

GCE 2004

June Series



Mark Scheme

Mathematics and Statistics B

MBS3

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.

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Dr Michael Cresswell Director General

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
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Alternative solution using a correct or partially correct method	award method and accuracy marks as appropriate
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Question Number and Part	Solution	Marks	Total	Comments
1(a)	<p>$r = 0.860$ (calculator) (allow 0.8599, 0.85988 etc)</p> <p>Or</p> $r = \frac{95293 - \left(\frac{1441 \times 635}{10}\right)}{\sqrt{211745 - \frac{1441^2}{10}} \times \sqrt{45063 - \frac{635^2}{10}}}$	B4	4	<p>sc awrt 0.86 B2</p> <p>$\sum x = 1441 \quad \sum x^2 = 211745$ $\sum y = 635 \quad \sum y^2 = 45063$ $\sum xy = 95293$ B1</p> <p>numerator = 3789.5 M1 denominator = 64.01×68.85 M1 A1</p> <p>(b) $H_0 \rho = 0$ B1 $H_1 \rho > 0$ 1 tail 1% sig level</p> <p>cv = 0.7155 B1</p> <p>ts = $r = 0.860$ since ts > 0.7155 Reject H_0 M1</p> <p>Significant evidence to suggest that there is a positive association between height and pulmonary anatomical dead space as the doctor believed. A1</p>
Total			8	<p>Conclusion in context</p> <p>sc SRCC (a) B0 (b) B1, B1 (0.7333 cv)</p>

MBS3 (cont)

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

MBS3 (cont)

Question Number and Part	Solution	Marks	Total	Comments
2(b)	cv = 5 (or 25)	B1 B1	13	For either tail cv (or near from table) For consistent with test stat – allow B1 ft provided sensible/correct method For comparison test stat./cv (ft if cv sensible, cv = 4 allowed M1)
	Since $3 < 5$, reject H_0	m1		
	Significant evidence to suggest that populations are not identical and that exhausts with a catalytic system contain less carbon monoxide on average	A1		
	Minimum value for T is $1+2+3+4+5 = 15$			
	Minimum value for $U = 15 - \frac{5 \times 6}{2}$ $= 0$	M1 A1		
	Maximum value for T is $6+7+8+9+10+11 = 51$			
	Maximum value for $U = 51 - \frac{6 \times 7}{2}$ $= 30$	M1 A1	4	For $\sum_{i=1}^5 i$ Or min $0+0+0+0+0$ (or $0+0+0+0+0$) for $\sum_{i=6}^{11} i$ Or max $6+6+6+6+6$ (or $5+5+5+5+5$)
	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)	$P(S T) = \frac{1}{18} = 0.0556$	M1 M1 A1	3	for 1 for 18
(vi)	$P(R H') = \frac{28}{127} = 0.220$	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)	<p>H_0 : Population median = 6.6 hours H_1 : Population median \neq 6.6 hours 2 tail test 10% sig level</p> <p>Signs -- + + + + + . + + + - t.s. 9 + or 3 - (or 9-, 3+)</p> <p>B(12, 0.5) model</p> <p>$P(9 \text{ or more } +) = P(3 \text{ or less } -)$ $= 0.0730 > 0.05$ (not 0.5)</p> <p>Accept H_0 No sig evidence to suggest patients taking new tablet have a different median number of hours sleep</p>	<p>B1</p> <p>M1 A1</p> <p>M1</p> <p>m1 m1</p> <p>A1</p>	<p>7</p>	<p>η acceptable</p> <p>Signs for 3 If differences found, M1A1 still OK</p> <p>Model with evidence of use</p> <p>correct probability compare probability and 5%</p> <p>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</p> <p>sc $p = 0.05$ M1 m0 m0</p> <p>sc $n = 13$ $P(\leq 3) = 0.0461$ M0 m0 m1 or $P(\leq 4) = 0.1234$ 3/7 max</p> <p>sc Wilcoxon signed-rank B1 M1 A1 as above M1 ranks max 4/7</p>

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. 1 tail test 5% sig level Differences .8, .1, -1, -4, .7, 1.0, .3, .9, .5, .2 Ranks 8, 1½, -1½, -5, 7, 10, 4, 9, 6, 3 $T_- = 6\frac{1}{2}$ $T_+ = 48\frac{1}{2}$ critical value 11 test statistic = $6\frac{1}{2}$ 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 B1 M1 M1 A1 m1 A1 B1 m1 A1	10	For population $H_0 : \mu_d = 0$ (or $\eta_d = 0$) $H_1 : \mu_d > 0$ (or $\eta_d > 0$) consistent For 1 tail For differences For ranks (smallest = rank 1 allow even if no differences found) Ranks correct For attempting totals For either correct sc rank 1 = -4, $T = 3$ M1 A0 m1 A0 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	