

GCE 2004
June Series



Mark Scheme

Mathematics and Statistics B *MBS8*

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.

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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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Mathematics and Statistics B Statistics 8 MBS8 June 2004

Question Number and Part	Solution	Marks	Total	Comments
1	$\mu = 100$ $\sigma = 4$ ($n = 6$)			
(a)(i)	CL: $\mu \pm z \times \frac{\sigma}{\sqrt{n}}$ z-values: 1.96(00) and 3.09(02) W (95%): $100 \pm 1.96 \times \frac{4}{\sqrt{6}} = 100 \pm 3.20$ (96.8, 103.2) A (99.8%): $100 \pm 3.09 \times \frac{4}{\sqrt{6}} = 100 \pm 5.05$ (94.9 to 95.0, 105.0 to 105.1)	M1 B1 A1 A1	4	Use of; may be implied Both; awrt awrt awfw; allow (95, 105)
(ii)	CL: $\sigma \times E$ LAL: $4 \times 0.20 = 0.8$ LWL: $4 \times 0.41 = 1.6$ UWL: $4 \times 1.60 = 6.4$ UAL: $4 \times 2.03 = 8.1$	M1 A2, 1	3	Use of; may be implied [M0 for use of $\sigma \times D$] awrt; $\geq 1 \Rightarrow A1$ $4 \Rightarrow A2$
(b)(i)	Attempt at means OR standard deviations $\bar{x} = 100.5$ $s = 1.9$ Both values within warning limits so no action is necessary	M1 A1 A1✓		Both awrt ft on values and limits
(ii)	$\bar{x} = 100.0$ $s = 6.6$ Standard deviation above UWL so take another sample / investigate	A1 A1✓	5	Both awrt; accept 100 ft on values and limits [A0 for 'no action necessary']
	Total		12	

MBS8 (cont)

Question Number and Part	Solution	Marks	Total	Comments																																			
3(a)(i)	Completion of table with numbers 5 to 20 so that there are 5 numbers in each of 4 columns	M1	1	5 and 20 No check on 1 to 4																																			
(ii)	(Completely) randomised design (CRD)	B1																																					
	One-way analysis of variance	B1	2	Or equivalent																																			
(b)(i)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th colspan="4" style="text-align: center;"><u>Environment</u></th> </tr> <tr> <th style="text-align: left;">Variety</th> <th>A</th> <th>B</th> <th>C</th> <th>D</th> </tr> </thead> <tbody> <tr> <td>I</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> <tr> <td>II</td> <td>5</td> <td>6</td> <td>7</td> <td>8</td> </tr> <tr> <td>III</td> <td>9</td> <td>10</td> <td>11</td> <td>12</td> </tr> <tr> <td>IV</td> <td>13</td> <td>14</td> <td>15</td> <td>16</td> </tr> <tr> <td>V</td> <td>17</td> <td>18</td> <td>19</td> <td>20</td> </tr> </tbody> </table>		<u>Environment</u>				Variety	A	B	C	D	I	1	2	3	4	II	5	6	7	8	III	9	10	11	12	IV	13	14	15	16	V	17	18	19	20	M1		One of each variety (I to V) to Each environment (A to D)
	<u>Environment</u>																																						
Variety	A	B	C	D																																			
I	1	2	3	4																																			
II	5	6	7	8																																			
III	9	10	11	12																																			
IV	13	14	15	16																																			
V	17	18	19	20																																			
(ii)	Randomised block design (RBD)	A1	2	Allocation																																			
	Two-way analysis of variance	B1		[B0 for CRB]																																			
	Two-way analysis of variance	B1	2	Or equivalent																																			
(c)	Allows for the removal (from the residual) of variation due to variety	B1	1	Reduces bias or SS_E ; or equivalent																																			
	Total		8																																				

