Version 1.0: 0606

ASSESSMENT and QUALIFICATIONS ALLIANCE

# General Certificate of Education

# Statistics 6380

*SS04 Statistics 4*

# Mark Scheme

## *2006 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.

# 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.**

**SS04**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **1(a)** | $\bar{x} = 161.167$ $s = 9.6003$ | B1 | | 161.167 (161 to 161.2) and 9.6003 ( 9.595 to 9.605 ) |
| | 95% confidence interval for mean | | | |
| | $161.167 \pm 2.571 \times 9.6003/\sqrt{6}$ | B1 | | 5df |
| | $161.167 \pm 10.077$ | B1√ | | 2.571 or 2.57 |
| | $151.09 \sim 171.24$ | M1 | | use of their sd/√6 |
| | | m1 | | method for confidence interval - allow incorrect t |
| | | A1 | 6 | 151.09 (151 to 151.2) and 171.24 (171 to 171.3) or 161.167 (161 to 161.2) and 10.077 ( 10.05 to 10.1 ) |
| **(b)** | Confidence interval provides evidence that mean weight of bananas exceeds 150g but some bananas will weigh less than 150g. | E1 | | evidence mean exceeds 150g |
| | | E1 | 2 | some weigh less than 150g |
| | **Total** | | **8** | |
| **2(a)** | $H_0$: $p = 0.25$ | B1 | | one correct hypothesis - generous |
| | $H_1$: $p > 0.25$ | B1 | | both correct - ungenerous but accept p as implying population |
| | B(14,0.25) | | | |
| | P(9 or more) = 1 – 0.9978 = 0.0022 | B1 | | use of B(14,0.25) |
| | < 0.01 | M1 | | Attempt to calculate P( 9 or more) -generous, allow P( more than 9 ), use of normal approx, wrong tail etc |
| | Reject $H_0$ evidence that more than 25% willing to pay an increased rent. | A1 | | 0.0022 ( 0.0021 to 0.0023 ) |
| | | A1√ | | conclusion, their figures - disallow normal approx, wrong tail |
| | | A1 | 7 | correct conclusion in context - requires previous M1A1A1√ |
| | s.c. critical region 8 or more ( nearest to 1%) or 9 or more (strictly less than 1%) | | | M1 attempt to find critical region - generous, allow normal approx, wrong tail etc<br>A1 allow 8 or more or 9 or more |

**SS04 (cont)**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **2(b)(i)** | $p = 65/124 = 0.52419$ | B1 | | 0.524 (0.524 to 0.525) or 65/124 |
| | 90% confidence interval | B1 | | 1.6449 (1.64 to 1.65) |
| | | M1 | | method for sd - their $p$ |
| | $0.52419 \pm 1.6449\sqrt{\left(\frac{0.52419 \times 0.47581}{124}\right)}$ | m1 | | correct method - allow arithmetic mistakes and incorrect $z$ |
| | $0.52419 \pm 0.07377$ | | | 0.450 (0.45 to 0.451)and 0.598 (0.597 to 0.599) or |
| | $0.450 \sim 0.498$ | A1 | | 0.524 (0.524 to 0.5245) and 0.0738 ( 0.0737 to 0.074) |
| | $p = 11/124 = 0.08871$ | B1 | | 0.0887 ( 0.088 to 0.089) or 11/124 |
| **(ii)** | 90% confidence interval | M1 | | method - allow arithmetic mistakes and incorrect $z$ |
| | $0.08871 \pm 1.6449\sqrt{\frac{0.08871 \times 0.91129}{124}}$ | A1 | 8 | 0.047 (0.046 to 0.047) and 0.131 (0.13 to 0.131) or 0.0887 (0.088 to 0.089) and 0.042 (0.0415 to 0.0425) |
| | $0.08871 \pm 0.04200$ | | | |
| | $0.047 \sim 0.131$ | | | |
| **(c)** | Evidence that more than 25% would say yes when increase is unspecified. | E1√ | | more than 25% for unspecified increase |
| | Confirmed in (b)(i) when a small(10%) increase is suggested but much less than 25% in (b)(ii) when a large(40%) increase is suggested. | E1√ | | confirmed for small increase |
| | | E1 | 3 | but less for large increase |
| | **Total** | | **18** | |
| **3(a)** | $\bar{x} = 59.575$ $s = 4.5380$ | B1 | | 59.575 (59.5 to 59.6) and 4.538 ( 4.53 to 4.55) |
| | $H_0$: $\mu = 60$ | | | |
| | $H_1$: $\mu \neq 60$ | B1 | | one hypothesis - generous |
| | | B1 | | both hypotheses - ungenerous |
| | $t = (59.575 - 60)/(4.538/\sqrt{8})$ | M1 | | use of their sd/√8 |
| | $= -0.265$ | m1 | | method - ignore sign |
| | | A1 | | $-0.265$ ( $-0.26$ to $-0.27$ ) |
| | cv $t_7 \pm 1.895$ | B1 | | 7df |
| | | B1√ | | their df |
| | Accept $\mu = 60$ | | | |
| | No significant evidence to suppose the mean temperature at which sprinklers are activated is not 60°C | A1√ | 9 | conclusion |

