

General Certificate of Education

Mathematics 6360

Statistics 6380

MS/SS1A Statistics 1A

Mark Scheme

2006 examination - January 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.

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/SS1A

| Q | Solution | Marks | Total | Comments |
|--------|--|----------------------|-----------|---------------------------------|
| 1(a) | Gradient, $b = 0.886$ to 0.887 $b = 0.88$ to 0.89 | B2 (B1) | | AWFW AWFW |
| | Intercept, $a = 2.31$ to 2.33 $a = 2.3$ | B2 (B1) | | AWFW AWRT |
| | Alternatively Attempt at Σx Σx^2 Σy Σxy or Attempt at S_{xx} S_{xy} | (M1) | | 72, 624, 87, 720 105.6, 93.6 |
| | Attempt at a correct formula for b $b = 0.886$ to 0.887 $a = 2.31$ to 2.33 | (m1) (A1) (A1) | | AWFW AWFW |
| | Accept a & b interchanged only if $y = ax + b$ stated or subsequently used correctly in either (b) or (c) | | 4 | |
| | (b) a : average waiting time of 2.32 minutes (139 seconds) when entering empty restaurant | B1 | | OE; accept minimum waiting time |
| | b : average increase in waiting time of 0.886 minutes (53 seconds) for each customer in restaurant on entry | B1 | 2 | OE |
| | (c) Use of $y = a + 5b$ or $y = a + 25b$ | M1 | | |
| | (i) For $x = 5$ $y = 6.6$ to 6.8 | | | |
| | (ii) For $x = 25$ $y = 24.3$ to 24.6 | A1 | 2 | Both; AFWW |
| (d)(i) | Reliable as interpolation and small residuals | B1 B1 | | Within range OE OE |
| | or Reliable as interpolation but large %age residuals so inconclusive | (B1) (B1) | | |
| | or Large %age residuals so unreliable | (B1) | | |
| | (ii) Unreliable as extrapolation | B1 | 3 | Outside range OE |
| | Total | | 11 | |

MS/SS1A (cont)

| Q | Solution | Marks | Total | Comments |
|-------------|--|----------|-----------|---|
| 2(a) | $P(X) = 0.3 \quad P(Y) = 0.4 \quad P(Z) = 0.2$ | | | |
| (i) | $P(X \cap Y \cap Z) = 0.3 \times 0.4 \times 0.2$ $= 0.024$ | M1 | 1 | |
| (ii) | $P(X' \cap Y' \cap Z') = 0.7 \times 0.6 \times 0.8$ $= 0.336$ | M1 A1 | 2 | At least 2 correct terms CAO |
| (iii) | $P(X' \cap Y' \cap Z) + P(X' \cap Y \cap Z') +$ $P(X \cap Y' \cap Z') =$ | M1 | | At least two different combinations of three events |
| | $(0.7 \times 0.6 \times 0.2) + (0.7 \times 0.4 \times 0.8) +$ $(0.3 \times 0.6 \times 0.8) =$ | A1 | | At least one correct numerical expression |
| | $0.084 + 0.224 + 0.144 = 0.452$ | A1 | 3 | CAO |
| (b) | $P(W Z) = 0.9 \quad P(W Z') = 0.25$ | | | |
| (i) | $P(Z \cap W) = 0.2 \times 0.9$ $= 0.18$ | M1 A1 | 2 | Correct numerical expression CAO |
| (ii) | $P((Z \cap W') \cup (Z' \cap W))$ or $1 - [P((Z \cap W) \cup (Z' \cap W'))]$ | | | |
| | $= 0.2 \times (1 - 0.9)$ + $(1 - 0.2) \times 0.25$ | M1 M1 | | 0.2×0.9 or (b)(i) $(1 - 0.2) \times (1 - 0.25)$ |
| | $= 0.02 + 0.20$ $= 0.22$ | A1 | 3 | Cannot score an M1 in both methods $1 - (0.18 + 0.60)$ CAO |
| | Total | | 11 | |

