Version 1.0

**General Certificate of Education (A-level)**
**June 2013**

# Mathematics/Statistics MS/SS1A/W

# (Specification 6360/6380)

# Statistics 1A

# 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 students' 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 students' 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 students' 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 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.**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **1(a)** | 98% (0.98) $\Rightarrow$ $z$ = **<u>2.32 to 2.33</u>** | B1 | | AWFW (2.3263) |
| | CI for $\mu$ is $\bar{x} \pm z \times \frac{\sigma}{\sqrt{n}}$ | M1 | | Used with $z$ (2.05 to 2.58), $\bar{x}$ (19.9) and $\sigma$(0.4) and $\div\sqrt{n}$ with $n > 1$ |
| | Thus $19.9 \pm 2.3263 \times \frac{0.4}{\sqrt{25}}$ | A1 | | $z$ (2.05 to 2.06 or 2.32 to 2.33 or 2.57 to 2.58), $\bar{x}$ (19.9) and $\sigma$(0.4) and $\div\sqrt{25 \text{ or } 24}$ |
| | Hence **<u>19.9 ± 0.2</u>** **or** **<u>(19.7, 20.1)</u>** | A1 | 4 | CAO/AWRT (0.186104) AWRT |
| **(b)** | **Clear correct comparison** of **20** with **CI** eg 20 is within CI **or** LCL < 20 < UCL so | BF1 | | F on CI providing it contains 20 Quoting values for CI is **not** required |
| | Agree with claim **or** no reason to doubt claim | Bdep1 | 2 | OE; dependent on previous BF1 |
| | **Total** | | **6** | |

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| | | | | **Accept percentage equivalents except for 27** |
| **2(a)(i)** | $\underline{O \sim \text{B}(40, p)}$ | | | |
| | $\text{P}(NS \leq 10) = \underline{\mathbf{0.97}}$ | B1 | 1 | AWRT (0.9701) |
| **(ii)** | | | | Requires '1 –' |
| | $\text{P}(LPE \geq 25) = \underline{\mathbf{1 - (0.9231 \text{ or } 0.9597)}}$ | M1 | | Accept 3 dp rounding<br>Can be implied by (0.0769 to 0.077)<br>but **not** by (0.04 to 0.0403) |
| | $= \underline{\mathbf{0.077}}$ | A1 | 2 | AWRT (0.0769) |
| **(iii)** | $\text{P}(UPE = 2) = \binom{40}{2}(0.175)^2(0.825)^{38}$ | M1 | | Correct expression; may be implied by a **correct** answer<br>Ignore extra terms |
| | $= \underline{\mathbf{0.016}}$ | A1 | 2 | AWRT (0.0160) |
| **(iv)** | | | | CAO; award on value only<br>May be implied by any of four probabilities below<br>or by a **correct** answer |
| | $p = 0.85 - 0.50 = \underline{\mathbf{0.35}}$ | B1 | | |
| | $\text{P}(10 < X < 15) = \mathbf{0.5721 \text{ or } 0.6946}$ $(p_1)$ | M1 | | Accept 3 dp rounding<br>May be implied by a **correct** answer |
| | **MINUS 0.1215 or 0.0644** $(p_2)$ | M1 | | Accept 3 dp rounding<br>May be implied by a **correct** answer |
| | $= \underline{\mathbf{0.45 \text{ to } 0.451}}$ | A1 | 4 | AWFW (0.4506) |
| **(b)** | $p = 0.85 - 0.175 = \underline{\mathbf{0.675}}$<br>**or**<br>$p' = \underline{\mathbf{0.325}}$ | B1 | | CAO; may be implied by 27<br>Each can be found in several ways<br>CAO; may be implied by 13 or 27 |
| | Number $= 40 \times 0.675 = \underline{\mathbf{27}}$ | B1 | 2 | CAO; can be found in several ways |
| | **Total** | | **11** | |

