



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

Mathematics

MS2B

(Specification 6360)

Statistics 2B

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.

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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.

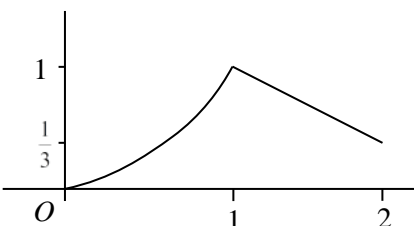
| Q | Solution | Marks | Total | Comments |
|---------------|---|----------|----------|--|
| 1(a) | $\bar{x} = 948$ and $s^2 = 4817.25$ $t_8 = 2.896$ | B1 B1 | | Both; AWR T 4820 ($s = 69.406$) AWRT 2.90 |
| | $\text{C.I.} = 948 \pm 2.896 \times \sqrt{\frac{4817.25}{9}}$ | M1 | | For division by $\sqrt{9}$ |
| | $= 948 \pm 67.0 = (881, 1015)$ | m1 A1 | 5 | For rest of expression, must be t_8 or $t_9 (= 2.821)$ Either form AWR T ± 67 Accept 1010 or 1020 as upper limit |
| | | | | |
| (b)(i) | $(927 + 1063) \div 2 = 995$ | B1 | 1 | CAO |
| (ii) | Dependent on partial overlap | | | |
| | Because of the overlap by the confidence intervals ... | E1 | | |
| | ... no definite conclusion is possible | Edep1 | 2 | Accept "No evidence" |
| SC | Reference to evidence provided by the mean or the limits being lower 'suggesting' or 'providing evidence' or 'supporting' weight reduction scores 1 | (E1) | | The statement must be not definite. Anything definite, eg. 'proves that' or 'shows that' scores 0 |
| | Total | | 8 | |

| Q | Solution | Marks | Total | Comments | | | | | | | | | | | | | | | | | | |
|-------|--|-----------------------|-------------------------------|--|---|------|--------|----|-----|--------|-----|-------|--------|----|------|--------|--|----------|---------------|----|--|---|
| 2(a) | <table border="1"> <thead> <tr> <th>O_i</th> <th>E_i</th> <th>$(O_i - E_i - 0.5)^2 / E_i$</th> </tr> </thead> <tbody> <tr> <td>30</td> <td>35.2</td> <td>0.6276</td> </tr> <tr> <td>14</td> <td>8.8</td> <td>2.5102</td> </tr> <tr> <td>130</td> <td>124.8</td> <td>0.1770</td> </tr> <tr> <td>26</td> <td>31.2</td> <td>0.7080</td> </tr> <tr> <td></td> <td>χ^2</td> <td>4.0228</td> </tr> </tbody> </table> | O_i | E_i | $(O_i - E_i - 0.5)^2 / E_i$ | 30 | 35.2 | 0.6276 | 14 | 8.8 | 2.5102 | 130 | 124.8 | 0.1770 | 26 | 31.2 | 0.7080 | | χ^2 | 4.0228 | M1 | | E attempted (at least two correct to 1 d.p.) |
| | O_i | E_i | $(O_i - E_i - 0.5)^2 / E_i$ | | | | | | | | | | | | | | | | | | | |
| | 30 | 35.2 | 0.6276 | | | | | | | | | | | | | | | | | | | |
| | 14 | 8.8 | 2.5102 | | | | | | | | | | | | | | | | | | | |
| | 130 | 124.8 | 0.1770 | | | | | | | | | | | | | | | | | | | |
| | 26 | 31.2 | 0.7080 | | | | | | | | | | | | | | | | | | | |
| | | χ^2 | 4.0228 | | | | | | | | | | | | | | | | | | | |
| | | | M1 | | Yates' correction attempted; at least one correct value in final column | | | | | | | | | | | | | | | | | |
| | | | M1 | | χ^2 attempted | | | | | | | | | | | | | | | | | |
| | | | A1 | | AWFW 4.02 to 4.03 | | | | | | | | | | | | | | | | | |
| | H_0 : No association between method of receiving information and outcome | | | At least one correct | | | | | | | | | | | | | | | | | | |
| | H_1 : Association between method of receiving information and outcome | B1 | | If "independent" used, it must be the right way round | | | | | | | | | | | | | | | | | | |
| | CV of χ^2 for 1 df = 3.84(1) | B1 | | | | | | | | | | | | | | | | | | | | |
| | 4.02 > 3.841 so reject H_0 There is significant evidence of an association between method of receiving information and outcome | A1 | | Dep on A1 and B1 for CV | | | | | | | | | | | | | | | | | | |
| | Applications higher than expected for telephone calls, so council's belief seems to be true | Adep1 | 8 | Dep on previous A1 Context conclusion about council's belief, referring to higher than expected for telephone | | | | | | | | | | | | | | | | | | |
| | Alternative if Yates' not used | | | | | | | | | | | | | | | | | | | | | |
| | <table border="1"> <thead> <tr> <th>O_i</th> <th>E_i</th> <th>$(O_i - E_i)^2 / E_i$</th> </tr> </thead> <tbody> <tr> <td>30</td> <td>35.2</td> <td>0.7682</td> </tr> <tr> <td>14</td> <td>8.8</td> <td>3.0727</td> </tr> <tr> <td>130</td> <td>124.8</td> <td>0.2167</td> </tr> <tr> <td>26</td> <td>31.2</td> <td>0.8667</td> </tr> <tr> <td></td> <td>χ^2</td> <td>4.9243</td> </tr> </tbody> </table> | O_i | E_i | $(O_i - E_i)^2 / E_i$ | 30 | 35.2 | 0.7682 | 14 | 8.8 | 3.0727 | 130 | 124.8 | 0.2167 | 26 | 31.2 | 0.8667 | | χ^2 | 4.9243 | | | Loses M1 for Yates' and A1 for final χ^2 value but can score all the other 6 marks |
| O_i | E_i | $(O_i - E_i)^2 / E_i$ | | | | | | | | | | | | | | | | | | | | |
| 30 | 35.2 | 0.7682 | | | | | | | | | | | | | | | | | | | | |
| 14 | 8.8 | 3.0727 | | | | | | | | | | | | | | | | | | | | |
| 130 | 124.8 | 0.2167 | | | | | | | | | | | | | | | | | | | | |
| 26 | 31.2 | 0.8667 | | | | | | | | | | | | | | | | | | | | |
| | χ^2 | 4.9243 | | | | | | | | | | | | | | | | | | | | |
| | | | | Final 2 A1 marks dep on 4.92 to 4.93 and B1 for CV | | | | | | | | | | | | | | | | | | |
| (b) | Type I error was made because H_0 has been rejected (when it was true) | E1 Edep | | Dep on previous E1 | | | | | | | | | | | | | | | | | | |
| SC | If 'H_0 accepted' when their χ^2 less than their CV No error was made because H_0 has been accepted (when it was true) | (E1) (Edep1) | 2 | Dep on previous (E1) | | | | | | | | | | | | | | | | | | |
| | Total | | 10 | | | | | | | | | | | | | | | | | | | |