**SS04 (cont)**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **(b)(i)** | Sprinklers set off unnecessarily causing mess and damage. | E2(1) | | E2 for reason in context<br><br>E1 reason unconvincing or not in context |
| **(ii)** | Sprinklers set off too late to prevent fire damage | E2(1) | | |
| **(iii)** | Large standard deviation means temperature at which sprinklers set off is variable and so unpredictable | E2(1) | | |
| **(iv)** | Testing is time consuming and expensive - may require sprinklers to be set off unnecessarily. | E2(1) | 8 | |
| | **Total** | | **17** | |
| **4(a)** | $H_0$: $\mu = 8$<br>$H_1$: $\mu > 8$<br>Poisson mean 8 | B1 | | both hypotheses - accept $\mu$ or $\lambda$ as implying population - generous |
| | P( 16 or more ) = 1 – 0.9918<br>= 0.0082<br>< 0.05 | M1 | | attempt to calculate P(16 or more) - generous |
| | Reject $H_0$; conclude there is significant evidence that the mean number of such emails received exceeds 8 per week | M1<br>A1<br>A1√ | | method for P(16 or more) disallow normal approx<br>0.0082 (0.008 to 0.0082)<br>conclusion - needs both M1s |
| | s.c. cr ≥ 13 nearest to 5%<br>≥ 14 strictly less than 5% | A1 | 6 | A1 in context - needs previous A1√ |
| **(b)** | $H_0$: $\mu = 8$<br>$H_1$: $\mu < 8$ | B1 | | both hypotheses - accept $\mu = 48$ etc |
| | 6 weeks → Poisson mean 48 | B1 | | Poisson mean $8 \times 6$ |
| | approximate by Normal, mean 48<br>standard deviation √48 = 6.9282 | M1<br>A1 | | attempted use of normal approx - generous<br>mean 48, sd √48 |
| | $z = (38.5 – 48)/\sqrt{48} = – 1.37$<br>critical value – 1.6449 | M1 | | method for $z$ - ignore sign and continuity correction |
| | Accept $H_0$; conclude no significant evidence that mean is less than 8 per week. | A1 | | – 1.37 ( – 1.365 to – 1.375) or – 1.44 ( – 1.44 to – 1.45) if c.c. not used. |
| | s.c. exact Poisson P(38 or fewer) = 0.0814 (0.081 to 0.0815 )<br>$p$ - value using normal 0.085 | B1<br>A1√<br>A1 | 9 | 1.6449 (1.64 to 1.65) -ignore sign<br>conclusion - must be compared with lower tail of $z$<br>in context - needs previous A1√ |

**SS04 (cont)**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **4(c)** | Evidence that mean number of emails before changes was greater than 8 per week. Some evidence - but not significant - that number is now less than 8 per week. Conclude changes have lead to a reduction in emails of complaint. | E1√<br><br><br><br><br>E1 | <br><br><br><br><br>2 | E1√ > 8 before change<br>E1 not greater than 8 now<br>E1 some evidence but not significant less than 8 now<br>E1 reduction<br>maximum 2<br>if not in context maximum 1 |
| | **Total** | | **17** | |
| **5(a)** | $z = (250 - 206)/28 = 1.5714$<br>Probability > 250 = 0.0580 | M1<br>m1<br>A1 | <br><br>3 | method for $z$ - ignore sign<br>correct method<br>0.0580 (0.058 to 0.0583) |
| **(b)(i)** | normal mean 412<br>standard deviation $\sqrt{28^2 + 28^2} = 39.598$ | B1<br>B1 | | 412 cao<br>method for sd |
| **(ii)** | $z = (300 - 412)/39.598 = -2.828$<br>Probability profit insufficient<br>$= 1 - 0.99765 = 0.00235$ | M1<br><br>m1<br>A1 | <br><br><br>5 | normal (may be implied) and method for $z$ - ignore sign<br>correct method<br>0.00235 ( 0.0023 to 0.0024) |
| **(c)(i)** | normal mean 412<br>standard deviation $2 \times 28 = 56$ | B1<br>B1 | | 412 cao<br>56 cao |
| **(ii)** | $z = (300 - 412)/56 = -2$<br>Probability insufficient = $1 - 0.97725$<br>$= 0.02275$ | M1<br><br>m1<br>A1 | <br><br>5 | normal (may be implied) and method for $z$ - ignore sign<br>correct method<br>0.02275 (0.0227 to 0.023) |
| **(d)** | Probability in (c) much larger than in (b) but still small. Probably OK just to hold one bring-and-buy sale. Assumption of independence in part (a) may be doubtful | E1<br><br><br><br>E1 | <br><br><br><br>2 | Any two points - maximum one if not in context. |
| | **Total** | | **15** | |
| | **TOTAL** | | **75** | |