GCE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Mathematics and Statistics B
MBS4

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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 4 MBS4 June 2004

Question Number and Part	Solution	Marks	Total	Comments
1(a)	$E(X) = 0\times0.08 + 1\times0.30 + 2\times0.34 + 3\times0.15 + 4\times0.10 + 5\times0.03 = 1.98$	M1 A1		Method 1.98 cao
	$E(X^2) = 0\times0.08 + 1\times0.30 + 4\times0.34 + 9\times0.15 + 16\times0.10 + 25\times0.03 = 5.36$	M1		Method for $E(X^2)$ - may be implied
	$V(X) = 5.36 - 1.98^2 = 1.4396$	m1		Method for variance - disallow if called standard deviation
	s.d = $\sqrt{1.4396} = 1.20$	m1 A1	6	Completely correct method 1.20 (1.195 to 1.205) **sc** m0 A1 for variance 1.44 (1.435 to 1.445)
(b)(i)	mean 1.98	B1√		1.98 - their mean
	s.d. $\frac{\sqrt{1.4396}}{280} = 0.0717$	M1 A1	3	Method, their s.d. 0.0717 (0.0716 to 0.0718)
(ii)	$k = 1.98 + 2.3263\times0.071704 = 2.15$	B1 M1 A1	3	2.3263 (2.32 to 2.33) (their z) × (their s.d.) 2.15 (2.14 to 2.15)
(iii)	$280\times2.1468 = 601$	B1	1	600, 601, 602
	Total		**13**	
2(a)	H_0: $\mu = 200$ H_1: $\mu > 200$ $\bar{x} = 205.545$ $s = 7.2438$	B1 B1 B1 B1		One correct hypothesis - generous Both hypotheses correct - ungenerous 205.545 (205.5 to 205.6) 7.24 (7.24 to 7.25) - may be implied by correct t-statistic
	$t = \frac{205.545 - 200}{\frac{7.2438}{\sqrt{11}}} = 2.54$	M1 m1 A1		Use of their $\frac{s}{\sqrt{11}}$ Correct method for t - ignore sign 2.54 (2.535 - 2.545)
	cv t_{10} for 5% 1-sided risk 1.812	B1 B1√		10 df 1.812 - allow 1.81, their df, disallow ± 1.812
	Reject H_0 Conclude mean time to spoilage is greater than 200 hours.	A1√	10	Correct conclusion - must be compared with correct tail of t
(b)	No problem unless the 3 containers sold could not be treated as a random sample. Unlikely to bias sample.	E1 E1	2	Comment on randomness of 3 containers Correct deduction Allow comment on reduced sample size
(c)	Claiming mean time to spoilage is more than 200 hours when it isn't	E1 E1	2	Idea of Type 1 error In context - must be 1-sided
(d)(i)	0.05	B1		0.05 cao
(ii)	0	B2	3	0 cao
	Total		**17**	

MBS4 (cont)

Question Number and Part	Solution	Marks	Total	Comments
3(a)	$\bar{x} = 135.6$	B1		135.6 cao
	$s = 0.45552$	B1		0.45552 (0.455 to 0.456) may be implied by correct interval
	95% confidence interval for mean is			
	$135.6 \pm 2.306 \times \frac{0.45552}{\sqrt{9}}$	B1		8df
		B1√		2.306
		M1		Use of their $\frac{s}{\sqrt{9}}$
	i.e. 135.6 ± 0.350	m1		Correct method for interval
	135.25 to 135.95	B1		Answer given to 4,5 or 6 sf, must be an interval
		A1	8	135.25 (135.2 to 135.3) and 135.95 (135.9 to 136) **Or** 135.6 cao ± 0.35 (0.349 to 0.351)
(b)	$135.8 \pm 1.96 \times \frac{3.9}{\sqrt{60}}$	B1		1.96 cao
		M1		Use of $\frac{3.9}{\sqrt{60}}$
	135.8 ± 0.987	m1		Correct method for interval
	134.81 to 136.79	A1	4	134.81 (134.8 to 134.820) and 136.79 (136.78 to 136.8) **Or** 135.8cao ± 0.987 (0.98 to 1)
(c)(i)	Decrease	B1	1	Decrease
(ii)	Increase - narrower interval → more likely to identify need for overhaul if $\mu \neq 135.0$	E1		Increase
		E1	2	Reason
(d)	Large variability as in (b) will lead to unsatisfactory production even if mean on target. Might prefer small variability as in (a) even if mean slightly off target.	E1		Large variability unsatisfactory/makes deviation from 135 difficult to detect.
		E1	2	Small variability with mean slightly off target may be preferable
	Total		**17**	

