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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Statistics 6380

SS06 Statistics 6

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.

SS06

Q	Solution	Marks	Total	Comments
1(a)	Warning limits $850 \pm 1.96 \times \frac{0.8}{\sqrt{4}}$ 850 ± 0.784 849.22 ~ 850.78 Action limits $850 \pm 3.09 \times \frac{0.8}{\sqrt{4}}$ 850 ± 1.236 848.76 ~ 851.24	 M1 m1 B1 A1	 4	 850 ± (their *z*) × (their sd) correct method - their *z* - both limits 1.96 and 3.09 - allow 2 and 3 or 3.0902 all limits correct 1dp - allow in ± form
(b)	Upper action 2.33×0.8 = 1.86 Upper warning 1.76×0.8 = 1.41 Lower warning 0.27×0.8 = 0.22 Lower action 0.09×0.8 = 0.07	M1 A1	 2	method - allow upper limits only/use of range factors/incorrect *n*, but only one of these errors all; ± 0.01
(c)	$\bar{x}$ = 850.7 s = 0.73 Both mean and standard deviation within warning limits - no action required.	B1 A1√ A1√	 3	850.7 CAO and 0.73 (0.72 ~ 0.73) both mean and sd within warning limits - may be implied by correct conclusion based on correct working no action
	Total		**9**	
2(a)	Design 1 is the completely randomised design.	B1	1	Design 1
(b)	Randomised block design	B1	1	block
(c)	In design 2 each technician uses each instrument panel. This reduces experimental error and makes it more likely that a difference - if one exists - will be detected.	E2,1	2	- each technician uses each panel - reduces experimental error - more likely to detect a difference - less technicians needed max 2
	Total		**4**	

SS06 (cont)

Q	Solution	Marks	Total	Comments
3(a)	(i) mean $\frac{792}{10}$ =79.2 must be whole number so 79 suitable estimate.			
	(ii) proportion of sweets with imperfect coating = $\frac{94}{792}$	M1		method for either - can be demonstrated by a correct value - eg 79.2 or 0.1187
	= 0.118686 suitable estimate is 0.119	A1	2	both answers correct based on correct working - AG
(b)	Warning limits $0.119 \pm 1.96\sqrt{\frac{0.119\times0.881}{79}}$	B1		method for sd
	0.119 ± 0.0714 0.048 ~ 0.190 Action limits			
	$0.119 \pm 3.09\sqrt{\frac{0.119\times0.881}{79}}$	M1 B1		0.119 ± (their *z*) × (their sd) 1.96 and 3.09 - allow 2 and 3 or 3.0902
	0.119 ± 0.1126 0.006 ~ 0.232	A1	4	0.048 (0.046 ~ 0.05) 0.190 (0.190 ~ 0.192) 0.006 (0.006 ~ 0.010) 0.232 (0.228 ~ 0.232)
(c)	(i) $\frac{16}{76}$ = 0.211 between upper warning and action limits - take another sample immediately - if still above upper warning limit take action.	B1 A1√		0.211 (0.21 ~ 0.211) correct action, their figures
	(ii) Sample too small for charts to be valid. Take another sample.	B2,1	4	sample too small for charts to be valid
	Total		**10**	

SS06 (cont)

Q	Solution	Marks	Total	Comments
4(a)	A B C D E F G H d –18 –10 43 7 –25 55 10 5	M1		method for differences
	$H_0: \mu_d = 0$ $H_1: \mu_d \neq 0$ $\bar{x}_d = 8.375$ $s_d = 28.121865$	B1		both hypotheses - needs μ or 'population'
	$t = \dfrac{8.375}{\frac{28.121865}{\sqrt{8}}}$	M1		use of their $\frac{sd}{\sqrt{8}}$
		m1		clearly correct method for t
	$= 0.842$	A1		0.842 (0.842 ~ 0.843) or –0.842
	critical value $t_7 \pm 1.895$	B1		7df
		B1		B1 1.895 - ignore sign
	Accept $H_0: \mu_d = 0$ - data supports claim that there is no difference between advised price and obtained price.	A1√		AG correct conclusion their figures - must be compared with correct tail of t
		A1√	9	correct conclusion in context - allow arithmetic errors or numerically incorrect t value only.
(b)	12 + 5 = 17 out of 12 + 8 = 20 items would have received less than advised by Sidney	B1		17 out of 20 received less - or equivalent
	$H_0: p = 0.5$ $H_1: p < 0.5$	B1		both hypotheses - accept p as implying population
	$n = 20$ P(17 or more) = 0.0013 < 0.01	M1		Attempt to use relevant binomial with $p = 0.5$
		A1		0.0013
	reject H_0. Significant evidence that price which would be obtained is on average less than that advised by Sidney.	A1√		conclusion - allow small errors in number of items eg 16 out of 19 or small errors in use of binomial.
		A1√	6	conclusion in context completely correct method
(c)	When only items which were sold are considered, the data is consistent with Sidney's claim. However when all items *offered for sale* are considered, there is significant evidence that Sidney on average overestimates the price which will be obtained. Before the auction it is not possible to tell whether or not the item will sell, so it is the latter result which is relevant.	E1√		One relevant point based on their conclusions
		E1	2	A second relevant point - both based on correct conclusions
	Total		**17**	

