GCE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Mathematics and Statistics B
MBS3

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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 2004

Question Number and Part	Solution	Marks	Total	Comments
1(a)	$r = 0.860$ (calculator) (allow 0.8599, 0.85988 etc) **Or** $r = \dfrac{95293 - \left(\dfrac{1441 \times 635}{10}\right)}{\sqrt{211745 - \dfrac{1441^2}{10}} \times \sqrt{45063 - \dfrac{635^2}{10}}}$	B4	4	**sc** awrt 0.86 B2 $\sum x = 1441 \ \sum x^2 = 211745$ $\sum y = 635 \ \sum y^2 = 45063$ $\sum xy = 95293$ B1 numerator = 3789.5 M1 denominator = 64.01×68.85 M1 A1
(b)	H_0 $\rho = 0$ H_1 $\rho > 0$ 1 tail 1% sig level	B1		Not H_0: $r = 0$ H_1: $r > 0$ If in words must mention correlation in population
	cv = 0.7155	B1		For cv
	ts = r = 0.860 since ts > 0.7155 Reject H_0	M1		Condone 0.86 For comparison ts/cv ft if cv from pmcc tables and close (eg 0.7646 2 tail)
	Significant evidence to suggest that there is a positive association between height and pulmonary anatomical dead space as the doctor believed.	A1	4	Conclusion in context **sc** SRCC (a) B0 (b) B1, B1 (0.7333 cv)
	Total		**8**	

MBS3 (cont)

Question Number and Part	Solution	Marks	Total	Comments
2 (a)	H_0 : Populations of amounts of carbon monoxide emissions from cars with and without catalytic systems are distributed identically.	B1		Must have population
	H_1 : Populations of amounts of carbon monoxide emissions from cars with and without catalytic systems are not distributed identically - emissions from cars with a catalytic system contain less carbon monoxide on average.	B1		For 1-tail
	Or			
	H_0 : Pop average emissions from cars with and without catalytic systems are the same.			
	H_1 : Pop average carbon monoxide emissions less for cars with catalytic system.			
	Or			
	H_0 : Samples taken from identical populations			
	H_1 : Samples not taken from identical populations (-emissions less with catalytic converter)			NB Many other methods acceptable
	catalytic ranks 1 2 7 5 3 (11 10 5 7 9)	M1		For ranks as one group (can be reversed)
		A1		For catalytic correct
	without catalytic ranks 6 8 9 10 11 4 (6 4 3 2 1 8)	A1		For without catalytic correct
	$T_{\text{catalytic}} = 18$	m1		Totals
	$T_{\text{without catalytic}} = 48$	A1		Either correct
	$U = 18 - \left(\frac{5\times 6}{2}\right) = 3$	m1		Method consistent for test stat Or $U = 48 - \left(\frac{6\times 7}{2}\right) = 27$ upper tail
	test stat = 3 (or 27)	A1		Either test stat OK, upper or lower
				Alternatively rank items above other group 6 6 4 5 6 M2 1 0 0 0 0 2 A2 ts = 3 (or 27) M1A2

MBS3 (cont)