| Q | Solution | Marks | Total | Comments |
|--------------|--|----------|----------|--|
| 3(a)(i) | Just catches a tram | E1 | 3 | Must refer to the 0 in some way to score the E1 but can score B1 for $2 + 20 + 5 = 27$ |
| | $= 2(+0) + 20 + 5 = 27$ | B1 | | |
| | (ii) $b = 37$ | B1 | | |
| (b) | $E(T) = 32$ | B1 | 2 | Any form |
| | $\text{Var}(T) = 10^2/12$ $= 100/12 = 25/3 = 8\frac{1}{3} = 8.33$ | B1 | | |
| (c) | $(35 - 27) = 8$ $\times 0.1 = 0.8$ | M1 A1 | 2 | Or by integration from 27 to 35 |
| Total | | | 7 | |
| 4(a)(i) | $\frac{e^{-3.5} \times 3.5^4}{4!}$ $= 0.189$ | M1 | 2 | AWRT 0.189 Answer only gets B2 |
| | | A1 | | |
| (ii) | Using or stating $Po(0.5)$ | B1 | 3 | An answer of 0.0144, 0.3935, 0.6065, 0.9098 or 0.9856 implies award of B1 but no further marks |
| | $P(\geq 2) = 1 - P(\leq 1)$ or $\quad = 1 - 0.9098$ | M1 | | |
| | $= 0.0902$ | A1 | | |
| (iii) | Using $Po(14)$ | B1 | 3 | Sight of 0.1094, 0.1757, 0.9235, 0.9521 |
| | $P(\leq 19) - P(\leq 10) = 0.9235 - 0.1757$ | M1 | | |
| | $= 0.7478$ | A1 | | |
| (b) | GRBs/explosions/events/etc will be random and/or independent | E1 | 1 | For any valid point |
| | GRBs/etc short in comparison to observation period (non-overlapping) | | | |
| Total | | | 9 | |