SS06 (cont)

Q	Solution	Marks	Total	Comments
5(a)	(i) $z = \dfrac{1003-999}{\frac{6}{\sqrt{5}}}$	M1		use of $\dfrac{6}{\sqrt{5}}$
		m1		method for either z - ignore sign
	= 1.491	m1		completely correct method both probabilities - allow interchanged
	P(accept) = 1 – 0.932 = 0.068	A1		0.068 (0.0675 ~ 0.07)
	(ii) $z = \dfrac{1003-1007}{\frac{6}{\sqrt{5}}}$			
	= –1.491			
	P(accept) = 0.932	A1	5	0.932 (0.93 ~ 0.933)
(b)	on insert	M1		method for graph
		A1	2	reasonably accurate plot - by eye: 5 printed points and attempt at curve; disallow if >1 or < 0
5(c)(i)	B(25, p)			
	% n-c 10 15 25 30			
	p 0.967 0.838 0.378 0.193	M1		method
		A1	2	all correct 2 dp
(ii)	on insert	M1		method - generous
		A1	2	reasonably accurate plot - including (0,1)
(d)(i)	0.036	B1	1	0.036 (0.025 ~ 0.04)
(ii)	$z = \dfrac{993-998}{6} = -0.833$			
	P(<993) = 1 – 0.798 = 0.202	B1	1	0.20 demonstrated - may be implied by 0.202 etc - AG
	0.20 to 2 sf			
(iii)	P(accept) = 0.6	B1	1	(0.58 ~ 0.64)
(iv)	$z = \dfrac{1000-998}{6} = 0.333$			
	Probability < 1000g is 0.631	B1		0.631 (0.629 ~ 0.631)
	ie 63% - more than half batch weigh less than nominal quantity - batch should clearly be rejected. Hence plan based on mean is preferred (prob rejection 0.96 compared to 0.4 for other plan).	E1		batch should be rejected
		E1	3	more chance of rejecting with plan based on mean - based on previous correct working
	Total		**17**	

SS06 (cont)

Q	Solution	Marks	Total	Comments
6(a)	P Q R Total A 96 35 122 253 B 42 31 146 219 C 131 54 137 322 Total 269 120 405 794			
	Σ Marian = 296 Σ John = 214 Σ Sajid = 284	M1		totals for cyclists calculated
	Total SS = $88212 - \frac{794^2}{9} = 18163.6$	M1		method for total SS - generous
	Between batteries SS $= \frac{269^2}{3} + \frac{120^2}{3} + \frac{405^2}{3} - \frac{794^2}{9} = 13546.9$	M1		method for between batteries SS
	Between back lights SS $= \frac{253^2}{3} + \frac{219^2}{3} + \frac{322^2}{3} - \frac{794^2}{9} = 1836.2$	M1		method for between lights SS
	Between cyclists SS $= \frac{296^2}{3} + \frac{214^2}{3} + \frac{284^2}{3} - \frac{794^2}{9} = 1307.6$	M1		method for between cyclists SS (M marks cannot be gained for negative SS.)
	Source S.S. D.F. MS Batteries 13546.9 2 6773.5 Lights 1836.2 2 918.1 Cyclists 1307.6 2 653.8 Error 1472.9 2 736.5 Total 18163.6 8	M1 m1 B1		method for error SS - their figures **SC** for the 5 SS method marks, allow 2/5 if consistently correct method for between SS apart from divisor of 794^2 method for MS - batteries and error - requires all previous Ms - their df df - batteries and error
	H_0: No difference between batteries $F = \frac{6773.5}{736.5} = 9.2$ Critical value $F_{2,2}$ is 19.00	B1 m1 A1 B1		null hypothesis method for F - their df 9.2 (9.19 ~ 9.21) 19.00
	Accept H_0 - no significant evidence of difference in mean lives of makes of battery.	A1√ A1√	14	AG conclusion - must be compared with upper tail of F in context - previous A mark required - cannot be gained if H_0 incorrect

SS06 (cont)

Q	Solution	Marks	Total	Comments
6(b)(i)	P Q R mean 89.7 40.0 135.0	E1		mean of R much larger than Q - may be implied by showing means
	Sample mean of batteries of make R much larger (more than 3 times) than that of make Q. Sajid was surprised that this difference was not significant.	E1		surprising this difference not significant
(ii)	More df (4,12) → much smaller critical value → more chance of detecting a difference if one exists.	E1		more df /smaller cv /more powerful
	Much more complicated / time consuming /difficult to implement.	E1	4	more complicated or equivalent
	Total		**18**	
	TOTAL		**75**	