Question Number and Part	Solution	Marks	Total	Comments
	cv = 5 (or 25)	B1 B1		For either tail cv (or near from table) For consistent with test stat – allow B1 ft provided sensible/correct method
	Since 3 < 5, reject H_0	m1		For comparison test stat./cv (ft if cv sensible, cv = 4 allowed M1)
	Significant evidence to suggest that populations are not identical and that exhausts with a catalytic system contain less carbon monoxide on average	A1	13	
2(b)	Minimum value for T is 1+2+3+4+5 = 15			
	Minimum value for $U = 15 - \frac{5\times 6}{2}$	M1		For $\sum_{i=1}^{5} i$
	$= 0$	A1		Or min 0+0+0+0+0 (or 0+0+0+0+0+0)
	Maximum value for T is 6+7+8+9+10+11 = 51			
	Maximum value for $U = 51 - \frac{6\times 7}{2}$	M1		for $\sum_{i=6}^{11} i$
	$= 30$	A1	4	Or max 6+6+6+6+6 (or 5+5+5+5+5+5)
	Total		**17**	
3(a)(i)	$P(S) = \frac{57}{174} = \frac{19}{58} = 0.328$	B1	1	
(ii)	$P(T) = \frac{18}{174} = \frac{3}{29} = 0.103$	B1	1	
(iii)	$P(R \cup T) = \frac{64}{174} = \frac{32}{87} = 0.368$	M1 A1	2	for attempt at 28+13+18+1+4
(iv)	$P(H \cap R') = \frac{16}{174} = \frac{8}{87} = 0.0920$	M1 A1	2	for attempt at 1+4+4+7
(v)	$P(S \mid T) = \frac{1}{18} = 0.0556$	M1 M1 A1	3	for 1 for 18
(vi)	$P(R \mid H') = \frac{28}{127} = 0.220$	M1 M1 A1	3	for 28 for 127 **sc** 0.221 M2A0
(b)	$P(R \cap H \cap T) = \frac{13}{174} = 0.0747$	M1 A1		for 13
	Male aged 55 – 74 years (with high blood pressure) who is undergoing treatment	B1	3	Not "given"
	Total		**15**	

MBS3 (cont)

Question Number and Part	Solution	Marks	Total	Comments
4(a)	H_0 : Population median = 6.6 hours H_1 : Population median $\neq$ 6.6 hours 2 tail test 10% sig level	B1		η acceptable
	Signs – – + + + + + + +.+ + + – t.s. 9 + or 3 – (or 9–, 3+)	M1 A1		Signs for 3 If differences found, M1A1 still OK
	B(12, 0.5) model	M1		Model with evidence of use
	P(9 or more +) = P (3 or less –) = 0.0730 > 0.05 (**not** 0.5)	m1 m1		correct probability compare probability and 5% **Or** cr = $\{0,1,2,10,11,12\}$ P(0, 1, 2) = 0.0193 < 0.05 or P(0, 1, 2, 10, 11, 12) = 0.0386 < 0.10 **Or** cr = $\{0,1,2\}$ and ts = 3 clearly identified and compared
	Accept H_0 No sig evidence to suggest patients taking new tablet have a different median number of hours sleep	A1	7	**sc** p = 0.05 M1 m0 m0 **sc** n = 13 $P(\leq 3) = 0.0461$ M0 m0 m1 or $P(\leq 4) = 0.1234$ 3/7 max **sc** Wilcoxon signed-rank B1 M1 A1 as above M1 ranks max 4/7

MBS3 (cont)

Question Number and Part	Solution	Marks	Total	Comments
(b)(i)	H_0 : Population average hours sleep same for new and existing tablet H_1 : Population average hours sleep greater for new tablet.	B1		For population $H_0 : \mu_d = 0$ (or $\eta_d = 0$) $H_1 : \mu_d > 0$ (or $\eta_d > 0$) consistent
	1 tail test 5% sig level	B1		For 1 tail
	Differences .8, .1, –.1, –.4, .7, 1.0, .3, .9, .5, .2	M1		For differences
	Ranks 8, 1½, –1½, –5, 7, 10, 4, 9, 6, 3	M1 A1		For ranks (smallest = rank 1 allow even if no differences found) Ranks correct
	$T_- = 6½$ $T_+ = 48½$	m1 A1		For attempting totals For either correct **sc** rank 1 = – 4, $T = 3$ M1 A0 m1 A0
	critical value 11 test statistic = 6½ test statistic <11 Significant evidence to reject H_0 and conclude that the average number of hours slept is greater with the new tablet	B1 m1 A1	10	For comparison ts/cv Not necessarily in context
(ii)	So that any effect of taking one of the tablets before or after the other is fairly dealt with and the effect of the tablets taken can be detected.	B1	1	Concept of 'fair' order enabling any difference to be detected. Need idea of order. Not 'bias'
(iii)	A paired design is preferred because it ensures that any differences between individual patients are eliminated so that a difference in tablets taken can be detected. **Or** (It is a more powerful test) (increased precision)	B1 B1	2	generous Explained well Not 'accurate' unless fully in context
	Total		**20**	
	TOTAL		**60**	