cannot comment  | (B1)   |   | Not dependent   |  |
|   | <b>Note:</b><br>If (B1) for extrapolation maximum mark is 2;<br>other mark available is for 91  |        | <b>3</b>  |   |  |

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|  |  |              |          |  |
|--|--|--------------|----------|--|
|  |  | <b>Total</b> | <b>8</b> |  |
|--|--|--------------|----------|--|

## MS/SS1B/W (cont)

| Q            | Solution   | Marks        | Total     | Comments   |
|--------------|--|--------------|-----------|--|
| 5(a) (i)     | Median (50) = 3  | B1           |           | CAO<br>Do not award marks if correct answers are based on shown incorrect method; eg accept use of 99/2, etc but not 276/2, etc<br>CAO; but<br>25 <sup>th</sup> value $\Rightarrow$ IQR = 2 $\Rightarrow$ B0 |
|              | If not identified, then assume order is median then IQR<br><br>IQR (75 – 25) = 4 – 2 = 2   | B2           |           |  |
| (ii)         | <b>Special Cases:</b><br>Identification that LQ = 2 and UQ = 4   | (B1)         | 3         | Both CAO<br><br>Can award if no marks scored in (i) even if then applied to continuous data  |
|              | Statement of $\geq 4$ cumulative frequencies<br>F: 14 49 74 87 96 98 99  | (M1)         |           |  |
|              | Mean = $\frac{\sum fx}{\sum f} = \frac{275}{99} = 2.77$ to 2.78  | B1           |           | AWFW (2.778)   |
| (b)(i)       | If not identified, assume order is $\bar{x}$ then s<br>SD ( $\sum fx^2 = 933$ ) = 1.3(0) to 1.32   | B2           | 3         | Treat rounding to integers as ISW<br>AWFW (1.307 & 1.314)  |
|              | <b>Special Case:</b><br>Evidence of $\frac{\sum fx}{99}$   | (M1)         |           | Can award if no marks scored in (ii)   |
|              | Mean <sub>163</sub> = $\frac{99 \times \text{Mean}_{99}}{163}$ or $\frac{\sum fx \text{ from (a)(ii)}}{163}$<br><br>= 1.68 to 1.69   | M1<br>A1     |           | Or equivalent; may be implied by an answer within range<br>AWFW (1.687)  |
| (ii)         | Increase   | B1           | 1         | CAO; or equivalent (1.696)<br>Ignore any working (1.702)   |
| (iii)        | Data is (positively/negatively) skewed / not symmetric / bimodal / not bell-shaped from frequency distribution / given table<br>or<br>[C's mean in (b)(i)] – 2 × [C's SD in (a)(ii)] < 0<br>or<br>[C's mean in (b)(i)] – 2 × [1.69 to 1.71] < 0<br><br>Thus claim appears <b>not valid</b> | B1<br>B1 dep | 2         | Or equivalent<br><br>(–1.75 to –0.90)<br><br>Or equivalent<br>Dependent upon previous B1   |
| <b>Total</b> |  |              | <b>11</b> |  |

## MS/SS1B/W (cont)

| Q    | Solution   | Marks        | Total     | Comments   |
|------|--|--------------|-----------|--|
| 6(a) | Mean = $\frac{470}{10} = 47$   | B1           |           | CAO  |
|      | 98% (0.98) $\Rightarrow z = 2.32$ to 2.33  | B1           |           | AWFW (2.3263)  |
|      | CI for $\mu$ is $\bar{x} \pm z \times \frac{\sigma}{\sqrt{n}}$   | M1           |           | Used<br>Must have $\sqrt{n}$ with $n > 1$  |
|      | Thus $47 \pm 2.3263 \times \frac{15}{\sqrt{10}}$   | A1F          |           | F on $\bar{x}$ and $z$ only  |
|      | Hence $47 \pm 11.0$ to 11.1  |              |           | CAO & AWRT (accept 11)   |
|      | <b>Or</b><br>(35.9 to 36.0, 58.0 to 58.1)  | A1           | 5         | AWRT (accept 36 & 58)  |
| (b)  | $Y \sim N(108, 28^2)$<br><br>Variance of $\bar{Y}_{40} = 28^2/40 = 19.6$<br><br>$\sqrt{\text{SD of } \bar{Y}_{40}} = 28/\sqrt{40} = 4.425$ to 4.43 | B1           |           | CAO<br>Stated or used<br>AWFW  |
|      | $P(\bar{Y}_{40} > 120) = P\left(Z > \frac{120-108}{28/\sqrt{40}}\right)$   | M1           |           | Standardising 120 with 108 and $\sqrt{19.6}$ or (4.425 to 4.43) or equivalent; allow (108 – 120) |
|      | $= P(Z > 2.71) = 1 - P(Z < 2.71)$  | m1           |           | Area change; may be implied  |
|      | $= 1 - 0.99664 = 0.0033$ to 0.0034   | A1           | 4         | AWFW (0.00336)<br>(1 – answer) $\Rightarrow$ B1 M1 max   |
| (c)  | Part (b) or Telear times   | B1           |           | Or equivalent; ignore reasoning  |
|      | Distribution of Y not known  | B1           |           | Or equivalent; must be clear reference to Y or population<br>B0 for $n > 30$                     |
|      | <b>Note:</b><br>To score B1 B1 there must be <b>both</b> a clear indication of where in question <b>and</b> a valid reason                         |              |           | Any reference to part (a) $\Rightarrow$ B0 B0  |
|      |  |              | 2         |  |
|      |  | <b>Total</b> | <b>11</b> |  |

