**General Certificate of Education (A-level)
June 2011**

**Mathematics**                                          **MS/SS1B**

**(Specification 6360)**

**Statistics 1B**

# Final

# *Mark Scheme*

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 events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process 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 standardisation each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised 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 abbreviations

| | |
|---|---|
| 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 |
| CAO | correct answer only |
| CSO | correct solution only |
| AWFW | anything which falls within |
| AWRT | anything which rounds to |
| ACF | any correct form |
| AG | answer given |
| SC | special case |
| OE | or equivalent |
| A2,1 | 2 or 1 (or 0) accuracy marks |
| $-x$ EE | deduct $x$ marks for each error |
| NMS | no method shown |
| PI | possibly implied |
| SCA | substantially correct approach |
| c | candidate |
| sf | significant figure(s) |
| 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.

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**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **1**<br>**(a)(i)** | Mode = **253** | B1 | 1 | CAO |
| **(ii)** | Median = **252** | B1 | | CAO |
| | Upper quartile = **253**<br><br>Lower quartile = **250** | B1 | | CAO; either<br>May be implied by IQR = 3 |
| | Interquartile range = **3** | B1 | 3 | CAO; do not award if **seen** to be not based on 253 and 250 |
| **(b)(i)** | Range = 271 – 227 = **44** | B1 | 1 | CAO; do not award if **seen** to be not based on 271 and 227 |
| **(ii)** | Mean, $\bar{x}$ = **251 to 251.4**<br>*Award B1 if divisor **seen** not to be 85 but answer in range*<br><br>**Note:**<br>If B0 then can award<br>M1 for attempt at $\sum fx \div 85$ **seen** | B2 | | AWFW $\sum fx$ = 21352  $\bar{x}$ = 251.2<br><br><br>*Ignore notation and condone incorrect midpoints (eg upper or lower limits used)* |
| | Standard deviation, $s$ or $\sigma$ = **4.21 to 4.28**<br>*Award B1 if divisor **seen** not to be 84 or 85 but answer in range* | B2 | 4 | AWFW $\sum fx^2$ = 5365134<br>$\sigma$ = 4.217      $s$ = 4.242 |
| **(c)** | Interquartile range (IQR) | B1 | | Named |
| | Not affected by unknown/large/small/extreme/ outlying/227 & 271 values | Bdep1 | 2 | Or equivalent<br>Dependent on previous B1<br>Only negative comments on other measures $\Rightarrow$ Bdep0 |
| | **OR** | | | *More than one named  $\Rightarrow$  B0 Bdep0*<br>*Range  $\Rightarrow$  B0 Bdep0* |
| | Standard deviation ($s$ or $\sigma$) | (B1) | | Named |
| | Uses all data values | (Bdep1) | | Or equivalent<br>Dependent on previous (B1)<br>Only negative comments on other measures $\Rightarrow$ Bdep0 |
| | **Total** | | **11** | |

