GCE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Mathematics A
Unit MAS3

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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 ..... method and 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 booklet

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)	Likely to adjust amount as she goes along/ measures not independent.	E1	1	
(b)	$\hat{\mu} = \bar{x} = \frac{473}{9} = 52.6$	B1		awrt
	$\hat{\sigma}^2 = s^2 = \frac{24935}{8} - \frac{(473)^2}{8\times 9} = 9.53$	M1		
		A1	3	awrt; if error in s^2 from rounding $\bar{x}$ to 4 or 5 sf, lose 1 mark here, then full marks available.
(c)(i)	Assume that weights of flour are normally distributed.	E1		
	$\nu = 9-1 = 8$	B1		cao; award here or in (ii)
	Critical value of t is 1.86	B1		cao
	Confidence limits are $52.6 \pm 1.860\sqrt{\frac{9.53}{9}}$	M1 A1√		allow z; M1 if not divided by 9. √on (b)
	giving (50.6 to 50.7, 54.4 to 54.5)	A1	6	cao
(ii)	$\nu = 8$ $\chi^2_{0.05} = 2.733;\ \chi^2_{0.95} = 15.507$	B1		cao; both
	Confidence limits are $\frac{8\times 9.53}{15.507}$ and $\frac{8\times 9.53}{2.733}$	M1 A1√		√ on χ^2 values
	Confidence interval for σ^2 is (4.92, 27.9)	A1		cao
	Confidence interval for σ is (2.22, 5.28)	A1√	5	√ on CI for variance
(d)	The whole of the CI for μ is above 50;	E1		
	Standard deviation seems to be more than 2 grams. Not very useful as Emma overestimates and her measures are rather variable.	E1	2	Reference to CIs required with some assessment.
	Total		**17**	

MAS3 (Cont)

Q	Solution	Marks	Total	Comments
2(a)	H_0: Median score = 50 H_1: Median score ≠ 50	B1		both; must refer to average.
	Differences from 50 are: $+8-2-10-12+4+1-16+13-11+9$	B1		
	Signed ranks are: $+4-2-6-8+3+1-10+9-7+5$	M1 A1		
	$T_+ = 22$; $T_- = 33$	A1√		either; √ on ranks
	Critical value of T is 8	B1		cao
	Accept H_0. Not enough evidence to say median is not 50.	A1√	7	√ on T_{crit} and T_{calc}
(b)(i)	First and last ranks become + 4.5	B1	1	
(ii)	Values of T_+ and T_- unchanged	B1	1	either
(c)	H_0: Median of Jamie's – Samir's score = 0	B1		or equivalent; both
	H_1: Median > 0			
	Under H_0, $X \sim B(15, 0.5)$	B1		cao
	$P(X \geq 12) = P(X \leq 3)$	M1		
	$= 0.0176$	A1		cao
	0.0176 < 5% so reject H_0; Evidence suggests that Jamie scores higher than Samir on average.	A1√	5	√ on probability
	Total		**14**	

MAS3 (Cont)

Q	Solution	Marks	Total	Comments
3(a)	Shape of histogram similar to pdf of exponential distribution. Mean and SD approximately equal.	E1 E1	2	
(b)(i)	$E(T) = \frac{1}{0.3} = 3.33$	B1	1	awrt
(ii)	$P(T \leq 1) = F(1)$ $= 1 - e^{-0.3}$ $= 0.259$	M1 A1	2	awrt
(iii)	$P(T > 1.75 \mid T > 1)$ $= \frac{1 - F(1.75)}{1 - F(1)} \left(= \frac{1 - F(1.75)}{0.741} \right)$ $= \frac{e^{-0.525}}{e^{-0.3}} = 0.799$	M1 A1 A1√	3	identifies correct probability. numerator correct √ on answer to (b)(ii) B1 for $P(T < 1.75 \mid T > 1)$ correctly evaluated.
(iv)	Let median value be m $F(m) = 0.5$ $1 - e^{-0.3m} = 0.5$ $e^{-0.3m} = 0.5$ $-0.3m = \ln(0.5)$ $m = 2.31$ Median time interval = 2.31 minutes	 M1 m1 A1	 3	 valid attempt to solve cao
	Total		**11**	

MAS3 (Cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	$\frac{s_X^2}{s_Y^2} = \frac{1.60}{1.40} = 1.143$	M1 A1		
	$\nu_1 = 10-1 = 9\,;\quad \nu_2 = 7-1 = 6$ 90% interval so $p = 0.95$	B1		CAO both
	$F_6^9 = 4.099\,;\quad F_9^6 = 3.374$ Confidence interval given by	B1		CAO; either
	$\frac{1}{F_6^9} \le \frac{\sigma_X^2 / \sigma_Y^2}{1.143} \le F_9^6$	M1		use of
	$\frac{1}{4.099} \le \frac{\sigma_X^2 / \sigma_Y^2}{1.143} \le 3.374$ giving (0.279, 3.86)	A1 A1√ A1√	8	correct values of F right way round; √ on Fs √on ratio and *F* values. M1A1 if one CL correct.
(ii)	Confidence interval includes 1	E1	1	
(b)	H_0: $\mu_X = \mu_Y$ H_1: $\mu_X > \mu_Y$ Pooled estimate of variance is	B1		both
	$\frac{(9\times1.6)+(6\times1.4)}{15} = 1.52$	M1 A1		
	$\bar{x} - \bar{y} = 1.16$	B1		CAO
	$\nu = 15$	B1		CAO
	Critical value of $t = 1.753$	B1		
	Sample statistic $= \frac{1.16}{\sqrt{1.52\left(\frac{1}{10}+\frac{1}{7}\right)}}$ $= 1.91$	M1 A1√		√ on $\bar{x} - \bar{y}$ and variance
	Sample $t > t_{crit}$ so reject H_0. Evidence supports Jayne's belief.	A1√	9	√ on sample *t* and t_{crit}
	Total		**18**	
	Total		**60**	