| Q | Solution | Marks | Total | Comments |
|----------------|---|--------------|-----------|---|
| 5(a)(i) | $1 - (\frac{1}{3} + \frac{1}{4} + \frac{1}{5} + \frac{1}{6})$ $= \frac{1}{20} = 0.05$ | M1 A1 | 2 | OE AG |
| (ii) | $E(X) =$ $1 \times \frac{1}{3} + 2 \times \frac{1}{4} + 3 \times \frac{1}{5} + 4 \times \frac{1}{6} + 5 \times \frac{1}{20}$ $= 2.35$ | M1 A1 | 2 | At least 2 terms OE: give B2 for only 2.35 seen |
| (iii) | $E(X^2) =$ $1 \times \frac{1}{3} + 4 \times \frac{1}{4} + 9 \times \frac{1}{5} + 16 \times \frac{1}{6} + 25 \times \frac{1}{20}$ $(= 7.05)$ | M1 | | All 5 terms $E(X^2) = 7.05$ with no working scores M0 Correct working but labelled $\text{Var}(X)$ and then no more done also scores M0 |
| | $\text{Var}(X) = E(X^2) - E(X)^2$ $= 1.5275$ | m1 A1 | 3 | Applied to this problem AG |
| (iv) | $1 - (\frac{1}{3} + \frac{1}{4})$ or $(\frac{1}{5} + \frac{1}{6} + \frac{1}{20})$ $= \frac{5}{12}$ or 0.417 | M1 A1 | 2 | AWRT Accept answer only for B2 |
| (b) | $'2.35' \times 100 - 50$ $= 185$ | M1 A1F | | Their value of mean FT from (a)(ii) Give B2 for only 185 seen |
| | $100^2 \times 1.5275$ or $100 \times \sqrt{1.5275}$ | M1 | | |
| | $\text{SD} = \sqrt{15275} = 5\sqrt{611} = 124$ | A1 | 4 | AWFW 123.5 to 124 or $5\sqrt{611}$ Give B2 for only 123.5 to 124 or $5\sqrt{611}$ seen |
| | Total | | 13 | |

| Q | Solution | Marks | Total | Comments |
|--------------|---|-------|-----------|---|
| 6(a) | $H_0: \mu = 175$ $H_1: \mu < 175$ | B1 | | Both; accept $H_0: \mu \geq 175$ Do not accept mean or \bar{x} but accept population mean |
| | $\bar{x} = 168.1$ | B1 | | |
| | $z = \frac{168.1 - 175}{9.4 / \sqrt{6}}$ $= -1.798$ | M1 | | For use of $9.4/\sqrt{6}$ |
| | | m1 | | |
| | CV = -1.6449 | A1 | 7 | Comparison of correct test statistic with correct CV must be seen (diagram or words) OE; suspicion supported Must be in context AG |
| | $-1.6449 > -1.798$ so test statistic in critical region Reject H_0 , significant evidence that batch mean is less than 175grams | A1 | | |
| (b) | $H_0: \mu = 175$ $H_1: \mu < 175$ | | | Award B1 for both correct if not scored in (a) |
| | $t = \frac{169.4 - 175}{11.2 / \sqrt{20}}$ $= -2.236$ | M1 | | |
| | CV(t_{19}) = -2.539 | m1 | | For use of $11.2/\sqrt{20}$ |
| | $-2.236 > -2.539$ so test statistic not in critical region Accept H_0 , no significant evidence that batch mean/weight is less than 175grams | A1 | | |
| | | B1 | 5 | For rest of formula (ignore sign) Must be negative AWRT -2.24 AWRT -2.54 |
| (c) | Because the significance level is 1% instead of 5% | E1 | 1 | Comparison of correct test statistic with correct CV (need not be seen) OE; suspicion not supported |
| | | | | OE; eg SL is different Reference to sample size \Rightarrow E0 |
| Total | | | 13 | |

| Q | Solution | Marks | Total | Comments |
|--------|--|----------------------|-----------|---|
| 7(a) |  | B1 B1 B1 | 3 | Curve concave upwards between (0, 0) and (1, y_1) Negative gradient line between (1, y_1) and (2, y_2) with $y_2 > 0$ (and not beyond 2) $y_1 = 1$ and $y_2 = \frac{1}{3}$ shown |
| (b)(i) | Attempt to integrate t^2 between 0 and x $F(x) = \frac{1}{3}x^3$ | M1 A1 | 2 | Accept integral of x^2 |
| (ii) | Their $F(x) = 0.25$ $x = 0.909$ | M1 A1 | 2 | AWRT; accept $\sqrt[3]{0.75}$ OE |
| (c)(i) | $F(1) = \frac{1}{3}$ $\int_1^x \frac{1}{3}(5-2t) dt = \left[\frac{1}{3}(5t-t^2) \right]_1^x$ $= \frac{1}{3}(5x-x^2) - \frac{4}{3}$ $F(x) = \frac{1}{3}(5x-x^2) - \frac{4}{3} + \frac{1}{3}$ $= \frac{1}{3}(5x-x^2-3)$ | B1 M1 A1 A1 | 4 | For integral attempted with correct limits For limits substituted in correct expression F(1) added to give complete F(x) AG |
| (ii) | $\frac{1}{3}(5q-q^2-3) = 0.75$ or integral of f(x) from q to 2 = 0.25 $4q^2 - 20q + 21 = 0$ or $q^2 - 5q + 5.25 = 0$ $(2q-3)(2q-7) = 0$ or $q = 2.5 \pm 1$ $q = 1.5$ | M1 A1 m1 A1 | 4 | Setting up equation Reaching correct simplified quadratic Factorising for two solutions or using formula or calculator Selecting only this one |
| | Total | | 15 | |
| | TOTAL | | 75 | |