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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Statistics 6380

SS05 Statistics unit 5

Mark Scheme

2007 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.

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Key to mark scheme and abbreviations used in marking

M	mark is for method
m or dM	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	MC	mis-copy
CAO	correct answer only	MR	mis-read
CSO	correct solution only	RA	required accuracy
AWFW	anything which falls within	FW	further work
AWRT	anything which rounds to	ISW	ignore subsequent work
ACF	any correct form	FIW	from incorrect work
AG	answer given	BOD	given benefit of doubt
SC	special case	WR	work replaced by candidate
OE	or equivalent	FB	formulae book
A2,1	2 or 1 (or 0) accuracy marks	NOS	not on scheme
–*x* EE	deduct *x* marks for each error	G	graph
NMS	no method shown	c	candidate
PI	possibly implied	sf	significant figure(s)
SCA	substantially correct approach	dp	decimal place(s)

No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded. However, there are situations in some units where part marks would be appropriate, particularly when similar techniques are involved. Your Principal Examiner will alert you to these and details will be provided on the mark scheme.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

Otherwise we require evidence of a correct method for any marks to be awarded.

SS05

Q	Solution	Marks	Total	Comments
1(a)(i)	$P(0.8 \le X \le 1.2) = \frac{1.2-0.8}{2-0}$	M1		
	$= \frac{0.4}{2} = 0.2$	A1	2	
(a)(ii)	$P(X = 1) = 0$	B1	1	
(b)(i)	$P(X \ge 0.6) = \frac{2-0.6}{2} = \frac{1.4}{2} = 0.7$	B1		
	P(all three ≥ 0.6)			
	$= (0.7)^3$	M1		probability raised to power of 3
	= 0.343	A1	3	CAO
(ii)	P(remnant less than 1 metre long)			
	$= \frac{1-0.6}{2-0.6} = \frac{0.4}{1.4}$	M1		
	= 0.286 (3 sf)	A1	2	
	or			
	$P(X < 1 \mid X \ge 0.6)$			
	$= \frac{P(0.6 \le X < 1)}{P(X \ge 0.6)} = \frac{0.2}{0.7}$	(M1)		
	= 0.286	(A1)	(2)	
	Total		**8**	

SS05 (cont)

Q	Solution	Marks	Total	Comments
2(a)(i)	$\nu = 9$	B1		here or in (ii)
	$t = \pm 2.262$	B1		$S^2 \times \frac{10}{9}$: withhold last A mark in 1 part
	95% confidence limits for mean are:			
	$446.9 \pm 2.262 \times \frac{13.9}{\sqrt{10}}$	M1 m1		use of formula standard error
	95% confidence interval is:			
	(437, 457) grams	A1	5	(436.9 to 437, 456.8 to 457)
(ii)	$\chi^2 = 2.700,\ 19.023$	B1		both
	95% confidence limits for variance are:			
	$\frac{9\times13.9^2}{19.023}$, $\frac{9\times13.9^2}{2.700}$	M1 A1√		correct values substituted ft on incorrect x^2 values
	(95% CI is (91.410, 644.03))			
	95% CI for standard deviation is:			
	$\left(\sqrt{\frac{9\times13.9^2}{19.023}}, \sqrt{\frac{9\times13.9^2}{2.700}}\right)$	M1		
	= (9.56, 25.4) grams	A1	5	(9.5 to 9.6, 25.3 to 25.4) CAO
(b)	Damien's claim seems to be correct	B1		must say **above** CI
	upper CL for mean is less than 460	E1	2	
(c)	taking lower CL for mean (437)	E1		
	and upper CL for SD (25.4)	E1		
	350 is more than 3 SDs below mean making it plausible that Damien made a mistake	E1	3	SC E1 for plausible because 350 well below CI for mean
	Total		**15**	

SS05 (cont)

Q	Solution	Marks	Total	Comments
3(a)	Morning: $s_X^2 = 12.136$ or $s_X = 3.48$	B1		12.1 to 12.2; AWRT
	Evening: $s_Y^2 = 35.045$ or $s_Y = 5.92$	B1		35.0 to 35.1; AWRT
	H_0: $\sigma_X^2 = \sigma_Y^2$	B1		or equivalent
	H_1: $\sigma_X^2 < \sigma_Y^2$	B1		or equivalent
	Ratio of variances $= \frac{35.045}{12.136}$	M1		
	$= 2.89$ (or 0.346)	A1√		2.86 to 2.89 (0.344 to 0.349) ft on sample variances
	$\nu_1 = 9$; $\nu_2 = 7$	B1		both, either way round
	Critical value of F = 3.677	B1		accept 0.368 (0.271 to 0.272)
	(or $\frac{1}{3.677} = 0.272$)			if used H_1 with $\neq$ must have $F = 4.823$
	2.89 < 3.677 (or 0.346 > 0.272) There is not sufficient evidence at the 5% level to support Sandeep's belief	A1√	9	ft on variance ratio and CV
(b)				μ_M, μ_A reversed, lose first B1 and last A1
	H_0: $\mu_M - \mu_A = 1$	B1		or equivalent
	H_1: $\mu_M - \mu_A > 1$	B1		or equivalent
	CV of z = 1.6449	B1		If H_1 $\neq$ must have 1.96 accept 1.64, 1.645 or $P(Z > 1.94) = 0.2619$
	sample value of $z = \frac{(61.7 - 58.9) - 1}{2.1\sqrt{\frac{1}{9} + \frac{1}{12}}}$	M1		difference of means over sd
		m1		correct form of sd
	= 1.94	A1		CAO; AWRT
	1.94 > 1.6449 so reject H_0. There is sufficient evidence at the 5% level to support the trainer's claim	A1√	7	ft on sample value and CV
	Total		**16**	

