

General Certificate of Education

Statistics 6380

SS06 Statistics 6

Mark Scheme

2009 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

М	mark is for method			
m or dM	mark is dependent on one or more M marks and is for method			
А	mark is dependent on M or m marks and is for accuracy			
В	mark is independent of M or m marks and is for method and accuracy			
Е	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	W So De Mar Di Sa Mah			
	<i>d</i> 7 8 6 12 -3 9 -1	M1		M1 method for differences
		DI		
	$\mathbf{H}_0:\boldsymbol{\mu}_{\mathrm{d}} = 0 \qquad \mathbf{H}_1:\boldsymbol{\mu}_d \neq 0$	BI		B1 both hypotheses — needs μ or
	_	D1		population'
	$x_d = 5.4286$ $s_d = 5.4423$	DI		B1 5.43 (5.42~5.43) and 5.44 (5.44~5.45)
				a their sd /
	$t = \frac{5.4286}{5.4286}$	M1		MI use of them $\frac{34}{\sqrt{7}}$
	5.4423	m1		m1 clearly correct method for t
	-2.64	Δ1		A1 2.64 (2.63 ~ 2.65) or -2.64
	-2.04	B1		B1 6df
	Cinical value $l_6 \pm 1.945$	B1		B1 1.943 — ignore sign
	Reject $H_0: \mu_d = 0$ — Conclude there is			A1 \checkmark correct conclusion their figures —
	significant evidence of a difference in	A1√		must be compared with correct tail of t.
	pulse rates for different bench heights		10	Disallow if contradicted subsequently $A_1 \wedge approx approx apply in context$
	(rate higher for 40cm than for 30cm)	Al√`	10	allow arithmetic errors or
				numerically incorrect t value only
				Needs previous $A1$
	Total		10	A
2(a)	Source SS df MS	B1		B1 any correct df
	Bands 3369.7 3 1123.23	B1		B1 all correct df
	Error 2168.8 15 144.59	M1	3	M1 method for error SS
	Total 5538.5 18			
(h)	Ha: No difference between bands	M1		M1 method for both MS — their df and
(0)	H_0 . No unreference between bands	1011		+ve Error SS
	_ 1123.23	m1		m1 method for F, their df — needs
	$F = \frac{14459}{14459} = 7.77$	A1		both Ms
	Critical value $F_{3,15}$ is 5.417	B1		A1 7.77 (7.76~7.78)
	Reject H_0 — significant evidence of a			B1 5.417 or 5.42
	difference in average attendance for the	A1√	5	Al \checkmark conclusion in context — must be
	different bands.			upper tail of E
	Total		8	
3(a)	Wednesday Thursday			
- ()	1 D M			
	2 M D	B1		B1 6Ms 6Ds
	3 D M	DI		
	4 M D	BI		BI paired
		R1	2	B1 3Ms 3Ds each day
(b)	Don't take a break/ take same number and		5	DI SIVIS SIDS Cacil day
	length of breaks	E2,1	2	E1 any reasonable point
	Drive as quickly as possible consistent			E1 clearly explained
	with safety and speed limits etc			Disallow drive same speed
(c)	Paired <i>t</i> -test	E1	_	E1 paired
		E1	2	El t-test
				Allow sign test, wilcoxon signed-rank test Disallow 2 Eactor A of V unloss some
				explanation included
	Tatal		7	
L	10tai		,	