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **2** | | | | |
| **(a)(i)** | Diameter, $D \sim N(57.15, \ 0.04^2)$ <br><br> $P(D < 57.2) = P\left(Z < \dfrac{57.2 - 57.15}{0.04}\right)$ | M1 | | Standardising 57.2 with 57.15 and 0.04; allow $(57.15 - 57.2)$ |
| | $= P(Z < \mathbf{1.25})$ | A1 | | CAO; ignore inequality and sign <br> May be implied by a **correct** answer |
| | $= \mathbf{0.894 \ to \ 0.895}$ | A1 | 3 | AWFW $\qquad$ (0.89435) |
| **(ii)** | $P(57.1 < D < 57.2)$ | | | Allow even if incorrect standardising providing $p - (1 - p)$ **seen** <br> May be implied by a correct answer |
| | $= p - (1 - p)$ | M1 | | |
| | $= 2 \times 0.89435 - 1 = \mathbf{0.788 \ to \ 0.79(0)}$ | A1 | 2 | AWFW $\qquad$ (0.78870) |
| **(b)(i)** | $P(16 \ balls \ < 57.2) = p^{16} \quad$ with $\quad 0 < p < 1$ | M1 | | Any probability to power 16 or $1 - p^{16}$; do **not** allow multiplying factors <br> *If only seen in (b)(ii), allow just M1* |
| | $= [(a)(i)]^{16} = (0.89435)^{16} = \mathbf{0.166 \ to \ 0.17(0)}$ | A1 | 2 | AWFW $\qquad$ (0.16754) |
| **(ii)** | Variance of $\bar{D}_{16} = \mathbf{0.04^2/16 = 0.0001}$ <br> **or** <br> Sd of $\bar{D}_{16} = \mathbf{0.04/\sqrt{16} = 0.01}$ | B1 | | CAO <br> Stated or used (*see* **Notes** *below*) <br> CAO <br> *If only seen in (b)(i), allow just B1* |
| | $P(\bar{D}_{16} > 57.16) = P\left(Z > \dfrac{57.16 - 57.15}{0.01}\right)$ | M1 | | Standardising 57.16 with 57.15 and **0.01 or equivalent**; allow $(57.15 - 57.16)$ |
| | $= P(Z > 1) = 1 - P(Z < 1)$ | m1 | | Area change <br> May be implied by a correct answer or answer $< 0.5$ |
| | $= 1 - 0.84134 = = \mathbf{0.158 \ to \ 0.159}$ | A1 | 4 | AWFW $\qquad$ (0.15866) <br> $(1 - $ answer$) \Rightarrow$ B1 M1 max |
| | **Notes:** <br> Ignore partial/incomplete attempts at (ii) in (i) if followed by correct method | | | Mark two complete answers in (i) as two attempts so $(0 + 2)/2 \Rightarrow$ 1max |
| | Answer to (i) or (ii) repeated | | | Mark as per scheme; thus <br> (2 max, 0) or (0, 4 max) |
| | **Total** | | **11** | |

| Q | Solution | Marks | Total | Comments |
|---|----------|-------|-------|----------|
| **3** | | | | |
| **(a)** | $b$ (gradient) = **191** <br> $b$ (gradient) = **190 to 192** | B2 <br> (B1) | | CAO <br> AWFW <br> *Treat rounding of correct answers as ISW* |
| | $a$ (intercept) = **115** <br> $a$ (intercept) = **93 to 137** | B2 <br> (B1) | 4 | CAO <br> AWFW |
| | **OR** | | | |
| | Attempt at $\sum x$ $\sum x^2$ $\sum y$ & $\sum xy$ $\left(\sum y^2\right)$ <br> **or** <br> Attempt at $S_{xx}$ & $S_{xy}$ $\left(S_{yy}\right)$ | (M1) | | 154 3452 30219 & **677042** <br> (133170091)   (all 4 attempted) <br><br> 12224 & **64** (2714668) <br> (both attempted) |
| | Attempt at **correct** formula for $b$ (gradient) <br> $b$ (gradient) = **191** <br> $a$ (intercept) = **115** | (m1) <br> (A1) <br> (A1) | | <br> CAO <br> CAO |
| | Accept $a$ & $b$ interchanged only if identified and used correctly in (ii) | | | If $a$ and $b$ are not identified anywhere in question, then: <br> 190 to 192 $\Rightarrow$ B1 <br> 93 to 137 $\Rightarrow$ B1 |
| **(ii)** | $y_{24}$ = 115 + 191 × 24 <br> = **£4699 or £4700** <br> = **£4650 to £4750** <br> **SC:** $(4290 + 5057)/2$ = 4673 to 4674 $\Rightarrow$ B1 <br><br> If B0 but **clear evidence** of correct use of c's equation with $x = 24$ | B2 <br> (B1) <br><br> (M1) | 2 | Either; ignore units   (£4699) <br> AWFW |
| **(iii)** | (Maximum) **temperature** (in February) is likely to be/will be lower/different <br><br> Must imply a temperature comparison with July | B1 | 1 | Or equivalent; must be **clear indication** that (max) **temperature** is less than/different <br> Extrapolation/not July/not summer/winter/etc $\Rightarrow$ B0 |
| **(iv)** | Rainfall amount/wind strength/sunshine hours/ daylight hours/opening times/day of week/ visitor numbers/public holidays/school holidays/ local attractions/etc <br><br> Allow if at least 1 variable correctly identified | B1 | 1 | Or equivalent <br> Accept any sensible reason; do **not** penalise for dubious 'variable name' so, for example, accept 'rainfall' <br> Minimum/average temp/etc $\Rightarrow$ B0 <br> Quality or price of food/ staff/etc $\Rightarrow$ B0 |
| | **Total** | | **8** | |

