



General Certificate of Education

Mathematics and Statistics 6320

Specification B

MBS6 Statistics 6

Mark Scheme

2005 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

| | | |
|---------------------|---|---|
| M | mark is for | method |
| m | 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 | 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 |
| sf | | significant figure(s) |
| dp | | decimal place(s) |
| A2,1 | | 2 or 1 (or 0) accuracy marks |
| -x ee | | deduct x marks for each error |
| pi | | possibly implied |
| sca | | substantially correct approach |

Abbreviations used in Marking

| | | |
|---------------|--|-------------------------------|
| MC – x | | deducted x marks for mis-copy |
| MR – x | | deducted x marks for mis-read |
| isw | | ignored subsequent working |
| bod | | given benefit of doubt |
| wr | | work replaced by candidate |
| fb | | formulae book |

Application of Mark Scheme

No method shown:

Correct answer without working

mark as in scheme

Incorrect answer without working

zero marks unless specified otherwise

More than one method / choice of solution:

2 or more complete attempts, neither/none crossed out

mark both/all fully and award the mean mark rounded down

1 complete and 1 partial attempt, neither crossed out

award credit for the complete solution only

Crossed out work

do not mark unless it has not been replaced

Alternative solution using a correct or partially correct method

award method and accuracy marks as appropriate

Mathematics and Statistics B Statistics 6 MBS6 June 2005

| Q | Solution | Marks | Total | Comments |
|--------------|--|--------------------|----------|--|
| 1 (a) | $H_0 \eta_d = 0$ $H_1 \eta_d \neq 0$ 2 tail test 10 % level | B1 | | or H_0 Population median price same for both supermarkets H_1 Population median price not the same for both supermarkets |
| | Signs or differences + + - . + + - - + + + test stat $7^+ / 3^-$ | M1 | | |
| | B (10, 0.5) model $P(\geq 7^+) = P(\leq 3^-) = 0.172$ $0.172 > 0.05$ | M1 M1 | | M1 if model seen to be used Comparison with 0.05 or use of identified critical region |
| | Hence, no significant evidence to reject H_0 There is no significant evidence to suggest a difference in median prices between the two supermarkets | A1 | 5 | |
| (b) | $P(\text{Type II error}) = 0$ | B1 | 1 | |
| | Total | | 6 | |
| 2 (a) | $\frac{1}{4} \times \frac{1}{3} \times \frac{1}{5} = \frac{1}{60}$ or 0.167 or 16.7% | M1 A1 | 2 | For product |
| (b) | $1 - \frac{1}{60} = \frac{59}{60}$ or 0.983 or 98.3% | B1 | 1 | |
| (c) | $[\frac{1}{4} \times \frac{2}{3} \times \frac{4}{5}] + [\frac{3}{4} \times \frac{1}{3} \times \frac{4}{5}] + [\frac{3}{4} \times \frac{2}{3} \times \frac{1}{5}]$ $= \frac{8}{60} + \frac{12}{60} + \frac{6}{60} = \frac{26}{60}$ or $\frac{13}{30}$ or 0.433 or 43.3% | M1 M1 A1 | 3 | For 3 products attempted For sum |
| (d) | $\frac{6}{26}$ or $\frac{3}{13}$ or 0.231 or 23.1% | M1 A1 | 2 | M1 for use of 26 as denominator |
| | Total | | 8 | |

MBS6 (cont)

| Q | Solution | Marks | Total | Comments |
|--|--|---------------------------|---------------------|---|
| 3(a)(i) | The 'highest' negative difference from 250 is 28 (222 – 250 = –28) and, if the remaining 6 batteries had lifetimes in excess of 280 hours, their positive differences from 250 will all be greater than 30. | E1 | 2 | Evidence of consideration of differences |
| | This means that the ranks assigned will be 10, 11, 12, 13, 14, 15 | E1 | | Understanding that 'missing' 6 will take the top 6 rank values. |
| (ii) | $H_0 \eta = 250$ | B1 | 8 | or |
| | $H_1 \eta > 250$ | | | H_0 Population median(average) = 250 |
| | 1 tail test 5% sig level | | | H_1 Population median(average) > 250 |
| | Differences | | | sc B1 here for no 'pop' if B0 for no pop in Q1 |
| | -28, -22, -15, -8, -2, +1, +9, +10, +25 and 6 in excess of 250 | M1 | | Differences seen |
| | Ranks | | | |
| | -9, -7, -6, -3, -2, +1, +4, +5, +8 and then +10,+11,+12,+13,+14,+15 | m1 | | Rank orders |
| | $T_+ = 1+4+5+8+10+\dots+15 = 93$ | | | |
| | $T_- = 9+7+6+3+2 = 27$ | m1 | | Attempt at total of ranks (+ or -) |
| | Test stat $T = 27$ | A1 | | Both totals OK or sight of cv =30 |
| Critical value, $n = 15$ 1 tail, 5% | | | | |
| cv = 30 | B1 | For cv | | |
| $T < 30$ | M1 | Comparison of T with cv | | |
| Significant evidence to reject H_0 | | | Do not allow cv = 8 | |
| There is significant evidence to suggest that the median lifetime of the new batteries is more than 250 hours. | A1 | | | |
| (b) | | | | |
| Battery lifetimes are symmetrically distributed | B1 | | | |
| Batteries in trial were selected at random | B1 | 2 | | |
| Total | | | 12 | |