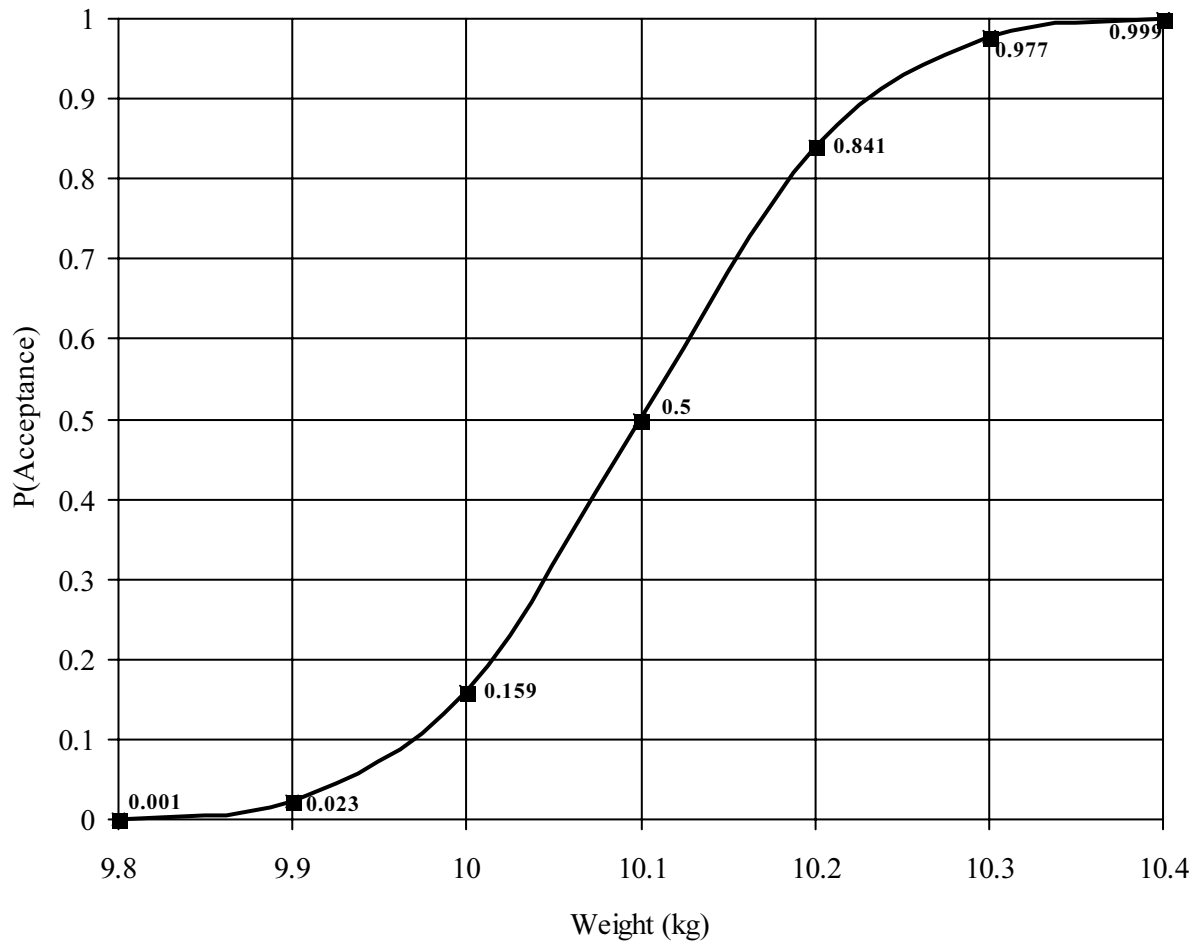
MBS8 (cont)

Question Number and Part	Solution	Marks	Total	Comments																								
4(a)	$P(A) = P(\bar{X} > 10.1) =$ $P\left(Z > \frac{10.1 - \mu}{\frac{0.2}{\sqrt{4}}}\right)$ $= P\left(Z > \frac{10.1 - \mu}{0.1}\right)$	M1 M1	2	Use of Standardising using μ and $\frac{\sigma}{\sqrt{n}}$ ag																								
(b)	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="border-bottom: 1px solid black;">μ</th> <th style="border-bottom: 1px solid black;">z</th> <th style="border-bottom: 1px solid black;">$P(A)$</th> </tr> </thead> <tbody> <tr><td>9.8</td><td>-3</td><td>0.001</td></tr> <tr><td>9.9</td><td>-2</td><td>(0.023)</td></tr> <tr><td>10.0</td><td>-1</td><td>0.159</td></tr> <tr><td>10.1</td><td>0</td><td>(0.500)</td></tr> <tr><td>10.2</td><td>1</td><td>0.841</td></tr> <tr><td>10.3</td><td>2</td><td>0.977</td></tr> <tr><td>10.4</td><td>3</td><td>0.999</td></tr> </tbody> </table>	μ	z	$P(A)$	9.8	-3	0.001	9.9	-2	(0.023)	10.0	-1	0.159	10.1	0	(0.500)	10.2	1	0.841	10.3	2	0.977	10.4	3	0.999	M1 A2, 1	3	z -values attempted (may be implied) $P(A)$ -values; 5 or 4 \Rightarrow A2 3 or 2 \Rightarrow A1
μ	z	$P(A)$																										
9.8	-3	0.001																										
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10.3	2	0.977																										
10.4	3	0.999																										
(c)	(Graph - see next page)	M1 M1	2	Points (≥ 5), must be ever increasing Curve or polygon, must be ever increasing																								
(d)	$\mu = 9.95$ has $P(\textit{Acceptance})$ $= 0.05$ to 0.095 ($< 10\%$) $\mu = 10.25$ has $P(\textit{Acceptance})$ $= 0.92$ to 0.95 so $\mu = 10.25$ has $P(\textit{Rejection})$ $= 0.05$ to 0.095 ($< 10\%$) Thus sampling scheme does meet requirements (as both probabilities less than 10%)	B1 B1	3	awfw awfw [B0 for non-increasing graph] ft on probabilities with 10%																								
Total			10																									

