

General Certificate of Education

Statistics 6380

SS06 Statistics 6

Mark Scheme

2006 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.

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	d is for method	and accuracy			
E	mark is for explanation					
\sqrt{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 <i>x</i> 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)(i)	Group treated with new ointment	B1		CAO
(ii)	Group treated with well established			
	ointment	B1	2	CAO
(b)	Neither patient nor medical staff	E1		patients don't know
	administering the ointment know			
	which is new and which is well	E1		administrators of treatment don't know
	established ointment. This is to			
	ensure that any differences observed			
	are due to the ointments and not due	E1	3	to ensure differences are due to
	to expectations that the new ointment			ointments - allow to eliminate
	will be better.			bias
	Total		5	
2(a)(i)	Chart for means	B1		1.96 (1.96~2) and 3.09 (3~3.1)
	Warning limits $210 \pm 1.96 \times 4/\sqrt{5}$	M1		use of their $z \times 4/\sqrt{5}$
	210 ± 3.51	m1		method - their z - for all limits
	206.5 ~ 213.5	A1		206.5 (206~207),
	Action limits $210 \pm 3.09 \times 4/\sqrt{5}$			213.5 (213 ~214)
	210 ± 5.53			$204.5 (204 \sim 205)$ and $215.5 (215 \sim 216)$
	$204.5 \sim 215.5$	D1	5	$215.5(215 \sim 216)$
	+ mints on chart	DI	3	disallow 206 214 ato
				- disallow 200,214 etc
(**)		D1		
(11)	Chart for ranges	BI		4.197 (or 4.20), and 5.484 (as 5.48)
	Lower Action $0.30/\times 4 = 1.5$	MI		(01 5.48)
	Lower Warning $4.107 \times 4 = 16.8$	101 1		$\frac{1}{2}$ sample size, use of E and/or
	Upper Action $5.484 \times 4 = 21.9$			upper limits only
	+ limits on chart	A1		all four limits +0.1
		B1	4	limits correctly plotted
(b)(i)	on granh	B 1		means correct by ave
(0)(1)	on graph	B1 B1	2	ranges correct - by eye
(::)	First source la suit of control on hoth		2	first comple system limits
(11)	First sample out of control on both	EIV		first sample outside action limits
	mean and range chart.			
	Action appears to have been taken	E1		other points within warning limits
	successfully as all other points within			* Č
	warning limits.			
	Mean appears to be drifting upwards	E1	3	mean appears to be increasing



2(a)(ii), b(i), (c)(i)