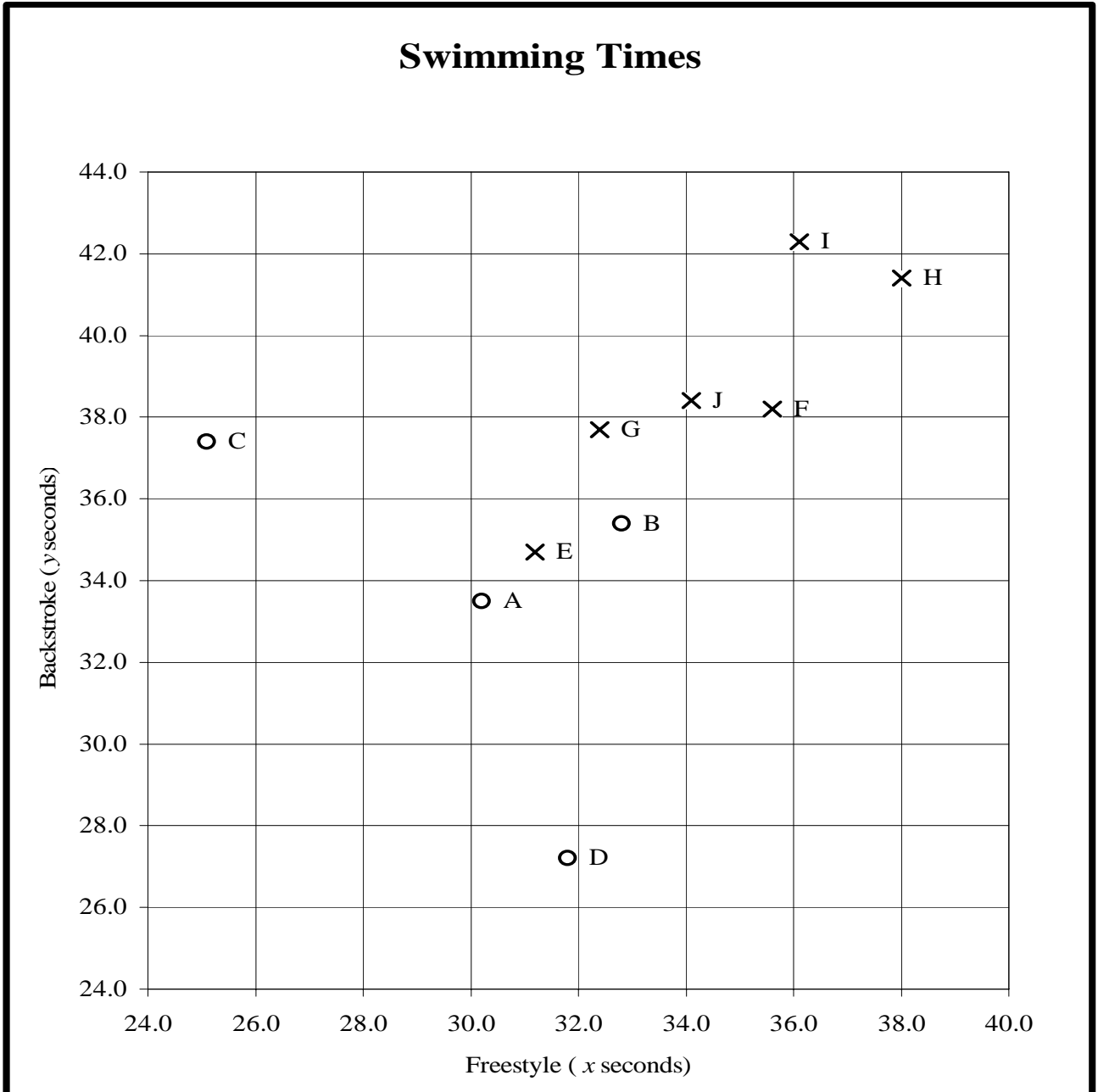
MS/SS1A (cont)

| Q | Solution | Marks | Total | Comments |
|------|--|-----------------|----------|---|
| 3(a) | Mean = $\frac{286.5}{50} = 5.73$ | B1 | | CAO |
| | Standard deviation = $\sqrt{\frac{45.16}{49 \text{ or } 50}} =$ 0.95 to 0.961 | B1 | 2 | AWFW |
| (b) | 99% $\Rightarrow z = 2.57$ to 2.58 | B1 | | AWFW 2.5758 |
| | CI for μ is $\bar{x} \pm z \times \frac{(\sigma \text{ or } s)}{\sqrt{n}}$ | M1 | | Use of Must have $(\pm\sqrt{n})$ with $n > 1$ |
| | Thus $5.73 \pm 2.5758 \times \frac{(0.95 \text{ to } 0.961)}{\sqrt{50}}$ | A1✓ | | ✓ on z and $s^2 > 0$ but not on \bar{x} Accept only 50 or 49 for n |
| | $5.73 \pm (0.34 \text{ to } 0.36)$ (5.37 to 5.39, 6.07 to 6.09) | ↑ A1 | 4 | Dependent AWFW |
| (c) | CI excludes both values of 5 and 6½ so Neither claim appears valid | B1✓ ↑ B1✓ | | ✓ on (b); OE Dependent ✓ on (b); OE |
| | or | | | |
| | CI excludes 5 so claim not valid and CI excludes 6½ so claim not valid | (B1✓) (B1✓) | 2 | ✓ on (b); OE ✓ on (b); OE |
| | Total | | 8 | |