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **3** | | | | |
| **(b)** | Any line (straight, freehand, curve) from $(0, -1)$ on Figure 1 **or** from $(0, 5)$ on Figure 2 | B1 | | Accept **clear marking** of $(0, -1)$ **or** $(0, 5)$ with no line |
| **(i)** | **Straight,** not freehand, line from $(0, -1)$ **to** $(40, 5)$ on F1 only; allow line extensions and only **very** minor inaccuracies in points plotted | B1 | | $(10, 0.5)$    $(20, 2)$    $(30, 3.5)$ |
| **(ii)** | **Straight ,** not freehand, line from $(0, 5)$ **to** $(10, 1)$ on F2 only; allow line extensions and only **very** minor inaccuracies in points plotted | B1 | 3 | $(2, 4.2)$    $(4, 3.4)$    $(6, 2.6)$    $(8, 1.8)$ |
| | **Notes:** Both lines on F1 $\Rightarrow$ B1 B1 B0 max Both lines on F2 $\Rightarrow$ B1 B0 B1 max >1 undeleted line on either F1 or F2 $\Rightarrow$ 2 max | | | |
| | **Total** | | **3** | |

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **4** **(a)** | $\sqrt{\dfrac{184.5}{49}}$   **or**   $1.92 \times \sqrt{\dfrac{50}{49}}$ $= 1.94$ | B1 | 1 | **Fully correct** expression or equivalent must be **seen** **Note:** $s = \sqrt{184.5/50} = 1.939 \;\Rightarrow\;$ B0 AG |
| **(b)** **(i)** | $96\% \; (0.96) \;\Rightarrow\; z = \mathbf{2.05 \; to \; 2.06}$ | B1 | | AWFW                              (2.0537) |
| | CI for $\mu$ is   $\bar{x} \;\pm\; z \times \dfrac{s}{\sqrt{n}}$ | M1 | | Used with 251.1 and 1.94 correctly Must have $\sqrt{n}$ with $n > 1$ |
| | Thus   $251.1 \pm 2.0537 \times \dfrac{1.94}{\sqrt{50 \text{ or } 49}}$ | AF1 | | F on $z$ only |
| | Hence   $\mathbf{251.1 \pm 0.6}$ **or** $\mathbf{(250.5, \; 251.7)}$ | Adep1 | 4 | CAO/AWRT Dependent on AF1 but not on $z$ so can be gained using an incorrect $z$ AWRT |
| **(ii)** | Claim is $\mu > 250$ | | | |
| | **Clear correct comparison** of **250** with **LCL or CI** so | BF1 | | F on CI              (250 < LCL or CI) |
| | Claim is supported/reasonable/correct/true/etc Must be consistent with c's comparison | Bdep1 | 2 | Dependent on BF1 |
| **(c)** | $\bar{x} - ns \;=\; 251.1 - n \times 1.94 \;<\; 250$ **SC:** Quoted values of 249.2, 247.2 or 245.3 (AWRT) $\Rightarrow$ M1 so | M1 | | Allow any multiple of 1.94 Must **clearly indicate** the value of a numerical expression giving a result less than 250 |
| | Some individual packets are likely to/will contain less than 250 grams | A1 | 2 | Or equivalent |
| | **Total** | | **9** | |

