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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Statistics 6380

SS05 Statistics 5

Mark Scheme

2008 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.

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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.

June 08

SS05

Q	Solution	Marks	Total	Comments
1(a)	$(8 - 4) \times 0.1 = 0.4$	M1 A1	 2	method 0.4 CAO
(b)	$0.2 + 0.4 = 0.6$	M1 A1	 2	method 0.6 CAO
(c)	Mean 3 standard deviation $\sqrt{\dfrac{(8-(-2))^2}{12}} = 2.89$	B1 M1 A1	 3	3 CAO - ignore units method for sd - allow variance if called variance 2.89 (2.88 ~ 2.9)
	Total		**7**	
2(a)(i)	$\bar{x} = 84741.143 \quad s = 34.677$ 95% confidence interval for σ $1.237 < 6\times\dfrac{34.677^2}{\sigma^2} < 14.449$ $1.237 < \dfrac{7214.9}{\sigma^2} < 14.449$ $499.33 < \sigma^2 < 5832.54$ $22.3 < \sigma < 76.4$	B1 M1 B1 B1√ m1 m1 A1	 7	34.677 (34.65 ~ 34.7) may be implied in (i) or (ii) method for inequality - allow incorrect χ^2/ incorrect $\dfrac{n}{n-1}$. 6df may be earned in (ii) 1.237 or 1.24 and 14.449 (14.4 ~ 14.5) method for interval for variance method for interval for sd 22.3 (22.3 ~ 22.4) and 76.4 (76.3 ~ 76.5) allow m1m0A1 correct interval for variance if called variance
(ii)	95% confidence interval for mean $84741.143 \pm 2.447 \times \dfrac{34.677}{\sqrt{7}}$ 84741.143 ± 32.072 $84709 \sim 84773$	B1 M1 m1 B1√ A1 B1	 6	84741.143 (84700 ~ 84800) use of their $\dfrac{\text{sd}}{\sqrt{7}}$ method for confidence interval - allow incorrect t 2.447 (2.44 ~ 2.45) 84709 (84708 ~ 84710) and 84773 (84770 ~ 84774) - allow in ± form final answer to 4 or 5 sf
(b)	Evidence that more expensive scales are less variable as 15 below 22.3. Less expensive scales seem sufficiently accurate for purpose of weighing yourself.	E1√ E1 E1	 3	more expensive scales less variable - their confidence interval for s.d. reason less expensive scales sufficiently accurate for purpose
(c)	No information can be deduced about possible bias as Akiva's actual weight is not known.	E1	1	none as Akiva's weight unknown allow comment on cost
	Total		**17**	

SS05 (cont)

Q	Solution	Marks	Total	Comments
3(a)	$s_B = 9.1354 \quad s_A = 11.030$	B1		9.1354 (9.13 ~ 9.14) and 11.030 (11 ~ 11.1) - may be earned in part (b)
	$H_0 : \sigma_B^2 = \sigma_A^2 \quad H_1 : \sigma_B^2 \neq \sigma_A^2$	B1		both hypotheses, needs σ, σ^2 or population
	$F = \dfrac{11.030^2}{9.1354^2} = 1.46$	M1		use of ratio of their variances
		m1		method for F
		A1		1.46 (1.45 ~ 1.46)
	c.v. $F_{[5,6]}$ is 5.988	B1		5,6 df
		B1√		5.988
	Accept H_0 , no significant evidence of a difference in standard deviations of speeds	A1√	8	conclusion AG no context required
(b)	$\bar{x}_B = 69.8429 \quad \bar{x}_A = 55.7333$			
	pooled variance estimate, s_p^2 $\dfrac{6\times 9.1354^2 + 5\times 11.030^2}{6+5} = 100.852$	M1		method for pooled variance
	$s_p = 10.043$			
	$H_0 : \mu_B = \mu_A \quad H_1 : \mu_B > \mu_A$	B1		both hypotheses - needs μ or population
	$t = \dfrac{69.8429 - 55.7333}{10.043\sqrt{\dfrac{1}{7}+\dfrac{1}{6}}}$	M1		method for t - their pooled variance allow if $\dfrac{s_x^2}{7}+\dfrac{s_y^2}{6}$ used for variance
		m1		correct method for t - ignore sign
	$= 2.53$	A1		2.53 (2.52 ~ 2.53) - ignore sign
	c.v. t_{11} is 1.796	B1		11df
		B1√		1.796 - ignore sign, their df
	reject H_0, significant evidence that mean speed has been reduced after introduction of speed cameras.	A1√		conclusion - needs one sided t-test plus +ve ts compared with +ve cv or –ve ts compared with –ve cv
		A1√	9	in context - allow arithmetic errors, incorrect t-value, 2-sided test.
(c)	Purpose of speed cameras was to slow down cars which would otherwise have been speeding. This car had been slowed down by abnormal circumstances (sheep on road) so it was sensible to exclude it.	E1		reason for abnormal speed unconnected with speed cameras
		E1	2	sensible to exclude sample no longer random
	Total		**19**	

