GCE 2004
June Series

AQA

ASSESSMENT and
QUALIFICATIONS
ALLIANCE

Mark Scheme

Mathematics and Statistics B
MBS4

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 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
	$s.d. \quad \dfrac{\sqrt{1.4396}}{280} = 0.0717$	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) $\times$ (their s.d.) 2.15 (2.14 to 2.15)
(iii)	$280\times2.1468 = 601$	B1	1	600, 601, 602
Total			**13**	
2(a)	$H_0: \mu = 200$	B1		One correct hypothesis - generous
	$H_1: \mu > 200$	B1		Both hypotheses correct - ungenerous
	$\bar{x} = 205.545$	B1		205.545 (205.5 to 205.6)
	$s = 7.2438$	B1		7.24 (7.24 to 7.25) - may be implied by correct t-statistic
	$t = \dfrac{205.545 - 200}{\dfrac{7.2438}{\sqrt{11}}} = 2.54$	M1		Use of their $\dfrac{s}{\sqrt{11}}$
		m1 A1		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 $\pm$ 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.	E1		Comment on randomness of 3 containers
	Unlikely to bias sample.	E1	2	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	B1		8df
	$135.6 \pm 2.306 \times \dfrac{0.45552}{\sqrt{9}}$	B1✓		2.306
		M1		Use of their $\dfrac{s}{\sqrt{9}}$
	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 $\pm$ 0.35 (0.349 to 0.351)
(b)	$135.8 \pm 1.96 \times \dfrac{3.9}{\sqrt{60}}$	B1		1.96 cao
		M1		Use of $\dfrac{3.9}{\sqrt{60}}$
	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 $\pm$ 0.987 (0.98 to 1)
(c)(i)	Decrease	B1	1	Decrease
(ii)	Increase - narrower interval $\rightarrow$ 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
	$\left[\dfrac{cx^2}{2} + dx \right]_0^2 = 1$	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
	$\left[\dfrac{0.5x^2}{2} \right]_0^m = 0.5$	M1		Any correct equation after integration
	$\dfrac{0.5m^2}{2} = 0.5$			
	$m = \sqrt{2} = 1.41$	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)	(see table below)	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

5(a) table:

	0	1	2	≥3	Total
<2	1478	212	21 6 (27)		1717
	1508.94	191.24	14.36 2.45 (16.81)		
	2830	334	20 1 (21)		3185
	2799.06	374.76	26.64 4.55 (31.19)		
Total	4308	546	41	7	4902

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√** — 2 df
— **B1√** — 9.21, disallow $\pm$ 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 — **E1** — Reason

	Claim	No claim
Male	412	2824
Female	181	1485

M1 — Method
A1 — Table cao

B
Classes overlap — **E1** — Reason

	Claim	No claim
<25	280	676
≥25	314	3632

M1 — Method
A1 — Table cao

C
Classes not complete — **E1** — Reason

	No claim	≤£2000	>£2000
<25	676	135	145
≥25	3632	122	192

M1 — Method
A1 — **9** — Table cao   M1A0 for correct 2×2 table

	Total	
Total	**20**	
TOTAL	**80**	