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **5** **(a)(i)** | <table><tr><td></td><td>**J**</td><td>**J′**</td><td>**Total**</td></tr><tr><td>**W**</td><td>**0.55**</td><td>**0.10**</td><td>0.65</td></tr><tr><td>**W′**</td><td>0.15</td><td>**0.20**</td><td>**0.35**</td></tr><tr><td>**Total**</td><td>**0.70**</td><td>0.30</td><td>1.00</td></tr></table> **Notes:** Use of Venn or tree diagrams **without** table completion $\Rightarrow$ B0 B0 B0 Printed table not completed but constructed and completed on Page 12/13 $\Rightarrow$ B1 B1 B1 max | B1 B1 B1 | 3 | **0.35 and 0.7**; CAO **0.55**; CAO **0.1 and 0.2**; CAO Accept fractional answers Do not accept percentages |
| **(ii)** | P(purchases exactly one) $= \mathrm{P}(W \cap J') + 0.15$ $= 0.10 + 0.15$ $= \mathbf{0.25 \ or \ 25/100 \ or \ 5/20 \ or \ 1/4}$ | M1 A1 | 2 | Only c's equivalent to 0.10 **shown and added to** 0.15 Can be implied by **correct** answer CAO |
| **(iii)** **(A)** | $\mathrm{P}(W \cup J) = \mathbf{0.8}$ **&/≠** $\mathrm{P}(W) + \mathrm{P}(J) = \mathbf{1.35}$ or $\mathrm{P}(W \cap J) = \mathbf{0.55}$ (>0); accept if indicated in a Venn diagram or $\mathrm{P}(W) + \mathrm{P}(J) = \mathbf{1.35 >0 \ or \ impossible}$ | B1 | | Any one of these three **seen** *Ignore contradictions, explanations & justifications* *Do **not** accept use of W′ and/or J′* |
| **(B)** | $\mathrm{P}(W \mid J) = 0.55/0.70 = \mathbf{0.79}$ **&/≠** $\mathrm{P}(W) = \mathbf{0.65}$ or $\mathrm{P}(J \mid W) = 0.55/0.65 = \mathbf{0.85}$ **&/≠** $\mathrm{P}(J) = \mathbf{0.70}$ or $\mathrm{P}(W) \times \mathrm{P}(J) = \mathbf{0.45 \ to \ 0.46}$ **&/≠** $\mathrm{P}(W \cap J) = \mathbf{0.55}$ | B1 Bdep1 | 3 | AWRT Any one of these three **seen** *Ignore contradictions, explanations & justifications* AWFW |
| **(b)** **(i)** | **Do not allow multiplying factors in (b)** P(0) = $0.15 \times 0.40 \times 0.45$ $= \mathbf{0.027 \ or \ 27/1000}$ | B1 B1 | 2 | Can be implied by **correct** answer or $1 - (0.2265 + 0.466 + 0.2805)$ CAO |
| **(ii)** | P(2) = $\mathbf{0.85} \times \mathbf{0.60} \times \mathbf{0.45} = 0.2295$ $+ \ \mathbf{0.85} \times \mathbf{0.40} \times \mathbf{0.55} = 0.1870$ $+ \ \mathbf{0.15} \times \mathbf{0.60} \times \mathbf{0.55} = 0.0495$ **or** $= 1 - (\mathbf{0.027} + \mathbf{0.2265} + \mathbf{0.2805})$ $= \mathbf{0.466 \ or \ 466/1000 \ or \ 233/500}$ | M2 (M1) A1 | 3 | *For either method:* **At least two bold** expressions correct **Only one bold** expression correct Can be implied by **correct** answer *For second method:* Must have '1 −' for any marks CAO; **do not** imply this from (i) |
| | **Total** | | **13** | |

