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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Mathematics and Statistics 6320
Specification B

MBS4 Statistics 4

Mark Scheme

2005 examination – June series

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 2005

Q	Solution	Marks	Total	Comments
1	$\bar{x} = 4.16667 \quad s = 0.5431$	B1		4.17 (4.16 to 4.17)
	95% confidence interval for mean	B1		0.543 (0.542 to 0.544) may be implied by correct final answer
	$4.16667 \pm 2.306 \times \frac{0.5431}{\sqrt{9}}$	M1		Use of their $\frac{\text{s.d}}{\sqrt{9}}$
		B1		8df
		B1√		2.306 - their df
	4.167 ± 0.147	m1		completely correct method their *t*
	$3.75 \sim 4.58$	A1	7	4.17(4.16 to 4.17) ± 0.417(0.417 to 0.418) or 3.75(3.745 to 3.755) and 4.58(4.58 to 4.59)
	Total		**7**	
2(a)				

	D		P		DN	
< 65	4	2.70	12	7.72	6	11.58
≥ 65	10	11.30	28	32.28	54	48.42

M1 — method for E's

Pooling D&P

	D&P		DN	
< 65	16	10.42	6	11.58
≥ 65	38	43.58	54	48.42

m1 — correct method for pooling - must be D&P

H_0 : Answer not associated with age
H_1 : Answer associated with age

B1 — correct null hypothesis - may be implied by clearly stated conclusion

$\frac{(|O-E|-0.5)^2}{E} =$

M1 — attempt at $\sum \frac{(O-E)^2}{E}$ - their figures

m1 — attempt at Yates' correction

m1 — correct method for Yates'

$$\frac{5.08^2}{\left(\frac{1}{10.42}+\frac{1}{11.58}+\frac{1}{43.58}+\frac{1}{48.42}\right)} = 5.83$$

A1 — 5.83 (5.81 to 5.85)

c.v χ^2_1 is 3.841

B1 — 1df or 2df if no pooling

B1 — 3.841 or 3.84 (allow 5.991/5.99 if no pooling)

Reject H_0, conclude evidence to suggest that answer is associated with age.

A1√ — 10 — correct conclusion - must be compared with upper tail of χ^2

(b) Older delegates more likely to answer that they would not change their votes.

E1 — 1 — Older delegates less likely to answer that they would change their votes

(c) Most delegates are over 65

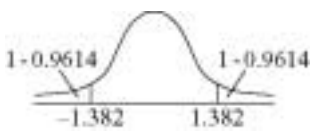
E1 — 1 — Most delegates are elderly

Total — **12**

MBS4 (cont)

Q	Solution	Marks	Total	Comments
3(a)(i)	$E(Y) = 0\times0.58 + 1\times0.27 + 2\times0.10 + 3\times0.05 = 0.62$	M1 A1		method 0.62 cao
(ii)	$E(Y^2) = 0^2\times0.58 + 1^2\times0.27 + 2^2\times0.10 + 3^2\times0.05 = 1.12$	M1		method for $E(Y^2)$ – or equivalent need not be called $E(Y^2)$
	s.d $= \sqrt{1.12 - 0.62^2} = 0.858$	m1		method for standard deviation - allow variance if called variance
		A1		0.858 (0.857 to 0.858)
(iii)	$E(Y^3) = 0^3\times0.58 + 1^3\times0.27 + 2^3\times0.10 + 3^3\times0.05 = 2.42$	M1 A1	7	method 2.42 cao
(b)(i)	0	B1		0 cao
(ii)	0	B1	2	0 cao
(c)(i)	mean	B1		mean
	allows comparison with cost of annual ticket	E1	2	allows comparison with cost of annual ticket / median, mode unrepresentative
(ii)	Expected weekly cost without annual ticket $0.62\times£4.50 = £2.79$	M1		attempt (not necessarily use of 0.62) to compare weekly or annual cost of two methods
	Weekly expenditure on annual ticket 120/52 = £2.31 (Or annual cost £145.08 or £120) annual ticket cheaper	A1	2	£2.79 cao or £145.08 (145 to 145.2) or equivalent (must use 0.62 and disallow for incorrect conclusion)
(iii)	Have to pay in advance / may change cinema going habits	E1	1	reason - generous
	Total		**14**	

