

# Mark scheme January 2004

## **GCE**

### **Mathematics & Statistics B**

### **Unit 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 mark and is for	accuracy
В	mark is independent of M or m marks and is for	method and accuracy
E	mark is for	explanation
$\sqrt{}$ or ft or ${f F}$		follow through from previous
		incorrect result
CAO		correct answer only
AWFW		anything which falls within
AWRT		anything which rounds to
AG		answer given
SC		special case
OE		or equivalent
A2,1		2 or 1 (or 0) accuracy marks
-x EE		Deduct <i>x</i> marks for each error
NMS		No method shown
PI		Perhaps implied
c		Candidate

#### Abbreviations used in marking

MC-x	deducted x marks for miscopy
MR-x	deducted x marks for misread
ISW	ignored subsequent working
BOD	gave benefit of doubt
WR	work replaced by candidate

### Application of mark scheme

Correct answer without working	mark as in scheme
Incorrect answer without working	zero marks unless specified otherwise

Award method and accuracy marks as appropriate to an alternative solution using a correct method or partially correct method.

Question	Solution	Marks	Total	Comments
Number				
and part				
1()	CC IC S <120 2 16.94 58 32.94 20 30.12	M1		Method for one <i>E</i>
1(a)	≥120 34 19.06 12 37.06 44 33.88	m1		Method for all E's
		7.1		
	H <sub>0</sub> : No association between asking price	B1		Correct H <sub>0</sub> - may be implied by
	and area			conclusion
	H <sub>1</sub> : Asking price associated with area			
	$\sum (O-E)^2$	M1		Attempt at $\sum \frac{(O-E)^2}{F} = 67.3$
	$\sum \frac{(O-E)^2}{E} = 67.3$	m1		Completely correct method
	_	A1		67.3 (67, 68) - allow if demonstrated to
				be greater than c.v.
	Critical value $\chi_2^2$ for 1% risk 9.210	B1√		ft 2df
	Reject H <sub>0</sub> , conclude asking price	B1√		ft c.v. – candidate's df
	associated with area.	A1√	9	ft correct conclusion - must be
				compared with upper tail of $\chi^2$
				(requires M1M1 only)
(1-)	Houses appear to be cheapest/proportion	E1		Cheapest in inner city
(b)	costing <£120 000 greatest, in inner city	21		Cheupest in inner city
	followed by suburban areas and most			
	expensive in city centre	E1	2	Most expensive in city centre
(c)(i)	Would need more detailed data, would not	E1		Need more details
(	need such a large sample.	E1		Smaller sample ok  E1 each max 3
(ii)	Relationship appears to be non-linear in	E1	2	Relationship non-linear PMCC not suitable
	this case , so PMCC not suitable	E1	3 14	PIVICE HOL SUITABLE
	Total		14	

Question	Solution	Marks	Total	Comments
Number				
and part				
2(a)	$\overline{x} = 1.33$	B1		1.33 cao
	90% confidence interval			
	$1.33 \pm 1.6449 \times \frac{0.11}{\sqrt{8}}$	M1		use of $\frac{0.11}{\sqrt{8}}$
		B1		1.6449 (1.64 , 1.65)
		m1		Completely correct method - candidate's z
	$1.33 \pm 0.0640$	A1	5	$1.33 \pm 0.0640  (0.063  ,  0.065)$
	(1.266, 1.394)			<b>or</b> 1.266 (1.265 , 1.267), allow 1.27 and 1.394 (1.393 , 1.395), allow 1.39
				$\mathbf{sc} \ 1.33 \pm 1.895 \ \frac{0.14}{\sqrt{8}}$ B1M1
				(1.236, 1.424) B1m1A0
				mixture $z \& s$ or $t \& \sigma$ max B1M1
(b)	Evidence mean content at least 1.20 but	E1		Mean above 1.20
	some individual oranges less than 1.20	E1	2	Some individuals <1.20
2(c)	0.11			
2(c)	$2 \times 1.96 \times \frac{0.11}{\sqrt{n}} \le 0.03$	M1		Reasonable attempt at equation/inequality
	$\sqrt{n}$	B1		1.96 cao
		m1		Completely correct equation/inequality
				- allow incorrect z value
	$n \ge 206.6$	m1		Method of solution
	207 needed	A1	5	207 cao
				sc Trial & Improvement:
				205 – 210 B3
				200 – 220 B1
	Total		12	