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **6** | | | | |
| **(a)** **(i)** | $\underline{X \sim B(10, 0.15)}$ <br><br> $P(X \leq 2) = \mathbf{0.82(0)}$ | B1 | 1 | AWRT (0.8202) |
| **(ii)** | $P(X \geq 2) = 1 - P(X \leq 1)$ <br><br> $= \mathbf{1 - (0.5443 \ or \ 0.8202)}$ | M1 | | Requires '1 –' <br> Accept 3/2 dp rounding or truncation <br> Can be implied by 0.455 to 0.456 <br> but **not** by 0.179 to 0.18(0) |
| | $= \mathbf{0.455 \ to \ 0.456}$ | A1 | 2 | AWFW (0.4557) |
| **(iii)** | $P(1 < X < 5) = \mathbf{0.9901 \ or \ 0.9986}$ $\quad (p_1)$ | M1 | | Accept 3 dp rounding or truncation <br> $p_2 - p_1 \Rightarrow$ M0 M0 A0 <br> $(1 - p_2) - p_1 \Rightarrow$ M0 M0 A0 <br> $p_1 - (1 - p_2) \Rightarrow$ M1 M0 A0 <br> only providing result $> 0$ |
| | $\mathbf{minus \ 0.5443 \ or \ 0.1969}$ $\quad (p_2)$ | M1 | | Accept 3 dp rounding or truncation |
| | $= \mathbf{0.445 \ to \ 0.446}$ | A1 | 3 | AWFW (0.4458) |
| | **OR** <br> B(10, 0.15) expressions stated for **at least 3** terms within $1 \leq X \leq 5$ gives probability | (M1) | | Can be implied by a correct answer |
| | $= \mathbf{0.445 \ to \ 0.446}$ | (A2) | | AWFW (0.4458) |
| **(b)** | $\underline{Y \sim B(50, 0.15)}$ | | | Normal approximation $\Rightarrow$ 0 marks |
| **(i)** | $P(Y > 5) = 1 - P(Y \leq 5)$ <br><br> $= \mathbf{1 - (0.2194 \ or \ 0.1121)}$ | M1 | | Requires '1 –' <br> Accept 3 dp rounding or truncation <br> Can be implied by 0.78(0) to 0.781 <br> but **not** by 0.888 to 0.89 |
| | $= \mathbf{0.78(0) \ to \ 0.781}$ | A1 | 2 | AWFW (0.7806) |
| **(ii)** | $P(5 \leq Y \leq 10) = \mathbf{0.8801 \ or \ 0.7911}$ $\quad (p_1)$ | M1 | | Accept 2/3 dp rounding or truncation <br> $p_2 - p_1 \Rightarrow$ M0 M0 A0 <br> $(1 - p_2) - p_1 \Rightarrow$ M0 M0 A0 <br> $p_1 - (1 - p_2) \Rightarrow$ M1 M0 A0 <br> only providing result $> 0$ |
| | $\mathbf{minus \ 0.1121 \ or \ 0.2194}$ $\quad (p_2)$ | M1 | | Accept 3 dp rounding or truncation |
| | $= \mathbf{0.768}$ | A1 | 3 | AWRT (0.7680) |
| | **OR** <br> B(50, 0.15) expressions stated for **at least 3** terms within $4 \leq Y \leq 10$ gives probability | (M1) | | Can be implied by a correct answer |
| | $= \mathbf{0.768}$ | (A2) | | AWRT (0.7680) |
| | **Total** | | **11** | |

| Q | Solution | Marks | Total | Comments |
|---|----------|-------|-------|----------|
| **7** | | | | |
| **(a)** | **Ryan:** Value indicates that as **volume increases** then **weight decreases** | B1 | | Or equivalent in context |
| | **Sunil:** Value indicates **no correlation/relationship/ association/link** between **volume and weight** | B1 | 2 | Or equivalent in context |
| | **SC**: If B0 B0: Would expect **weight** to **increase** with **volume** **or** Would expect **strong**(er) **positive** correlation between **weight** and **volume** | (B1) | | Or equivalent in context |
| **(b)** | **Ryan & Sunil:** $r$ is not affected by units/(linear) scaling | B1 | | Or equivalent |
| | **Tim:** $r$ is not affected by sample size **or** $2 \times 0.612 > 1 \implies$ impossibility | B1 | 2 | Either; or equivalent |
| **(c)** **(i)** | $r = $ **0.541 to 0.543** $r = $ **0.54 to 0.55** $r = $ **0.5 to 0.6** | B3 (B2) (B1) | 3 | AWFW (0.54186) AWFW AWFW |
| | **OR** Attempt at $\sum v$ $\sum v^2$ $\sum w$ $\sum w^2$ & $\sum vw$ **or** Attempt at $S_{vv}$ $S_{ww}$ & $S_{vw}$ | (M1) | | 216  6633.16  136  2376.84  & **3795.5** (all 5 attempted) Accept notation of $x$ and $y$ 801.16  64.84  & **123.5** (all 3 attempted) |
| | Attempt at substitution into **correct** corresponding formula for $r$ | (m1) | | |
| | $r = $ **0.541 to 0.543** | (A1) | | AWFW |
| **(ii)** | (Quite or fairly) **weak/some/moderate** **positive** (linear) **correlation**/relationship/ association/link (*but not ' trend'*) between | Bdep1 | | Dependent on **$0.5 \leq r \leq 0.6$** Or equivalent; must **qualify strength** and **state positive** Bdep0 for very strong/strong/high/ good/average/medium/reasonable/ poor/very weak/little/etc |
| | **volumes** and **weights** of suitcases | B1 | 2 | Context; providing **$0 < r < 1$** |
| | **Total** | | **9** | |
| | **TOTAL** | | **75** | |