MBS4 (cont)

Question Number and Part	Solution	Marks	Total	Comments
4(a)	$\int_0^2 cx + d \, dx = 1$	M1		Any correct expression - ignore limits
	$\left[\frac{cx^2}{2} + dx\right]_0^2 = 1$	M1		Any correct integration - may be awarded elsewhere in question
	$2c + 2d = 1$	A1	3	Wholly correct proof allow geometrical proof
(b)(i)	$\int_0^m 0.5 \, dx = 0.5$	M1		Any correct expression
	$[0.5x]_0^m = 0.5$			
	$0.5m = 0.5 \qquad m = 1$	A1	2	1 cao by correct method allow geometrical proof
(ii)	$\int_0^m 0.5x \, dx = 0.5$	M1		Any correct expression
	$\left[\frac{0.5x^2}{2}\right]_0^m = 0.5$	M1		Any correct equation after integration
	$\frac{0.5m^2}{2} = 0.5$			
	$m = \sqrt{2} = 1.41$	A1	3	$\sqrt{2}$ or 1.41 (1.41 to 1.42) disallow $\pm\sqrt{2}$
(c)	**A** not valid - $2c + 2d \neq 1$	M1 A1		Reason Not valid
	B valid	B1		Valid
	C not valid - f(x) negative for small x	M1 A1	5	Reason Not valid
	Total		**13**	

MBS4 (cont)

Question Number and Part	Solution	Marks	Total	Comments
5(a)	<table><tr><td></td><td>0</td><td>1</td><td>2 ≥3</td><td>Total</td></tr><tr><td><2</td><td>1478 1508.94</td><td>212 191.24</td><td>21 6 (27) 14.36 2.45 (16.81)</td><td>1717</td></tr><tr><td></td><td>2830 2799.06</td><td>334 374.76</td><td>20 1 (21) 26.64 4.55 (31.19)</td><td>3185</td></tr><tr><td>Total</td><td>4308</td><td>546</td><td>41 7</td><td>4902</td></tr></table>	M1 M1 M1 m1		Method for 4 E's Method for all E's Attempt to combine classes Correct method for combining classes - needs all previous M marks
	H_0: No association between number of claims and time for which policy held. H_1: Number of claims associated with time for which policy held.	B1		Correct H_0 - may be implied by correctly stated conclusion.
	$\sum\frac{(O-E)^2}{E} = \frac{30.94^2}{1508.94}+\frac{30.94^2}{2799.06}+$	M1		Attempt at $\sum\frac{(O-E)^2}{E}$ - allow spurious continuity correction etc
	$\frac{20.76^2}{191.24}+\frac{20.76^2}{354.76}+\frac{10.19^2}{16.81}+\frac{10.19^2}{31.19}$	m1		Correct use of $\sum\frac{(O-E)^2}{E}$ - requires first two and 4th M mark
	$= 14.0$	A1		14.0 (13.9 to 14.1)
	c.v. χ^2_2 for 1% risk is 9.21	B1√ B1√		2 df 9.21, disallow ± 9.21
	Reject H_0 . Conclude number of claims associated with time policy held.	A1√	11	Conclusion - mu be compared with upper tail of χ^2.
(b)(i), (ii)	**A** Observed members not frequencies <table><tr><td></td><td>Claim</td><td>No claim</td></tr><tr><td>Male</td><td>412</td><td>2824</td></tr><tr><td>Female</td><td>181</td><td>1485</td></tr></table>	E1 M1 A1		Reason Method Table cao
	B Classes overlap <table><tr><td></td><td>Claim</td><td>No claim</td></tr><tr><td><25</td><td>280</td><td>676</td></tr><tr><td>≥25</td><td>314</td><td>3632</td></tr></table>	E1 M1 A1		Reason Method Table cao
	C Classes not complete <table><tr><td></td><td>No claim</td><td>≤£2000</td><td>>£2000</td></tr><tr><td><25</td><td>676</td><td>135</td><td>145</td></tr><tr><td>≥25</td><td>3632</td><td>122</td><td>192</td></tr></table>	E1 M1 A1	9	Reason Method Table cao M1A0 for correct 2×2 table
	Total		**20**	
	TOTAL		**80**	