MBS4 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	$197 \pm 1.96 \times \frac{103}{\sqrt{90}}$	M1		use of $\frac{103}{\sqrt{90}}$
		B1		1.96 (or allow 1.987 to 1.99)
		m1		completely correct method - their z
	197 ± 21.3	A1	4	197 ± 21.3(21.2 to 21.7) or
	$176 \sim 218$			176(175 to 176) and 218 (218 to 219)
(ii)	42.6	B1	1	42.6(42.5 to 42.6) or 43.2(43.1 to 43.3) if t is used
(iii)	$2z \times \frac{103}{\sqrt{90}} = 30$	M1		reasonable attempt at equation containing z - ignore omission of 2
		m1		completely correct equation containing z
	z = 1.382	m1		method for finding z - allow omission of 2
				
	$1 - 2(1 - 0.9164) = 0.833$	M1		method for probability - their z
	83.3%	A1	5	83.3 (83 – 83.5)
(iv)	$2 \times 2.5758 \times \frac{103}{\sqrt{n}} = 30$	B1		2.5758 (2.57 to 2.58)
		M1		reasonable attempt at equation involving n - ignore omission of 2, incorrect z
	$n = 312.8$	m1		method of solution of equation
	313 needed	A1	4	313 (310 to 315)
(b)(i)	large sample → sample mean normally	E1		large sample / CLT
	distributed	E1	2	**mean** normally distributed
(ii)	Mean less than 2 s.d. above zero → non-trivial probability of negative values	E1		mean less that 2 s.d. above zero / possibility of
	which are not possible	E1	2	negative values / money discrete variable / normal continuous
	Total		**18**	
5(a)(i)	1	B1		1 cao
(ii)	1.54	B1		1.54 cao
(iii)	1.56	B1		1.56 cao
(iv)	1.73	B1		1.73 cao
(v)	1	B1	5	1 cao
(b)(i)	$0.5 - 0.291 = 0.209$	M1		method
		A1	2	0.209 cao
(ii)	$\sqrt{0.0751} = 0.274$	M1		method
		A1	2	0.274 (0.2735 to 0.2745)
				allow B1 for variance = 0.0751
(iii)	$E(X^2) - 1.54^2 = 0.0751$	M1		any correct equation
	$E(X^2) = 2.45$	A1	2	2.45 (2.44 to 2.45)
	Total		**11**	

MBS4 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	$\bar{x} = 46.5 \quad s = 10.81$	B1		46.5 cao and 10.8 (10.8 to 10.82)
	$H_0 : \mu = 40$	B1		one correct hypothesis – generous
	$H_1 : \mu \neq 40$	B1		both hypotheses correct – ungenerous Allow $H_1\ \mu > 40$
	$t = \dfrac{(46.5 - 40)}{\frac{10.81}{\sqrt{8}}} = 1.70$	M1		use of their $\dfrac{\text{s.d}}{\sqrt{8}}$
		m1		completely correct method for *t* ignore sign
		A1		1.70 (1.695 to 1.705)
	c.v $t_7 \pm 2.365$; 1.70 lies between	B1		7df
	± 2.365 so accept H_0, mean is 40 mins	B1√		2.365 – their df – ignore sign (cv 1.895 for one tail test)
		A1√		correct conclusion – must be compared with *t*
	Alternatively Allow confidence interval approach			
(ii)	$H_0 : \mu = 50$	B1		both hypotheses correct – ungenerous
	$H_1 : \mu \neq 50$			Allow $H_1\ \mu < 50$
	$t = \dfrac{(46.5 - 50)}{\frac{10.81}{\sqrt{8}}} = -0.916$	A1		–0.916 (–0.915 to –0.916)
	c.v $t_7 \pm 2.365$; -0.916 lies between			(cv 1.895 for one tail test)
	± 2.365 so accept H_0, mean is 50 mins	A1√	12	correct conclusion must be compared with both tails or lower tail of *t*
	Alternatively Allow confidence interval approach			
				N.B. Mark a(ii) as a(i) and a(i) as a(ii) if more favourable
(b)	Claim 1. **C** Not true – no null hypothesis rejected so no Type 1 error made	E2,1		correct conclusion for correct reason – be generous for E1 but disallow no or clearly incorrect reason
	Claim 2. **B** Possibly true – true if population mean is equal to neither 40 nor 50	E2,1		correct conclusion for correct reason – be generous for E1 but disallow no or clearly incorrect reason
	Claim 3. **A** Definitely true – since mean cannot equal both 40 and 50	E2,1	6	correct conclusion for correct reason – be generous for E1 but disallow no or clearly incorrect reason
	Total		**18**	
	TOTAL		**80**	