SS05 (cont)

Q	Solution	Marks	Total	Comments
4(a)	mean $\frac{1}{0.02}$ = 50 hours	M1 A1	 2	method 50 CAO - ignore units
(b)	$1 - e^{-8 \times 0.02} = 1 - e^{-0.16}$ $= 1 - 0.8521437$ $= 0.148$	B1 M1 A1	 3	attempt to use $e^{-8 \times 0.02}$ correct method 0.148 (0.1475 ~ 0.1485)
(c)	Probability not fail during 40 hours $1 - e^{-0.8} = 1 - 0.4493$ $= 0.551$ Probability not failing = 0.449 (or $0.8521437^5 = 0.449$)	M1 m1 A1	 3	attempt to find probability not failing during 40 hours or (their prob not fail in 8 hours)^5. Allow fail/not fail errors correct method 0.449 (0.449 ~ 0.45)
(d)	Makes no difference - exponential distribution has no memory.	E1 E1	 2	no difference exponential distribution has no memory
(e)(i)	Mean time between failures is 50 hours. Mean number of drill bits which fail in 40 hours is $\frac{40}{50} = 0.8$	 M1 A1	 2	 method 0.8 CAO
(ii)	From tables (or otherwise) 0.449	B1	1	0.449 (0.449 ~ 0.45)
	Total		**13**	

SS05 (cont)

Q	Solution	Marks	Total	Comments
5(a)	$p = \frac{1}{120\times8}$ (0×5 + 1×21 + 2×56 +… …3×10 + 4×19 + 5×5 + 6×4)	M1		method; disallow $\frac{36}{120}$
	$= \frac{288}{960} = 0.3$	A1	2	0.3 AG
(b)	Binomial n=8 p=0.3	B1		attempt to use B(8, 0.3)
	r P(r) E O 0 0.0576 6.91 5	M1		method for binomial probabilities
	1 0.1977 23.72 21 2 0.2965 35.58 56	M1		their probabilities × 120
	3 0.2541 30.49 10 4 0.1361 16.33 19			
	5 0.0467 5.60 6 0.0100 1.20 } 6.96 9	M1		attempt at pooling
	≥7 0.0013 0.16	m1		correct method of pooling - requires previous M1M1M1
	H_0 : Binomial suitable model H_1 : Binomial not suitable model	B1		hypotheses - may be implied in conclusion
	$\sum\frac{(O-E)^2}{E} = 27.3$	M1		use of $\sum\frac{(O-E)^2}{E}$ their figures
		A1		27.3 (27.2 ~ 27.5)
	c.v. χ_4^2 is 13.277	B1√		4df
		B1√		13.277 (13.27 ~ 13.3)
	Reject H_0; significant evidence that binomial model does not provide suitable model for the number of tasks judged to have been carried out successfully.	A1√		conclusion their figures AG must be compared with upper tail of χ^2
		A1√	12	in context - requires all method marks except pooling
(c)	Binomial → probability of applicant failing test constant. Since binomial unsuitable the theory is not supported.	E1		Binomial implies constant probability
		E1	2	theory not supported - needs a reason
(d)	More than expected are unsatisfactory on 2 tasks - less than expected unsatisfactory on 3 tasks. Other frequencies close to expected.	E1		large differences on 2 or 3 tasks identified
	It appears that Ebony may have been generous in judging borderline applicants - allowing some applicants who would have failed 3 tasks and not been considered for employment to only fail 2 tasks.	E1		possibly related to candidates failing 3 tasks not being considered for employment.
		E1	3	adequate explanation.
	Total		**19**	
	TOTAL		**75**	