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ASSESSMENT and QUALIFICATIONS ALLIANCE

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 $P(\geq 7^+) = P(\leq 3^-) = 0.172$	M1		M1 if model seen to be used
	$0.172 > 0.05$	M1		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 (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)	$[\frac{1}{4}\times\frac{2}{3}\times\frac{4}{5}] + [\frac{3}{4}\times\frac{1}{3}\times\frac{4}{5}] + [\frac{3}{4}\times\frac{2}{3}\times\frac{1}{5}]$	M1 M1		For 3 products attempted For sum
	$= \frac{8}{60} + \frac{12}{60} + \frac{6}{60} = \frac{26}{60}$ or $\frac{13}{30}$ or 0.433 or 43.3%	A1	3	
(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		Evidence of consideration of differences
	This means that the ranks assigned will be 10, 11, 12, 13, 14, 15	E1	2	Understanding that 'missing' 6 will take the top 6 rank values.
(ii)	H_0 $\eta = 250$ H_1 $\eta > 250$ 1 tail test 5% sig level	B1		or H_0 Population median(average) = 250 H_1 Population median(average) > 250 **sc** B1 here for no 'pop' if B0 for no pop in Q1
	Differences -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
	$T_+ = 1+4+5+8+10+\ldots+15 = 93$ $T_- = 9+7+6+3+2 = 27$	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 Do not allow cv = 8
	Significant evidence to reject H_0 There is significant evidence to suggest that the median lifetime of the new batteries is more than 250 hours.	A1	8	
(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, 4½, 6½, 10, 8, 17, 15, 13, , 1, 9, 16, 12, 14, 11, 2, 6½, 4½ 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 ft on incorrect ranks	B3√	3	**Alternatively** differences, d 8, 1½, 8½, 9, 3, 4, 9, 9, 7, 3, 14, 3, 3, 3, 8, ½, 11½ $\sum d^2 = 884$ B1 $r_s = 1 - \frac{6\times884}{17\times288} = -0.0833$ M1, A1
(ii)	r_s (from calculator) = 0.9484 can ft on incorrect ranks	B3√	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 $r_s = 1 - \frac{6\times42}{17\times288} = 0.9485$ 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√	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√	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		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		
	$U_{\text{Top League}} = 104 - ½(8 \times 9) = 68$	m1		for U values, either
	$U_{\text{Other}} = 106 - ½(12 \times 13) = 28$	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	12	
(b)	Max value $(13+14+15+\ldots+19+20) - ½(8 \times 9)$ or $(9+10+11+\ldots\ldots+19+20) - ½(12 \times 13)$	M1		For 174/132
	Max U= 96	A1	2	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.	E1		Concept of 'matched pairs' explained.
	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, E1	3	Full explanation with some detail of subject relevance and gender
(ii)	Wilcoxon signed-rank test or sign test	B1	1	
	Total		**18**	
	TOTAL		**60**	