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ASSESSMENT and QUALIFICATIONS ALLIANCE

## General Certificate of Education

# Mathematics 6360
# Statistics 6380

## MS/SS1B Statistics 1B

# Mark Scheme

*2008 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.



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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**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **1(a)** | *b* (gradient) = –1.01 to –1(.00)<br>(*b* (gradient) = –1.05 to –0.95) | B2<br>(B1) | | AWFW (–1.00337) |
| | *a* (intercept) = 53(.0) to 53.2<br>(*a* (intercept) = 52(.0) to 54(.0)) | B2<br>(B1) | 4 | AWFW (53.06736) |
| | **OR** | | | |
| | Attempt at $\sum x$, $\sum x^2$, $\sum y$ and $\sum xy$<br>**or**<br>Attempt at $S_{xx}$ and $S_{xy}$ | (M1) | | 180, 3986, 297 and 5552.7<br><br>386 and –387.3 |
| | Attempt at **correct** formula for *b* (gradient) | (m1) | | |
| | *b* (gradient) = –1.01 to –1(.00)<br>*a* (intercept) = 53(.0) to 53.2 | (A1)<br>(A1) | | AWFW<br>AWFW |
| | Accept *a* and *b* interchanged only if then identified correctly in part (b), but B2 in (b) does **not** necessarily imply 4 marks in (a) | | | |
| **(b)** | When $x$ = 21, | | | |
| | $y$ = 31.7 to 32.2<br>($y$ = 29.9 to 34.1) | B2<br>(B1) | 2 | AWFW (32.0)<br>AWFW |
| | Evidence of use of 21 in c's equation | (M1) | | |
| | *Special Cases (if seen)*: | | | |
| | $y = \frac{33.0+30.7}{2}$ = 31.8 to 31.9 | (B1) | | AWFW; or equivalent |
| | $y$ = 31.85 without working | (B1) | | |
| | **Total** | | **6** | |

**MS/SS1B (cont)**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **2(a)** | P(*B*lue) = $\frac{160}{400}$ = 0.4 or $\frac{2}{5}$ or $\frac{160}{400}$ | B1 | 1 | CAO; or equivalent |
| | *In (b) to (e), method marks are for single fractions, or equivalents, only* | | | |
| **(b)** | P(*M*arker) = $\frac{280}{400}$ | M1 | | 270 ≤ Numerator ≤ 290 and Numerator < Denominator ≤ 400 |
| | = 0.7 or $\frac{7}{10}$ or $\frac{280}{400}$ | A1 | 2 | CAO; or equivalent |
| **(c)** | P(*B* or *M*) = P($B \cup M$) = | | | |
| | $\frac{160+280-119}{400} = \frac{280+41}{400} = \frac{321}{400}$ | M1 | | 290 ≤ Numerator ≤ 321 and Numerator < Denominator ≤ 400 |
| | = 0.802 to 0.803 or $\frac{321}{400}$ | A1 | 2 | AWFW/CAO (0.8025) |
| **(d)** | P(*G*reen \| *H*ighlighter) = P($G \mid H$) = $\frac{42}{120}$ | M1 | | Numerator = 42 and 110 ≤ Denominator ≤ 120 |
| | = 0.35 or $\frac{7}{20}$ or $\frac{42}{120}$ | A1 | 2 | CAO; or equivalent |
| **(e)** | P(*N*on-*P*ermanent \| *R*ed) = P($P' \mid R$) = $\frac{21}{90}$ | M1 | | Numerator = 21 and 80 ≤ Denominator ≤ 90 |
| | = 0.233 to 0.234 or $\frac{7}{30}$ or $\frac{21}{90}$ | A1 | 2 | AWFW/CAO (0.2333) |
| | **Total** | | **9** | |