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **3(a)(i)** | Volume, $X \sim N(507.5, 4.0^2)$ | | | |
| | $P(X < 515) = P\left(Z < \frac{515 - 507.5}{4.0}\right)$ | M1 | | Standardising 515 with 507.5 and 4.0 but allow $(507.5 - 515)$ |
| | $P(Z < 1.875) =$ **0.97** | A1 | | AWRT (0.96960) |
| **(ii)** | $P(500 < X < 515) = P(-a < Z < a) =$ | | | |
| | $P(Z < a) - (1 - P(Z < a))$ **or** $2 \times P(Z < a) - 1$ | M1 | | OE; $a = 1.875$, $p = 0.97$ (AWRT) or correct standardising are not required. May be implied by a **correct** answer |
| | = [(i) – (1 – (i)) **or** (2 × (i)) – 1] = **0.94** | A1 | | AWRT (0.93921) |
| **(iii)** | $P(X \neq 507.5)$ = **1 or one or unity or 100%** | B1 | 5 | CAO; accept nothing else but ignore additional words providing that they are not contradictory (eg certain so = 1) |
| **(b)** | $0.96 \Rightarrow z =$ **1.75** | B1 | | AWRT (*ignore sign*) (1.7507) |
| | $\left(\frac{x - 507.5}{4.0}\right)$ = 1.5 to 2.1 | M1 | | Standardising $x$ with 507.5 and 4.0 but allow $(507.5 - x)$; **and** equating to a ***z*-value** (*ignore signs*) |
| | $x =$ **514 to 515** | A1 | 3 | AWFW (514.50) *Must be consistent signs throughout* |
| **(c)(i)** | $p =$ **(a)(ii)** [= 0.94] | BF1 | | F on (a)(ii) providing $0 < p < 1$ |
| | $P(\geq 5 \text{ in } 6) = (6 \times p^5 \times (1 - p)) + p^6$ | M1 | | Either expression with value of $p$ |
| | = **0.948 to 0.956** | A1 | 3 | AWFW (0.95296) |
| **(ii)** | V(mean) = $\mathbf{4^2/6}$ **or 2.66 to 2.67** | B1 | | CAO/AWFW (2.66667) |
| | **or** SD(mean) = $\mathbf{4/\sqrt{6}}$ **or 1.63** | | | CAO/AWRT (1.63299) |
| | $P(\bar{X} > 505) = P\left(Z > \frac{505 - 507.5}{4/\sqrt{6}}\right)$ | M1 | | Standardising 505 using 507.5 and $\mathbf{4/\sqrt{6}}$ **OE** but allow $(507.5 - 505)$ |
| | = P($Z >$ –**1.53**) | A1 | | AWRT; (*ignore sign*) |
| | = **0.93 to 0.94** | A1 | 4 | AWFW (0.93711) (1 – answer) $\Rightarrow$ B1 M1 max |
| | **Total** | | **15** | |

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **4(a)(i)** | $r_{gy} = \dfrac{24.15}{\sqrt{0.1196 \times 5880}}$ = **0.91 to 0.911** | M1<br>A1 | | May be implied by a **correct** answer in (a)(i) or (a)(ii) or (c)(i)<br>AWFW (0.91067) |
| **(ii)** | $r_{ly} = \dfrac{10.25}{\sqrt{0.0436 \times 5880}}$ = **0.64 to 0.641** | A1 | 3 | AWFW (0.64017) |
| **(b)** | (Very) **Strong positive** correlation | Bdep1 | | Dependent on $0.9 \leq r_{gy} < 1$ |
| | (Some) **Moderate positive** correlation | Bdep1 | | Dependent on $0.6 \leq r_{ly} \leq 0.7$<br>Bdep0 for any mention of 'strong' |
| | between<br>girth and weight **and/or** length and weight | B1 | 3 | At least one interpretation in context |
| **(c)(i)** | $r_{xy} = \dfrac{5662.97}{\sqrt{5656.15 \times 5880}}$ = **0.98 to 0.982** | B1 | | AWFW (0.98196) |
| | Most strongly correlated with $y$ is **x** | Bdep1 | 2 | CAO; dependent on $0.97 \leq r_{xy} < 1$ |
| **(ii)** | $x = 69.3 \times 1.25^2 \times 1.15$<br>= **124 to 125** | M1<br>A1 | 2 | May be implied by a **correct** answer<br>AWFW (124.52) |
| **(iii)** | $b = \dfrac{5662.97}{5656.15}$ | M1 | | 116/115.4 (= 1.005) ⇒ M0 A0 |
| | = **1 to 1.002** | A1 | | AWFW (1.00121) |
| | $a = 116 - 115.4b$ = **0.3 to 0.6** | B1 | 3 | AWFW (0.46085) |
| **(iv)** | $r_{xy}$ ≈/nearly/almost/close to (+)**1 or very strong/almost exact** (positive) **correlation**<br>(Stating $r_{xy} = 0.98$ to $0.982$ ⇒ Bdep0) | Bdep1 | | OE<br>Dependent on $0.97 \leq r_{xy} < 1$<br>OE; 'strong' is not sufficient |
| | $b$ =/≈/nearly/almost/close to (+)**1** | Bdep1 | | OE; must reference value of 1 or unity<br>Dependent on M1 A1 in (c)(iii) |
| | a ≈/nearly/almost/close to **0**<br>(Stating $a = 0.4$ to $0.6$ ⇒ Bdep0) | Bdep1 | | OE; must reference value of 0 or origin<br>Dependent on B1 in (c)(iii) |
| | **Estimate** (not 'it' or 'this' or 'value', etc) is (very/highly/likely to be) accurate/precise/ reliable **or** (almost) exact/correct | Bdep1 | 4 | OE; dependent on scoring **at least 2** of the previous 3 marks in (c)(iv)<br>Fairly accurate, good approximation, (quite) likely, (very) close, reasonable, etc ⇒ Bdep0 |
| | **Total** | | **17** | |

