



General Certificate of Education

Mathematics and Statistics 6320 *Specification B*

MBS3 Statistics 3

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

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Q	Solution	Marks	Total	Comments
1 (a)(i)	$\frac{87}{170}$ or 0.512 or 51.2%	B1	1	
(ii)	$\frac{18}{170}$ or $\frac{9}{85}$ or 0.106 or 10.6%	B1	1	
(iii)	$\frac{96}{170}$ or $\frac{43}{85}$ or 0.565 or 56.5%	M1 A1	2	For attempt at $18+46+23+9$
(iv)	$\frac{9}{83}$ or 0.108 or 10.8%	M1 M1 A1	3	For numerator For denominator
(b)	Resident occupies a two-bedroomed apartment and replies excessive	E1 E1	2	Correct description No negatives, description clear If “given” used E1 only
Total			9	
2 (a)	$H_0 \quad \eta_d = 0$ $H_1 \quad \eta_d \neq 0$ 2 tail test 10 % level Signs + + - . + + - - + + + test stat $7^+ / 3^-$ B (10, 0.5) model $P(\geq 7^+) = P(\leq 3^-) = 0.172$ $0.172 > 0.05$ Hence, no significant evidence to reject H_0 There is no significant evidence to suggest a difference in median prices between the two supermarkets	B1 M1 A1 M1 M1 A1	6	or H_0 Population median price same for both supermarkets H_1 Population median price not the same for both supermarkets Or differences M1 if model seen to be used Comparison with 0.05 or use of identified critical region
(b)	Conclude that there is a difference in prices between the supermarkets when, in fact, there is no difference.	E1 E1	2	Explanation of Type I error Explanation in context
(c)	Wilcoxon signed-rank	B1	1	
Total			9	

MBS3 (cont)

Q	Solution	Marks	Total	Comments
3(a)	Ranks for x and y x 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 y 2, 4, 1, 3, 5, 6, 10, 7, 9, 8, 13, 12, 11, 16, 16, 14, 16 r_s (from calculator) = 0.9484 (0.948)	M1 M1 A1 B3	6	for ranks, can be reversed for ties (y only) Alternatively differences, d 1, 2, 2, 1, 0, 0, 3, 1, 0, 2, 2, 0, 2, 2, 1, 2, 1 $\sum d^2 = 42$ B1 $r_s = 1 - \frac{6 \times 42}{17 \times 288} = 0.9485$ (0.949) M1, A1
(b)(i)	$H_0 \rho_s = 0$ $H_1 \rho_s > 0$ 1 tail 5% test stat $r_s = 0.9484$ (or 0.9485) critical value = 0.4124 test stat > 0.4124 so significant evidence to reject H_0 Sig evidence of an association	B1 B1 M1 A1	4	For hypotheses for cv If 2 tail H_1 , allow cv=.4821 M1A1 For comparison relevant ts/cv; ft Conclusion
(ii)	Crime rate has a significant positive association with the number of males aged 16-24 who are unemployed. The more males aged 16-24 who are unemployed, the higher the crime rate	B1✓	1	Conclusion in context ft if r sensible
	Total		11	

MBS3 (cont)

Q	Solution	Marks	Total	Comments
4(a)	$H_0 \eta = 250$ $H_1 \eta > 250$ 1 tail test 5% sig level	B1 B1		or H_0 Population median(average) = 250 H_1 Population median(average) > 250
	Differences -5, +33, +25, -8, -2, -28, +9, +10, +8, +31, -15, +42	M1 A1		Differences
	Ranks -2, 11, 8, $-3\frac{1}{2}$, -1, -9, +5, +6, $+3\frac{1}{2}$, +10, -7, +12	m1 A1		Rank orders m1 A0 if rank 1 = biggest
	$T_+ = 11+8+5+6+3\frac{1}{2}+10+12 = 55\frac{1}{2}$ $T_- = 2+3\frac{1}{2}+1+9+7 = 22\frac{1}{2}$	A1		total of ranks (+ or -)
	Test stat $T = 22\frac{1}{2}$ Critical value, $n = 12$ 1 tail, 5% cv = 17 $T > 17$ Accept H_0	B1 M1		For cv Comparison of T with cv
	There is no significant evidence to suggest that the median lifetime of the new batteries is more than 250 hours.	A1	10	In context
(b)	Battery lifetimes are symmetrically distributed Batteries in trial are selected at random	B1 B1	2	Other sensible comments possible
Total			12	

MBS3 (cont)

Q	Solution	Marks	Total	Comments
5(a)	<p>H_0 Samples are from identical populations</p> <p>H_1 Samples are not from identical populations – average starting salary for students who went to ‘Top League’ universities is higher</p> <p>1 tail test 5% sig level</p> <p>Ranks ‘Top League’ 8 4 11 10 13 15</p> <p>Other 1 3 5 6 7 9 14 12 2</p> <p>$T_{\text{Top League}} = 61$ $T_{\text{Other}} = 59$</p> <p>$U_{\text{Top League}} = 61 - \frac{1}{2}(6 \times 7) = 40$ $U_{\text{Other}} = 59 - \frac{1}{2}(9 \times 10) = 14$</p> <p>test stat $U = 14$</p> <p>critical value = 12 test stat > 12 Accept H_0 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)</p>	<p>B1</p> <p>B1</p> <p>M1</p> <p>M1</p> <p>A1 A1</p> <p>m1 A1</p> <p>m1</p> <p>A1</p> <p>M1 B1 m1</p> <p>A1</p>	<p>14</p> <p>2</p> <p>3</p>	<p>for ranks as one group (can be reversed)</p> <p>for totals, either correct</p> <p>for U values, either note: various other alternative methods accepted</p> <p>for use of correct cv consistent with U for comparison ts/cv</p> <p>For concept of likelihood of experimental error – with reason – and matched pairs preferred Other sensible reason Other methods possible</p> <p>For 75 or 99</p>
	Total		19	
	TOTAL		60	