**MS/SS1B (cont)**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **3(a)** | $r$ = 0.806 to 0.807 | B3 | 3 | AWFW (0.80656) |
| | ($r$ = 0.8(0) to 0.81) | (B2) | | AWFW |
| | ($r$ = 0.7 to 0.9) | (B1) | | AWFW |
| | **OR** | | | |
| | Attempt at $\sum x$, $\sum x^2$, $\sum y$, $\sum y^2$ and $\sum xy$ | | | 2859, 681575, 1428, 170342 and 340555 |
| | **or** | (M1) | | |
| | Attempt at $S_{xx}$, $S_{yy}$ and $S_{xy}$ | | | 418.25, 410 and 334 |
| | Attempt at **correct** formula for $r$ | (m1) | | |
| | $r$ = 0.806 to 0.807 | (A1) | | AWFW |
| **(b)** | **Moderate/fairly strong/strong positive correlation** (relationship/association) | B1 | | Or equivalent; must qualify strength and indicate positive<br>B0 for some/average/medium/very strong/etc |
| | between<br>**length and width** of plaques | B1 | 2 | Context; providing $0 < r < 1$ |
| **(c)** | **Figure 1:** | | | |
| | 6 correct labelled points | B3 | 3 | |
| | (5 correct labelled points) | (B2) | | Deduct 1 mark if not labelled |
| | (4 correct labelled points) | (B1) | | |
| **(d)** | A to F: $r$ = –0.2 to +0.2 | B1 | | AWFW (–0.0275)<br>No penalties for calculations |
| | Accept 'Zero' but not 'No' correlation | | | Statements must include a **single value** within range |
| | G to L: $r$ = –0.2 to +0.2 | B1 | 2 | AWFW (–0.0196) |
| | *Special Cases*: | | | |
| | $r$ = –0.2 to +0.2 with **no** sources | (B1) | | AWFW |
| | $r$ = –0.2 to +0.2 for **each/both** source(s) | (B2) | | AWFW; or equivalent identification |
| | If B0 B0 but both values of<br>$r$ = –0.4 to +0.4 | (B1) | | AWFW |
| | **Total** | | **10** | |

**MS/SS1B (cont)**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **4(a)** | Ordering:<br>0 0 13 28 35 40 47 51 63 77 *a* | M1 | | May be implied by 40 and/or 63 and 13 |
| | Median ($6^{th}$) = 40 | B1 | | CAO |
| | IQR = $Q_3(9^{th})$ – $Q_1(3^{rd})$ | | | |
| | = 63 – 13 | (B1) | | Identification of 63 and 13 |
| | = 50 | B2 | 4 | CAO |
| **(b)(i)** | *Mode*:<br>Zero is not representative / sensible reason<br>Wide range of (known) values<br>Small number of values mostly different | B1 | | Or equivalent |
| **(ii)** | *Range*:<br>Largest value, *a*, is unknown<br>Cannot be calculated | B1 | 2 | Or equivalent |
| | **Total** | | **6** | |

**MS/SS1B (cont)**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **5** | Height $X \sim N(140, 2.5^2)$ | | | |
| **(a)(i)** | $P(X < 145) = P\left(Z < \frac{145-140}{2.5}\right) =$ | M1 | | Standardising (144.5, 145 or 145.5) with 140 and ($\sqrt{2.5}$, 2.5 or $2.5^2$) and/or (140 – $x$) |
| | $P(Z < 2) =$ | A1 | | 2 CAO; ignore sign |
| | 0.977 to 0.98(0) | A1 | 3 | AWFW (0.97725) |
| **(ii)** | $P(138 < X < 142) =$ | | | |
| | $P(X < 142) - P(X < 138) =$ | M1 | | Difference (142 – 138) |
| | $P(Z < 0.8) - P(Z < -0.8) =$ | B1 | | 0.8 CAO |
| | $P(Z < 0.8) - \{1 - P(Z < 0.8)\} =$<br>$(0.78814) - (1 - 0.78814) =$ | m1 | | Correct area change |
| | 0.576 to 0.58(0) | A1 | 4 | AWFW (0.57628) |
| **(b)** | 0.85 (85%) $\Rightarrow z = -1.03$ to $-1.04$ | B1 | | AWFW; ignore sign (–1.0364) |
| | $z = \frac{x-140}{2.5}$ | M1 | | Standardising $x$ with 140 and 2.5; allow (140 – $x$) |
| | $= \pm 1.03$ to $\pm 1.04$ | A1 | | Equating $z$-term to the $z$-value |
| | Hence $x = 137.3$ to 137.5 | A1 | 4 | AWFW; CSO (137.41) |
| **(c)** | Variance of $\bar{X}_4 = \frac{2.5^2}{4} = 1.56(25)$<br>SD of $\bar{X}_4 = \frac{2.5}{2} = 1.25$ | B1 | | CAO; stated or used |
| | $P(\bar{X}_4 > 139) = P\left(Z > \frac{139-140}{\sqrt{2.5^2/4}}\right) =$ | M1 | | Standardising 139 with 140 and 1.25; allow (140 – 139) |
| | $P(Z > -0.8) = P(Z < 0.8) =$ | m1 | | Correct area change |
| | 0.788 to 0.79(0) | A1 | 4 | AWFW (0.78814) |
| | **Total** | | **15** | |

