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ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Mathematics and Statistics B Statistics 3 MBS3 June 2005

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 $\eta_d = 0$ 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 + + - . + + - - + + + test stat $7^+ / 3^-$	M1 A1		Or differences
	B (10, 0.5) model $P(\geq 7^+) = P(\leq 3^-) = 0.172$	M1		M1 if model seen to be used
	$0.172 > 0.05$ Hence, no significant evidence to reject H_0	M1		Comparison with 0.05 or use of identified critical region
	There is no significant evidence to suggest a difference in median prices between the two supermarkets	A1	6	
(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	M1		for ranks, can be reversed
	y 2, 4, 1, 3, 5, 6, 10, 7, 9, 8, 13, 12, 11, 16, 16, 14, 16	M1 A1		for ties (y only)
	r_s (from calculator) = 0.9484 (0.948)	B3	6	**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%	B1		For hypotheses
	test stat r_s = 0.9484 (or 0.9485) critical value = 0.4124	B1		for cv If 2 tail H_1, allow cv=.4821 M1A1
	test stat > 0.4124 so significant evidence to reject H_0	M1		For comparison relevant ts/cv; ft
	Sig evidence of an association	A1	4	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 $\eta = 250$	B1		or
	H_1 $\eta > 250$	B1		H_0 Population median(average) = 250
	1 tail test 5% sig level			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, -3½, -1, -9, +5, +6, +3½, +10, -7, +12	m1 A1		Rank orders m1 A0 if rank 1 = biggest
	$T_+ = 11+8+5+6+3½+10+12 = 55½$ $T_- = 2+3½+1+9+7 = 22½$	A1		total of ranks (+ or –)
	Test stat $T = 22½$			
	Critical value, $n = 12$ 1 tail, 5%			
	cv = 17	B1		For cv
	$T > 17$	M1		Comparison of T with cv
	Accept H_0			
	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	B1		
	Batteries in trial are selected at random	B1	2	Other sensible comments possible
	Total		**12**	

MBS3 (cont)

Q	Solution	Marks	Total	Comments
5(a)	H_0 Samples are from identical populations	B1		
	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' 8 4 11 10 13 15	M1		for ranks as one group (can be reversed)
	Other 1 3 5 6 7 9 14 12 2	M1 A1 A1		
	$T_{\text{Top League}} = 61$ $T_{\text{Other}} = 59$	m1 A1		for totals, either correct
	$U_{\text{Top League}} = 61 - ½(6 \times 7) = 40$ $U_{\text{Other}} = 59 - ½(9 \times 10) = 14$	m1		for U values, either note: various other alternative methods accepted
	test stat $U = 14$	A1		
	critical value = 12	M1 B1		for use of correct cv consistent with U
	test stat > 12 Accept H_0	m1		for comparison ts/cv
	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	14	
(b)	Result might be influenced by such factors as gender or subject studied so a matched pairs design would reduce risk of experimental error as a consequence.	E1		For concept of likelihood of experimental error – with reason – and matched pairs preferred
	People might have lied about their salaries as they were asked to state, not provide verification. Obtaining verification would eliminate this problem.	E1	2	Other sensible reason Other methods possible
	Sample sizes should be more evenly balanced.			
(c)	(10+11+12+13+14+15) – ½(6 × 7) or (7+8+9+10+……+15) – ½(9 × 10)	M1 M1		For 75 or 99
	Max $U = 54$	A1	3	
	Total		**19**	
	TOTAL		**60**	