MBS6 (cont)

| Q | Solution | Marks | Total | Comments |
|--------------|---|-----------------------------------|-----------|---|
| 4(a) | Ranks for x, y and z x 11, 3, 15, 1, 5, 13, 6, 4, 8, 12, 2, 9, 17, 14, 10, 7, 16 y 3, $4\frac{1}{2}$, $6\frac{1}{2}$, 10, 8, 17, 15, 13, , 1, 9, 16, 12, 14, 11, 2, $6\frac{1}{2}$, $4\frac{1}{2}$ z 13, 1, 16, 2, 5, 11, 6, 3, 7, 12, 4, 9, 16, 16, 8, 10, 14 | M1 M1 A1 | 3 | for ranks for ties |
| (b)(i) | r_s (from calculator) = -0.0847 can fit on incorrect ranks | B3 \checkmark | 3 | Alternatively differences, d 8, $1\frac{1}{2}$, $8\frac{1}{2}$, 9, 3, 4, 9, 9, 7, 3, 14, 3, 3, 3, 8, $\frac{1}{2}$, $11\frac{1}{2}$ $\sum d^2 = 884$ B1 $r_s = 1 - \frac{6 \times 884}{17 \times 288} = -0.0833$ M1, A1 |
| (ii) | r_s (from calculator) = 0.9484 can fit on incorrect ranks | B3 \checkmark | 3 | Alternatively differences, d 2, 2, 1, 1, 0, 2, 0, 1, 1, 0, 2, 0, 1, 2, 2, 3, 2 $\sum d^2 = 42$ B1 $r_s = 1 - \frac{6 \times 42}{17 \times 288} = 0.9485$ M1, A1 |
| (c)(i) | The calculated value indicates virtually no association in rank order between the number of offences reported per million population and the number males aged 16-24 per thousand pop . | E1 \checkmark | 1 | In context; ft |
| (ii) | $H_0 \rho_s = 0$ $H_1 \rho_s \neq 0$ 2 tail 5% test stat $r_s = 0.9484$ (or 0.9485) critical value = 0.4821 test stat > 0.4821 so significant evidence to reject H_0 Sig evidence of an association | B1 B1 M1 A1 \checkmark | 4 | For hypotheses for cv For comparison relevant ts/cv Conclusion; ft |
| (d) | Crime rate has no sig association with the actual number of males aged 16 – 24 but has clear association (positive) with the number of males aged 16-24 who are unemployed | E2,1 | 2 | Interpretation in context |
| Total | | | 16 | |

MBS6 (cont)

| Q | Solution | Marks | Total | Comments | |
|--|---|--|------------------------|---|----------------------------|
| 5(a) | H ₀ Samples are from identical populations | B1 | 12 | B1 if wording not exact but 1 tail idea | |
| | H ₁ Samples are not from identical populations – average starting salary for students who went to ‘Top League’ universities is higher | B1 | | | |
| | 1 tail test 5% sig level | | | | |
| | Ranks | | | | |
| | ‘Top League’ | M1 | | | for ranks as one group |
| | 8 4 14 12 18 17 20 11 | A1 | | | |
| | Other | | | | |
| | 1 3 5 6 7 10 13 15 16 9 19 2 | A1 | | | |
| | $T_{\text{Top League}} = 104$ | m1 | | | for totals, either correct |
| | $T_{\text{Other}} = 106$ | A1 | | | |
| $U_{\text{Top League}} = 104 - \frac{1}{2}(8 \times 9) = 68$ | m1 | for U values, either | | | |
| $U_{\text{Other}} = 106 - \frac{1}{2}(12 \times 13) = 28$ | A1 | note: various other alternative methods accepted | | | |
| test stat $U = 28$ | | | | | |
| critical value = 26 | B1 | for use of correct cv consistent with U | | | |
| test stat > 26 Accept H ₀ | M1 | | | | |
| No significant evidence (just) to suggest that the samples are from different populations (or no evidence to suggest that there is a difference in average starting salary for the two university groups) | A1 | | | | |
| (b) | Max value (13+14+15+...+19+20) – $\frac{1}{2}(8 \times 9)$ or (9+10+11+.....+19+20) – $\frac{1}{2}(12 \times 13)$ | M1 | 2 | For 174/132 | |
| Max $U = 96$ | A1 | | Other methods possible | | |
| (c)(i) | Students in the trial should be matched according to subject area studied and gender so that a range of identical subjects are covered at each type of university. One pair of students, matched for gender, in each of a range of subject areas, at each type of university, would then be involved in the trial. | E1 | 3 | Concept of ‘matched pairs’ explained. | |
| (ii) | Wilcoxon signed-rank test or sign test | B1 | 1 | Full explanation with some detail of subject relevance and gender | |
| | Total | | 18 | | |
| | TOTAL | | 60 | | |