**MS/SS1B (cont)**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **6** | Binomial distribution | M1 | | Used somewhere in question |
| **(a)(i)** | $M \sim$ B(40, 0.35) | A1 | | Used; may be implied |
| | P($M \leq 15$) = 0.69(0) to 0.696 | A1 | 3 | AWFW (0.6946) |
| **(ii)** | P($10 < M < 20$) = | | | |
| | 0.9637 or 0.9827 | M1 | | Accept 3 dp accuracy |
| | minus 0.1215 or 0.0644 | M1 | | Accept 3 dp accuracy |
| | = 0.84(0) to 0.843 | A1 | 3 | AWFW (0.8422) |
| | **OR** | | | |
| | B(40, 0.35) expressions stated for **at least 3** terms within $10 \leq M \leq 20$ | (M1) | | Or implied by a correct answer |
| | Answer = 0.84(0) to 0.843 | (A2) | | AWFW |
| **(b)** | $W \sim$ B(10, 0.29) | B1 | | Used; may be implied |
| | P($W = 3$) = $\binom{10}{3}(0.29)^3(0.71)^7$ | M1 | | Stated; may be implied |
| | = 0.266 to 0.2665 | A1 | 3 | AWFW (0.2662)<br>**Note**: B(10, 0.3) $\Rightarrow$ 0.2668 |
| **(c)(i)** | $n = 20$ $p = 0.71$ | B1 | | Stated or used; may be implied by 14.2 |
| | Mean, $\mu = np = 14.2$ | B1 | | CAO |
| | Variance, $\sigma^2 = np(1-p)$ = 4.11 to 4.12 | B1 | 3 | AWFW (4.118) |
| **(ii)** | Mean of 16.5 is greater/different **or** 16.5/20 = 0.825 is greater/different to 0.71 | B1dep | | Dependent on $\mu = 14.2$ |
| | *Means and variances are different* | *(B2,1 dep)* | | |
| | Variance of 2.50 is smaller/different | B1dep | | Dependent on $\sigma^2$ = 4.11 to 4.12 |
| | Suggests **claim** that groups are not random samples **is justified** | B1dep | 3 | Dependent on previous 2 marks<br>Or equivalent |
| | **Total** | | **15** | |

**MS/SS1B (cont)**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **7(a)(i)** | $x$: –5 –3 –1 1 3 5 7 9<br>$f$: 4 9 13 27 21 15 7 4 | | | |
| | Mean ($\bar{x}$) = 1.9<br>(0.9 to 2.9) | B2<br>(B1) | | CAO (190)<br>AWFW |
| | Standard deviation ($s_{n-1}$ or $\sigma_n$) =<br>3.3(0) to 3.32<br>(3(.00) to 3.5(0)) | <br>B2<br>(B1) | <br>4 | (1452)<br>AWFW (3.31967)<br>AWFW (3.30303) |
| | If no marks scored but $\sum fx$ attempted and result divided by 100 | (M1) | | |
| **(ii)** | Mean = 60 + $\bar{x}$<br>= 61.9 | M1<br>A1√ | | √ on (a)(i) |
| | Standard deviation = 3.3(0) to 3.32 | B1√ | 3 | √ on (a)(i); accept 'same as' only providing answer in (a)(i) |
| **(b)(i)** | 98% $\Rightarrow$ $z$ = 2.32 to 2.33<br>($\Rightarrow$ $t$ = 2.36 to 2.37) | B1 | | AWFW (2.3263)<br>AWFW (2.364) |
| | CI for $\mu$ is $\bar{x} \pm z/t \times \frac{s_{n-1} \text{ or } \sigma_n}{\sqrt{n \text{ or } n-1}}$ | M1 | | Used; must have $\sqrt{n}$ with $n > 1$ |
| | Thus $61.9 \pm 2.3263 \times \frac{3.3 \text{ to } 3.32}{\sqrt{100 \text{ or } 99}}$ | A1√ | | √ on (a)(ii) and $z/t$ only |
| | Hence 61.9 ± (0.7 to 0.8)<br>**or** (61.1 to 61.2, 62.6 to 62.7) | A1 | 4 | Accept 1.03 ± (0.012 to 0.013)<br>AWFW<br>Accept (1.01 to 1.02, 1.04 to 1.05) |
| **(ii)** | Mean and SD based upon grouped data<br>SD (**not mean**) calculated from a sample<br>CLT used / Times (may) not (be) normal | B1 | 1 | Actual times/values unknown<br>Or equivalent |
| **(c)** | $S$ > *1 hour or 60 minutes*:<br>**Valid** as 74/100 or 0.74 or 74% > 50% | B1 | | Must use 74 etc<br>Or equivalent |
| | $\bar{S}$ >> *1 hour or 60 minutes*:<br>**Not valid** as UCL ≈ 1 hour<br>(Accept Both limits ≈ 1 hour) | B1dep | 2 | Dependent on<br>UCL = 62.6 to 62.7 or<br>UCL = 1.04 to 1.05 |
| | **Total** | | **14** | |
| | **TOTAL** | | **75** | |