MBS8 (cont)

Graph for Question 4

Operating Characteristic Curve



MBS8 (cont)

Question Number and Part	Solution	Marks	Total	Comments																									
5(a)	R_i : 1150 1200 1250 1300 1400	M1		May be implied																									
	C_j : 1285 1285 1260 1260 1210	M1		May be implied																									
	$SS_R = \sum_i \frac{R_i^2}{n} - \frac{T^2}{n^2}$ and																												
	$SS_C = \sum_j \frac{C_j^2}{n} - \frac{T^2}{n^2}$	M1		Use of either; may be implied																									
	$SS_R = \frac{7975000}{5} - \frac{6300^2}{25} = 7400$	A1		cao																									
	$SS_C = \frac{7941750}{5} - \frac{6300^2}{25} = 750$	A1		cao																									
	$SS_E = SS_T - SS_R - SS_C - SS_L$	M1		Use of																									
	$= 8606 - 7400 - 750 - 269.2 = 186$ to 187	A1		awfw																									
	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">SV</th> <th style="width: 10%;">SS</th> <th style="width: 10%;">DF</th> <th style="width: 10%;">MS</th> <th style="width: 10%;">F</th> </tr> </thead> <tbody> <tr> <td>VG (R)</td> <td>7400</td> <td>4</td> <td>1850</td> <td>119</td> </tr> <tr> <td>C (C)</td> <td>750</td> <td>4</td> <td>187.5</td> <td>12</td> </tr> <tr> <td>HC (L)</td> <td>269.2</td> <td>4</td> <td>67.3</td> <td>4.32</td> </tr> <tr> <td>Resid (F)</td> <td>186.8</td> <td>12</td> <td>15.6</td> <td></td> </tr> </tbody> </table>	SV	SS	DF	MS	F	VG (R)	7400	4	1850	119	C (C)	750	4	187.5	12	HC (L)	269.2	4	67.3	4.32	Resid (F)	186.8	12	15.6				
	SV	SS	DF	MS	F																								
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	Resid (F)	186.8	12	15.6																									
			M1		Attempt at an F -ratio (all $SS > 0$)																								
		A1		awfw 4.30 to 4.35; accept 4.3																									
		B1		$\nu = 4$ and 12; cao																									
	Total (T) 8606 24																												
	CV $F_{12}^4(0.05) = 3.259$	B1		awrt 3.26																									
	For HC (L): F -ratio (4.3) > CV (3.259)	m1		Correct F -ratio comparison (must be ≥ 2 possible ratios)																									
	Thus, at 5% level of significance, evidence of a difference in vehicle hire rates between the 5 companies	A1✓	13	ft on F -ratio and upper CV Dependent on m1																									
(b)	For countries (C):																												
	F -ratio = 12 or % $SS = 9$	B1✓		ft on table; either must be > 0																									
	Thus has proved (reasonably) effective	B1✓		ft on table; dependent on previous B1																									
	For vehicle groups (R):																												
	F -ratio = 119 or % $SS = 86$	B1✓		ft on table; either must be > 0																									
	Thus has proved (extremely) effective	B1✓	4	ft on table; dependent on previous B1																									
	Total		17																										
	TOTAL		60																										