Question	Solution	Marks	Total	Comments
Number				
and part	1			
3(a)	$\int_{0}^{1} px + q  \mathrm{d}x = 1$	M1		Any correct expression - ignore limits
	$\left[\frac{px^2}{2} + qx\right]_0^1 = 1$	M1		Any correct integration - anywhere
	$\frac{p}{2} + q = 1$	A1	3	Correct proof - ag - allow by diagram
(b)	$E(X) = \int_{0}^{1} px^2 + qx  dx$	M1		Correct expression - ignore limits
	$= \left[\frac{px^3}{3} + \frac{qx^2}{2}\right]_0^1$	m1		Correct method
	$=\frac{p}{3}+\frac{q}{2}$	A1	3	$\frac{p}{3} + \frac{q}{2}$ cao
(c)	$\frac{p}{3} + \frac{q}{2} = 0.6$	M1		Correct equation – candidate's (b) (assuming $p = 1.2$ and showing $q = 0.4$ M0)
	$q = 1 - \frac{p}{2}$ from (a)			
	$\frac{p}{3} + 0.5 - \frac{p}{4} = 0.6$			
	$\frac{p}{12} = 0.1$	m1		Completely correct method
	from (a) $q = 0.4$	A1	3	p = 1.2  ag $q = 0.4  cao$
(d)	$E(X^{2}) = \int_{0}^{1} 1.2x^{3} + 0.4x^{2} dx$	M1		Correct expression for $E(X^2)$ , candidate's $p$ and $q$ - allow in terms of $p$ and $q$
	$= \left[\frac{1.2x^4}{4} + \frac{0.4x^3}{3}\right]_0^1$	m1		and if called variance Correct evaluation of $E(X^2)$ , candidate's $p$ and $q$ - allow in terms of $p$ and $q$ and if called variance
	= 0.4333			
	$V(X) = 0.4333 - 0.6^2 = 0.07333$	m1		Completely correct method for $\sigma$ - allow variance if called variance
	$\sigma = 0.271$	A1	4	0.271 ( 0.27 – 0.272)
	Total		13	

Question	Solution	Marks	Total	Comments
Number and part				
4(a)	$\bar{x} = 37.75$ $s = 4.6928$	B1		37.75 ( 37.7 , 37.8) & 4.69 (4.69 , 4.7)
	$H_0: \mu = 40$	B1		One correct hypothesis - generous
	$H_1: \mu < 40$	B1		Both hypotheses correct - ungenerous
	• •	21		
	$t = \frac{37.75 - 40}{4.6928} = -1.66$	M1		use of candidate's $\frac{s}{\sqrt{12}}$
	$\sqrt{12}$	m1		method for <i>t</i> - ignore sign
		m1		Completely correct method for t
	1706	A1		-1.66 (-1.65 , -1.67)
	c.v. $t_{11} - 1.796$ accept $H_0$ , conclude no	B1 B1		11df
	significant evidence to show mean is less	A1	10	- 1.796 (- 1.79, - 1.8) ignore sign Conclusion, must be compared with
	than 40 months.	711	10	correct tail of <i>t</i> -distribution
(b)	$H_0: \mu = 40$			
	$H_1: \mu < 40$	B1		Both hypotheses correct
	39.2 – 40	M1		method for z
	$z = \frac{39.2 - 40}{\frac{4.2}{\sqrt{160}}} = -2.41$			
	c.v. $-1.6449$ reject $H_0$ , significant evidence to show mean is less than 40.	A1		-2.41 (-2.4, -2.42) and
	evidence to snow mean is less than 40.	A1√	4	- 1.6449 (- 1.64, - 1.655) ignore sign Conclusion, must be compared with
			_	correct tail of $z$ or $t$ .
4(c)(i)	neither, both 5%	B1		neither
/···		E1		both 5%
(ii)	neither - cannot make a Type II error if mean is 40	B1 E1		neither
(iii)	(a), smaller sample	B1		No chance of Type II error (a)
(111)	(a), smaner sample	E1	6	Smaller sample
	Total		20	

Question	Solution	Marks	Total	Comments
Number and part				
5(a)(i)	$0.6 \times 0.8 = 0.48$	M1		Method shown
(ii)	$0.6 \times 0.2 \times 0.75 = 0.09$	M1		Method shown
(iii)	1 - 0.4 - 0.48 - 0.09	M1		Method shown
	<b>or</b> $0.6 \times 0.2 \times 0.25 = 0.03$	A1	4	All answers correct - ag
(b)	$1 - 0.6 \times 0.2 \times 0.25 \times 0.1 = 0.997$	M1		Attempt 1 – P (fail)
	or $0.4 + 0.48 + 0.09 + 0.03 \times 0.9 = 0.997$			or $P(H) + P(O) + P(M) + P(W)$
		m1		Completely correct method
		A1	3	0.997 cao
(c)(i)	$E(X) = 14 \times 0.4 + 19 \times 0.48 + 25 \times 0.09 +$	M1		method - correct probabilities
	$32 \times 0.03 = 17.93$	A1		17.9(17.9 , 18)
	$E(X^2) = 14^2 \times 0.4 + 19^2 \times 0.48 + 25^2 \times$			
	$0.09 + 32^2 \times 0.03 = 338.65$	M1		
	$Var(X) = 338.65 - 17.93^3 = 17.1651$	m1		method for variance - disallow if called standard deviation
	s.d. = 4.14	m1		method for s.d.
	5.6.	A1	6	4.14(4.1, 4.2)
				sc allow M1m1m0A1 for
				variance = 17.2 ( 17.1 , 17.2)
				M1m0m0A0 for s.d. = 17.2
(ii)	$z = \frac{19 - 17.93}{4.1431} = 1.633$	M1		Attempt to use normal
		M1		use of candidate's $\frac{\text{s.d.}}{\sqrt{40}}$
	$\sqrt{40}$	1411		$\sqrt{40}$
		m1		method for z, candidate's mean and s.d.
	P(>19) = 1 - 0.9488 = 0.0512	m1		Correct method requires all previous
			_	method marks in (c)
		A1	5	0.0512(0.05, 0.052)
(iii)	Time away from home predictable	E1		No variation in time
	Mean time away from home longer	E1		Mean longer
	Less (slightly) chance of obtaining milk	E1	3	Less chance of obtaining milk
	Total		21	
	TOTAL		80	