MS/SS1A (cont)

| Q | Solution | Marks | Total | Comments |
|--------|---|--|-----------|--|
| 4(a) | Scatter Diagram or or | B2 (B1) (B1) | 2 | 4 labelled points plotted 3 labelled points plotted 4 unlabelled points plotted |
| (b)(i) | Positive/linear correlation/relationship except for two unusual values/results | B1 B1 | 2 | OE OE |
| (ii) | 0.462 | B1 | 1 | CAO; accept 3 rd /final/last value |
| (c) | C and D C is likely freestyle champion D is likely backstroke champion or C is likely freestyle champion D is likely backstroke champion | B1 B1 (B1) (B1) | 2 | CAO Style identified |
| (d)(i) | $r = 0.912$ to 0.913 or $r = 0.91$ to 0.92 or 0.46 to 0.47 or $r = 0.9$ Alternatively Attempt at Σx Σx^2 Σy Σy^2 Σxy or Attempt at S_{xx} S_{yy} S_{xy} Attempt at a correct formula for r $r = 0.912$ to 0.913 | B3 (B2) (B1) (M1) (m1) (A1) | 3 | AWFW AWFW AWRT 270.4, 9188.46 301.6, 11437.84 10246.53 48.94, 67.52, 52.45 |
| (ii) | Boys are faster/slower at both strokes or Boys are equally good at both strokes | B1 | 1 | OE; do not accept freestyle times are proportional to backstroke times |
| | Total | | 11 | |

Question 4 (a)



(a) Scatter Diagram

- 4 labelled points plotted B2
- 3 labelled points plotted (B1)
- 4 unlabelled points plotted (B1)

Total = 2

MS/SS1A (cont)

| Q | Solution | Marks | Total | Comments |
|----------------|---|--------------|--------------|--|
| 5(a)(i) | Time, $X \sim N(55, 8^2)$ | | | |
| | $P(X < 60) = P\left(Z < \frac{60-55}{8}\right)$ | M1 | | Standardising (59.5, 60 or 60.5) with 55 and ($\sqrt{8}$, 8 or 8^2) and/or $(55 - x)$ |
| | $= P(Z < 0.62 \text{ to } 0.63)$ | A1 | | AWFW; ignore sign 0.625 |
| | $= 0.732 \text{ to } 0.736$ | A1 | 3 | AWFW 0.73401 |
| (ii) | $P(55 < X < 60) =$ | | | |
| | $(i) - P(X < 55) = (i) - 0.5$ | M1 | | Difference OE |
| | $= 0.232 \text{ to } 0.236$ | A1 | 2 | AWFW 0.23401 |
| (b) | Time, $Y \sim N(\mu, 16^2)$ | | | |
| | $0.95 \Rightarrow z = 1.64 \text{ to } 1.65$ | B1 | | AWFW 1.6449 |
| | $P(Y < 90) = P\left(Z < \frac{90-\mu}{16}\right)$ | M1 | | Standardising 90 using μ and 16 |
| | Thus $\frac{90-\mu}{16} = 1.6449$ | m1 | | Equating z-term to z-value; Not using 0.95, 0.05 or $ 1 - z $ |
| | Thus $\mu = 63.6 \text{ to } 63.8$ | A1 | 4 | AWFW |
| Total | | | 9 | |

MS/SS1A (cont)

| Q | Solution | Marks | Total | Comments |
|----------------|--|-------|-----------|-----------------------------------|
| 6(a)(i) | B(20, p) | M1 | | Use of in (a) |
| | $P(O \leq 10 \mid p = 0.40) = 0.872$ to 0.873 | A1 | 2 | AWFW 0.8725 |
| (ii) | $P(A = 3) = \binom{20}{3}(p)^3(1-p)^{17}$ | M1 | | Any value of p with $0 < p < 1$ |
| | $P(A = 3 \mid p = 0.28) =$ $\binom{20}{3}(0.28)^3(0.72)^{17}$ | A1 | | Fully correct expression |
| | $= 0.093$ to 0.095 | A1 | 3 | AWFW 0.0940 |
| (iii) | $P(4 < B < 8 \mid p = 0.20) =$ $P(B \leq 7 \text{ or } 8) = 0.9679$ or 0.9900 | M1 | | |
| | minus $P(B \leq 4 \text{ or } 3) = 0.6296$ or 0.4114 | M1 | | |
| | $= 0.338$ to 0.34 | A1 | | AWFW 0.3383 |
| | or B(20, 0.2) expressions stated for at least 3 of $B = 4, 5, 6, 7$ & 8 | (M1) | | Or implied by a correct answer |
| | Answer | (A2) | 3 | |
| (b) | Mean, $\mu = np = 500 \times 0.12 = 60$ | B1 | | CAO |
| | Variance, $\sigma^2 = np(1-p) = 60 \times 0.88 = 52.8$ | B1 | 2 | CAO |
| | Total | | 10 | |
| | TOTAL | | 60 | |