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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Mathematics 6300
Specification A

MAS3 Statistics 3

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
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 *x* marks for each error
NMS		no method shown
PI		possibly implied
SCA		substantially correct approach
c		candidate
sf		significant figure(s)
dp		decimal place(s)

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

MAS3

Q	Solution	Marks	Total	Comments
1(a)(i)	$\bar{x} = 179.6$	B3	3	CAO
	$s_X^2 = 133.16$			133 to 133.2 (B1 M1 A1 if by formula)
(ii)	$\nu = 10 - 1 = 9$	B1		
	Critical value of t = 1.833	B1		
	90% confidence limits for μ_X are			
	$179.6 \pm 1.833\sqrt{\frac{133.16}{10}}$	M1		(M1 only if z-value used)
	giving (172.9, 186.3)	A1√		ft on answers to (i) and t value
		A1	5	AWFW (172.9 to 173, 186 to 186.3)
(b)(i)	Confidence limit for price in £ is			
	$\left(1.20 \times \frac{173}{1000}, 1.20 \times \frac{186}{1000}\right)$	M1		
	= (0.21, 0.22)	A1√	2	AWRT; or (21p, 22p); ft on CI in (a)(ii)
(ii)	20 pence is below confidence interval	E1√		comparing 20p with CI; ft on CI
	so oranges are cheaper/ less profit per orange	E1√	2	sensible deduction (both marks if lower end of CI implied)
	Total		**12**	
2(a)	$P(T = 0) = 0$	B1	1	
(b)(i)	$P(T < 2) = 1 - e^{\frac{-2}{4}} = 1 - e^{-0.5}$	M1		
	= 0.393	A1	2	AWRT
(ii)	$P(2 \le T < 6) = F(6) - F(2)$	M1		
	$= e^{-0.5} - e^{-1.5}$	m1		PI
	= 0.383	A1	3	0.383 to 0.384
(c)	We require $P(T > 4 \mid T > 1)$	M1		
	$= \frac{P(T > 4 \text{ and } T > 1)}{P(T > 1)}$	m1		
	$= \frac{e^{-1}}{e^{-0.25}}$	m1		
	= 0.472	A1	4	CAO
	Total		**10**	

MAS3 (cont)

Q	Solution	Marks	Total	Comments
3	H_0: Median decrease = 5 H_1: Median decrease ≠ 5	B1		both; accept average
	Values of d – 5 are +1 –1 –1 –2 –4 0 –3 –5 +3 +2	B1		
	Ignore zero so $n = 9$	B1		
	Values to be ranked are d–5: +1 –1 –1 –2 –4 –3 –5 +3 +2	M1		
	Rank: +2 –2 –2 –4.5 –8 –6.5 –9 +6.5 +4.5	A1A1		A1 for ranking equal values
	T+ = 13; T– = 32	B1√		either; ft on ranks
	Critical value of T for 2-tailed test at 10% level is 8	B1√		ft on n
	13 > 8 so accept H_0			
	Reasonable to claim that the median decrease is 5	A1√	9	ft on calculated and critical values of T
	Total		**9**	
4(a)	H_0: $\sigma_X = 15$ or $\sigma_X^2 = 225$ H_1: $\sigma_X > 15$ or $\sigma_X^2 > 225$	B1		both
	$\nu = 9 - 1 = 8$	B1		
	One-tailed test at 5% level so critical value of χ^2 = 15.5(07)	B1		
	Sample value of $\chi^2 = \dfrac{8 \times 470.3}{225}$ $= 16.7$	M1		
		A1		AWRT
	16.7 > 15.5 so reject H_0 The evidence supports Evan's belief that $\sigma_X > 15$	A1√	6	ft on sample and critical values
(b)	H_0: $\sigma_X^2 = \sigma_Y^2$ or $\sigma_X = \sigma_Y$ H_1: $\sigma_X^2 > \sigma_Y^2$ or $\sigma_X > \sigma_Y$	B1		both or equivalent
	$\nu_1 = 8$; $\nu_2 = 7 - 1 = 6$	B1		
	One-tailed test at 5% level so $F_{8,6} = 4.15$ (4.147)	B1		
	Sample value = $\dfrac{s_x^2}{s_y^2} = \dfrac{470.3}{136.3}$	M1		
	$= 3.45$	A1		AWRT
	3.45 < 4.15 so accept H_0 There is not enough evidence to claim a decrease in standard deviation	A1√	6	ft on sample and F values
	Total		**12**	

MAS3 (cont)

Q	Solution	Marks	Total	Comments
5(a)(i)	Standard error = $2.7\sqrt{\frac{1}{10}+\frac{1}{10}}$	M1		(M1 if 9 instead of 10)
	$= 1.207$	A1		AWFW 1.207 to 1.21; PI later
	Critical value is $z = 2.3263$	B1		
	Confidence limits are $(37.6 - 31.3) \pm 2.3263 \times 1.207$	M1		
	giving (3.49, 9.11)	A1	5	AWRT; CAO
(ii)	Lower CL > 0 so evidence that there has been a reduction in average speed	E1	1	
(iii)	Width of CI is 5.62 (mph)	B1√	1	ft on confidence interval
(b)(i)	Width = $2z\times$ standard error	B1M1	3	B1 for z-value
	$= 2 \times 1.2265 \times 1.207$	A1√		ft on standard error from (a)(i) and z-value
	$= 2.961 < 3$			accept < or =
(ii)	$2 \times 2.3263 \times 2.7\sqrt{\frac{1}{n}+\frac{1}{n}} \le 3$	M1		
	$\sqrt{\frac{2}{n}} \le 0.2388$	A1		
	$n \ge \frac{2}{(0.2388)^2} = 35.1$	m1		appropriate method for solving
		A1		inequality/equation including $\sqrt{\frac{k}{n}}$
	Minimum value of n is 36	A1	5	must be rounded up from result of calculation
(iii)	Method 2: higher confidence level so interval more likely to include true value of mean / larger samples so smaller standard error	E2	2	E1 for correct choice with appropriate reference to sample size
	Total		**17**	
	TOTAL		**60**	