## MS/SS1B/W (cont)

| Q     | Solution   | Marks        | Total     | Comments  |
|-------|--|--------------|-----------|---|
| 7(a)  | $R \sim B(50, 0.15)$   |              |           |   |
| (i)   | $P(R < 10) = 0.791$  | B1           |           | AWRT (0.7911)   |
| (ii)  | $P(5 \leq R \leq 10) = 0.8801$ or $0.7911$ ( $p_1$ )   | M1           |           | Accept 3 dp accuracy<br>$(1 - p_2) - p_1 \Rightarrow$ M0 M0 A0<br>$p_1 - (1 - p_2) \Rightarrow$ M1 M0 A0<br>only providing result $> 0$ |
|       | minus $0.1121$ or $0.2194$ ( $p_2$ )   | M1           |           | Accept 3 dp accuracy  |
|       | $= 0.768$  | A1           |           | AWRT (0.7680)   |
|       | <b>or</b>  |              |           |   |
|       | B(50, 0.15) expressions stated for <b>at least 3</b> terms within $4 \leq R \leq 10$ gives probability $= 0.768$   | (M1)<br>(A2) | 4         | Can be implied by correct answer<br>AWRT  |
| (b)   | <b>Confusion of</b> 22, 35, 120 and/or 0.15, 0.06  |              |           | Do <b>not</b> treat as misreads   |
| (i)   | $S \sim B(22, 0.06)$   | M1           |           | Used in (b)(i) as evidenced by any correct binominal term for $S > 0$   |
|       | $P(S = 2) = \binom{22}{2}(0.06)^2(0.94)^{20}$  | A1           |           | Can be implied by correct answer<br>Ignore any additional terms   |
|       | $= 0.24$ to $0.242$  | A1           | 3         | AWFW (0.24125)  |
| (ii)  | $P(S \geq 1) = 1 - q^{35}$ where $0.84 \leq q \leq 0.96$   | M1<br>(B1)   |           | Can be implied by correct answer<br>Award for $(0.94)^{35}$ seen in an expression but not if accompanied by a multiplier $\neq 1$       |
|       | $= 0.885$ to $0.89$  | A1           | 2         | AWFW (0.88532)  |
| (iii) | Mean = $np = 120 \times 0.94 = 112.8$ or $113$<br>If not identified, assume order is $\mu$ then $\sigma^2$<br>Variance = $np(1 - p)$<br>$= 120 \times 0.94 \times 0.06 = 6.76$ to $6.78$ | B1<br><br>B1 | 2         | Either<br><br>Must clearly state variance value<br>AWFW (6.768)   |
| (iv)  | <b>Means</b> are (approximately) the <b>same</b> stated<br>or<br><b>Variiances</b> are (very) <b>different</b> stated  | B1           |           | Must have scored 1 <sup>st</sup> B1 in (iii)<br>Must have scored 2 <sup>nd</sup> B1 in (iii)  |
|       | <b>Agree</b> with $P(\text{sorts letter incorrectly}) = 0.06$  | B1 dep       |           | Dependent on 'means same' stated  |
|       | <b>Disagree</b> with independent from letter to letter   | B1 dep       | 3         | Dependent on 'variances different' stated   |
|       |  | <b>Total</b> | <b>14</b> |   |
|       |  | <b>Paper</b> | <b>75</b> |   |