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **5(a)(i)** | $P(A = 2) = 0.90 \times 0.95 =$ **<u>0.85 to 0.86</u>** | B1 | | AWFW (0.855 or 171/200 OE) |
| **(ii)** | $P(A = 1) = (0.90 \times 0.05) + (0.10 \times 0.95)$ | M1 | | May be implied by a **correct** answer |
| | **or** $= 1 - [0.855 + (0.10 \times 0.05)]$ | | | Do **not** ignore extra terms |
| | $=$ **<u>0.14</u>** | A1 | 3 | CAO (7/50 OE) |
| **(b)(i)** | $P(A_W \cap D_W) = 0.90 \times 0.80$ | M1 | | May be implied by a **correct** answer |
| | $=$ **<u>0.72</u>** | A1 | 2 | CAO (18/25 OE) |
| **(ii)** | $P(A_B \cap D_B) = $ (b)(i) $\times 0.95$ ($\times 1$) | | | |
| | **or** $= 0.90 \times 0.80 \times 0.95$ ($\times 1$) | M1 | | May be implied by a **correct** answer |
| | **or** = (a)(i) $\times 0.80$ | | | |
| | **<u>0.68 to 0.685</u>** | A1 | 2 | AWFW (0.684 or 171/250 OE) |
| **(iii)** | $P(A_T \cap D'_T) = 0.95 \times 0 =$ **<u>0</u>** | B1 | 1 | CAO; award on value only |
| **(iv)** | P(neither) = $P([A'_W \cap D'_W] \cap [A'_T \cap D'_T])$ | | | |
| | $(1 - 0.90) \times (1 - 0.15)$ | M1 | | Accept 0.085 or 17/200 OE |
| | | | | Award M1 and m1 on value(s) only |
| | $(1 - 0.95) \times (1 - 0)$ | m1 | | Accept 0.05 or 1/20 OE |
| | **or** | | | |
| | P(neither) = | | | |
| | $P(A'_W \cap A'_T) \cap P(D'_W \mid A'_W) \cap P(D'_T \mid A'_T)$ | | | |
| | $(1 - 0.90) \times (1 - 0.95)$ | (M1) | | Accept 0.005 or 1/200 OE |
| | | | | Award M1 and m1 on value(s) only |
| | $(1 - 0.15) \times (1 - 0)$ | (m1) | | Accept 0.85 or 17/20 OE |
| | $= 0.085 \times 0.05$ **or** $0.005 \times 0.85$ | | | OE |
| | $=$ **<u>0.0042 to 0.0043</u>** | A1 | 3 | AWFW (0.00425 or 17/4000 OE) |
| | **Total** | | **11** | |
| | **TOTAL** | | **60** | |