SS06 (cont)				
Q	Solution	Marks	Total	Comments
4(a)	1st 0 1 1 1 2 2	M1		M1 reasonable attempt at double sampling
.,	2nd 0 1 2 0 1			
	$P(Accept) = P(0) + P(1) \times P(2 \text{ or fewer}) +$	m1		m1 method their attempt
	$P(2) \times P(1 \text{ or fewer})$			
	$= 0.2146 + 0.3389 \times 0.8122 +$	B1		B1 use of B(30, 0.05)
	0.2587×0.5535	M1		M1 completely correct method
	= 0.633	A1	5	A1 0.633 (0.632~0.634)
(h)	F (number tested)			
(0)	$= 30 + 30 \times P(1 \text{ or } 2)$	M1		M1 reasonable attempt at method
	$= 30 + 30 \times 0.5976$	m1		m1 completely correct method
	= 47.9	A1	3	A1 47 9 (47 8~48)
	Total		8	
5(a)(i)	1001-998	M1	0	M1 upp of $29/$
	$z = \frac{1001}{29} = 2.534$	ml		MT use of $\frac{2}{\sqrt{6}}$
(ii)	$\frac{2.5}{\sqrt{6}}$			m1 method for either z — ignore sign
	P(accept) = 1 - 0.994 = 0.006			
	1001-1004			m1 completely correct method both
	$z = \frac{-2.9}{2.9}$	m1		probabilities — allow interchanged
	$\sqrt{6}$			A1 0.006 ($0.005 \sim 0.006$) and
	P(accept) = 0.994	Al	4	0.994 (0.994 ~ 0.995)
(b)	on insert	M1		M1 method for graph
		A1	2	A1 reasonably accurate plot — by eye
(c)	999.5	M1	_	M1 method — needs M1 in (b)
		Al	2	A1 999.5 (999.3~999.6)
(d)	$\frac{999.5-1001}{-1.6449}$	MI D1		M1 reasonable attempt at expression
	2.9/	BI m1		(generous) $P_{1,1} = (440)(1, 64, -1, 65)$
	$/\sqrt{n}$	1111		m1 correct expression — allow $\leq > =$
	$\sqrt{n} > 1.6449 \times \frac{2.9}{1.5}$	m1		m1 method for manipulation of
	1.5			expression
	$n > 3.180^{-1}$	A 1	5	A = 1 + 1 + 1
	n-11	AI	ر 12	AT IT OF at least IT
6(0)	$\frac{101a1}{100}$	M1	13	M1 method for upper limits
0(a)	Upper warning $1.76 \times 2.3 = 4.048$	m1		m1 method for all limits
	Lower warning $0.27 \times 2.3 = 0.621$	1111		int method for an mints
	Lower action $0.09 \times 2.3 = 0.207$			
	+ graph	A1	3	A1 accurate plot by eve
	0- wp		U	Allow B1 if values for range charts used
				or if incorrect sample size (eg 7) used —
				but not both
(b)(i)	$\overline{x} = 399.0 s = 3.92$	B1	1	399 CAO and 3.92 (3.91~3.92)
(ii)	on graph	B1		B1 accurate plot of means — by eye
		B1	2	B1 accurate plot of sd — by eye
(iii)	Means — all within warning limits except			
	sample 2 which is below lower action	E1		an E mark for any sensible point —
	limit. Action appears to have been taken			maximum 2 for each chart. Maximum 3 in
	successfully.	E1		total.
	all / below target sd — all between			
	warning limits but variability appears to		_	
	be increasing over last 5 samples.	El	3	

SS06 (cont)				
Q	Solution	Marks	<u>Tot</u> al	Comments
6(c)	Sd between warning and action limits. Take another sample immediately if still above warning limit take action.	E1√ E1	2	E1 \checkmark sd between warning and action E1 take another sample immediately
(d)(i)	$z_1 = \frac{392 - 396}{2.3} = -1.739$ $z_2 = \frac{408 - 396}{2.3} = 5.217$	M1		M1 method — allow upper limit not considered
(ii)	proportion outside tolerance 1 - 0.959 = 0.041 Tolerance width $16 = \frac{16}{2} \approx 7$ sd	A1	2	A1 0.041 (0.04~0.042) E1 possible to meet tolerances as
	2.3 Possible to meet tolerances consistently provided mean on target.	E1 E1	2	E1 provided mean is on target
	Total		15	
7(a)	P Q R Total J 23 33 42 98 Gi 46 37 79 162 Gw 56 44 80 180 N 54 60 75 189 Total 179 174 276 629			
	Total SS = $36721 - \frac{629^2}{12} = 3750.92$ Between designs SS	M1		M1 method for total SS
	$= \frac{179^2}{4} + \frac{174^2}{4} + \frac{276^2}{4} - \frac{629^2}{12} = 1653.17$ Between examiners SS	M1		M1 method for between designs or examiners SS (generous)
	$= \frac{98^2}{3} + \frac{162^2}{3} + \frac{180^2}{3} + \frac{189^2}{3} - \frac{629^2}{12} = 1686.25$	M1		M1 method for between designs and examiners SS
	Source SS df MS Designs 1653.17 2 826.58 Examiners 1686.25 3 Error 411.5 6 68.58 Total 3750.92 11 H ₀ : No difference between designs 6 6	M1 B1 M1		M1 method for error SS — their figures B1 df error M1 method for MS — designs and error — their SS and df
	H ₁ : Difference between designs $F = \frac{826.58}{68.58} = 12.1$ Critical value $F_{2,6}$ is 5.143 Reject H ₀ — significant evidence of difference between designs	m1 A1 B1 A1√ A1√	11	m1 method for F — requires all previous Ms A1 12.1 (12 ~ 12.2) B1 5.143 A1 \checkmark conclusion — must be compared with upper tail of F A1 \checkmark in context — previous A mark required Special case If designs and error SS interchanged, allow M and B but not A marks

<u>SS06 (cont)</u>				
Q	Solution	Marks	Total	Comments
7(b)	Results show significant evidence that not all means equal. Hence Q (lowest mean/total) differs from R(highest mean/total).	E1		E1 significant evidence of difference or Q different from R
	However means/totals suggest P and Q similar.	E1		E1 P and Q similar
	Recommend choose design R.	E1	3	E1 Choose R
	Total		14	
	TOTAL		75	