SS05 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	$P(X < 2) = 1 - e^{-0.4\times 2}$	M1		or by integration
	$= 1 - e^{-0.8} = 0.551$	A1	2	AWRT
(ii)	$P(2 \le X \le 5) = F(5) - F(2)$			
	$= (1 - e^{-2}) - (1 - e^{-0.8})$	M1		or by integration
	$= 0.314$	A1	2	AWRT
(b)	for median m, $F(m) = 0.5$ $(= 1 - F(m))$	B1		may be implied
	$F(1.7) = 1 - e^{-0.68} = 0.493$	B1		
	$\left(e^{-0.68} = 0.507\right)$			
	$F(1.8) = 1 - e^{-0.72} = 0.513$	B1		
	$\left(e^{-0.72} = 0.487\right)$			
	0.5 lies between 0.493 and 0.513 so median lies between 1.7 and 1.8	E1	4	
	or			
	$e^{-0.4m} = 0.5$	(M1)		equation of correct form
	$-0.4m = \ln(0.5)$	(m1)		attempt to solve using logs
	$m = \dfrac{0.693}{0.4} = 1.73$	(A1)		
	so median lies between 1.7 and 1.8	(E1)		solution used to answer question
	Total		**8**	

SS05 (cont)

Q	Solution	Marks	Total	Comments
5(a)	$P(X < 304) = \Phi\left(\frac{304-310}{4}\right)$	M1		attempt to find a probability
	$a = \Phi(-1.5) = 0.0668$ (or 0.0667)	A1		one missing value found
	$b = 0.0918$ (or 0.0919)	B1		second value found by any method
	$c = 0.0918$ (or 0.0919)			
	$d = 0.0668$ (or 0.0667)	B1	4	remaining values correct
(b)				
	O | E | $\frac{(O-E)^2}{E}$ 5 | 6.68 | 0.42 13 | 9.19 | 1.58 10 | 14.99 | 1.66 18 | 19.15 | 0.07 25 | 19.15 | 1.79 20 | 14.99 | 1.68 5 | 9.19 | 1.91 4 | 6.68 | 1.08 | | 10.2			If E = 12.5 throughout, just second M1 available
		M1		probabilities ×100
		M1		use of formula
		A1		at least 4 values correct (AWRT)
		A1		$\sum E \neq 100$: lose this and final A1 total correct; AWRT
	H_0: can be modelled by $N(310, 4^2)$			
	H_1: Not H_0	B1		both
	$\nu = 8 - 1 = 7$	B1		
	$\chi^2_{10\%} = 12.017$	B1		any grouping of categories: lose final A1
	$10.2 < 12.017$ Accept H_0 at 10% level. There is not sufficient evidence to reject the model	A1√	8	ft on calculated value and cv
(c)	(1) Reasonable claim as model has mean 310. (Does not say much about one punnet)	E1		
	(2) Looks a safe claim. Only 5 punnets in sample < 304g; shape of normal distribution suggests few, if any, will be < 300g	E1		reference to relevant figure from sample in (2) or (3)
		E1		reference to property of normal in (2) or (3)
	(3) At least 5 punnets in sample < 305g and shape suggests claim could be wrong for about 10% of punnets	E1	4	appropriate assessment of possibilities must use data **and** model for E4
	Total		**16**	

SS05 (cont)

Q	Solution	Marks	Total	Comments
6	assume weights selected by Amy and Ben are normally distributed with common variance independence between samples	B1 B1		any two
		M1		attempt to use t-test for difference of means
	H_0: $\mu_A = \mu_B$ H_1: $\mu_A \neq \mu_B$	B1		both
	pooled estimate of variance $= \frac{(10\times 3.24^2)+(8\times 2.71^2)}{10+8}$	M1		
	$= 9.096$	A1		accept 9.09 to 9.10
	$v = 18$	B1		
	$t = \pm 2.878$	B1		
	sample statistic $= \frac{41.6-38.4}{\sqrt{9.096\left(\frac{1}{11}+\frac{1}{9}\right)}}$	M1 A1		correct values substituted
	$= 2.36$	A1√		ft on standard error; AWRT
	$2.36 < 2.878$ so accept H_0 There is not enough evidence at the 1% level to say that the earlier assessment was wrong	A1√	12	ft on sample statistic and *t* depends on first and last M1
	Total		**12**	
	TOTAL		**75**	