QJoint MMarksForm2(c)(i)mean 211.6MImethod for calc and plot mean method for calc and plot range(ii)Mean between warning limits, range below lower action limit. No action/ investigate apparent improvement in order to maintait/ check readings are correctE123(a)H ₀ : $\mu_{diff} = 0$ H ₁ : $\mu_{diff} = 0$ H ₁ : $\mu_{diff} = 0$ B1both hypotheses - must use μ or population - allow $\mu_{a} = \mu_{B}$ H ₁ : must be consistent with differencesPair123456B - A7359-1222M1 $\overline{x} = 12.167$ $s = 15.741$ m1method for cill and $\mu_{a} = \mu_{B}$ H ₁ : must be consistent with differencesPair123456B - A7359-1222 $\overline{x} = 12.167$ $s = 15.741$ m1method for cill and $\mu_{a} = \mu_{B}$ $t = (12.167 - 0)/(15.741/\do) = 1.89$ A11.89 (1.89 to 1.9) or -1.89 if A-B used 5dfcvt is is 1.476 reject H ₀ : significant evidence that older girls score more points on average.A1Alternative s.c. confidence interval 1.2.167 ± 1.476x15.741/\do 2.68 < 21.65 2.68 > 0 A1s.c unpaired t used allow maximum B1 MOMOMOA0 BIB1 A0A0B1 hypotheses B1 100dfB1 hypotheses B1 1.372 or 1.37		Solution	Marks	Total	Comments
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s.c. confidence interval $12.167 \pm 1.476x15.741/\sqrt{6}$ $2.68 \sim 21.65$ $2.68 > 0$ s.c critical value $1.476x15.741/\sqrt{6} = 9.49$ $9.49 < 12.167$ s.c unpaired t used allow maximum B1 M0M0m0A0 B1B1 A0A0 s.c all differences same sign		Alternative			
$12.167 \pm 1.476 \times 15.741/\sqrt{6}$ $2.68 \sim 21.65$ $2.68 > 0$ s.c critical value $1.476 \times 15.741/\sqrt{6} = 9.49$ $9.49 < 12.167$ s.c unpaired t used allow maximum B1 M0M0m0A0 B1B1 A0A0 s.a all differences some sign		s.c. confidence interval			
$\begin{array}{c} 2.68 \sim 21.65\\ 2.68 > 0\\ \text{s.c critical value}\\ 1.476 x 15.741/\sqrt{6} = 9.49\\ 9.49 < 12.167\\ \text{s.c unpaired t used}\\ \text{allow maximum}\\ \text{B1 M0M0m0A0 B1B1 A0A0}\\ \text{B1 M0M0m0A0 B1B1 A0A0}\\ \text{a.e. all differences same sign}\\ \end{array}$		$12.167 \pm 1.476 \times 15.741 / \sqrt{6}$			
2.68 > 0 s.c critical value $1.476x15.741/\sqrt{6} = 9.49$ 9.49 < 12.167 s.c unpaired t used allow maximum B1 M0M0m0A0 B1B1 A0A0 s.c oll differences some sign		2.68~21.65			
s.c critical value $1.476x15.741/\sqrt{6} = 9.49$ $9.49 < 12.167$ s.c unpaired t used allow maximum B1 M0M0m0A0 B1B1 A0A0 s.a. all differences same sign		2.68 > 0			2.68 (2.65 to 2.7)
s.c critical value $1.476x15.741/\sqrt{6} = 9.49$ $9.49 < 12.167$ s.c unpaired t used allow maximum B1 M0M0m0A0 B1B1 A0A0 B1 differences same sign					
$\begin{array}{c} 1.476x15.741/\sqrt{6} = 9.49 \\ 9.49 < 12.167 \\ \text{s.c unpaired t used} \\ \text{allow maximum} \\ \text{B1 M0M0m0A0 B1B1 A0A0} \\ B1 model back back back back back back back back$		s.c critical value			
9.49 < 12.167 s.c unpaired t used allow maximum B1 M0M0m0A0 B1B1 A0A0 s.c all differences same sign		$1.476 \times 15.741 / \sqrt{6} = 9.49$			
s.c unpaired t used allow maximum B1 M0M0m0A0 B1B1 A0A0 B1 lodf B1 1.372 or 1.37		9.49 < 12.167			9.49 (9.48 to 9.5)
B1 M0M0m0A0 B1B1 A0A0 B2 a all differences same sign		a a unnaired tugad			
B1 M0M0m0A0 B1B1 A0A0 B1 1.372 or 1.37		s.c unparted t used			R1 hypotheses
BI WOWOMOAO BIBI AOAO BI 1.372 or 1.37		$\mathbf{P}_{1} = \mathbf{M}_{0} \mathbf{M}_{0}$			P1 10df
B1 1.3/2 OF 1.3/					D 1 1001 D 1 1 272 or 1 27
		s c. all differences same sign			D1 1.3/2 01 1.3/
s.c. all unificiences same sign		allow maximum			
1000000000000000000000000000000000000		$\mathbf{R}_{1} \mathbf{M}_{1} \mathbf$			

SS06 (cont)

SS06 (cont)					
Q	Solution	Marks	Total	Comments	
3(b)	Differences may be regarded as a random sample from the population and are normally distributed	E1 E1	2	random normal	
(c)	Boys would introduce an additional source of experimental error and make any effect of age more difficult to detect.	E1	1	explanation	
(d)(i)	ranks also unreliable - Wilcoxon signed-	E1		ranks unreliable	
	rank test unsuitable.	El		Wilcoxon unsuitable	
(ii)	sign test valid but unlikely to detect a difference with such a small sample.	E1	3	sign test valid sample too small for sign test to be effective. maximum 3	
			15		
4(a)(i)	% non-conf 1 3 5 7 10 15 P(Accept) 0.998 0.962 0.873 0.747 0.537 0.254	B1 M1 A1	3	Use of Binomial n = 25 method for P(Accept) at least two points all correct 3dp -allow one small slip	
(ii)	on graph below	M1		points plotted	
		A1	2	accurate plot - points joined - passes through (0,1)	
(iii)	on graph below	M1		shape of ideal OC	
		A1	2	accurate plot - line above 5% not necessarily visible	



SS06 (cont)

				2 (
Q	Solution	Marks	Total	Comments
4(b)	% non-conforming 3 15			0.983 (0.9825 to 0.9835) and
	P(Accept) 0.983 0.112	B1	1	0.112 (0.1115 to 0.1125)
(c)(i)	More chance of accepting batch with low	E1		advantage (b) compared to (a)
(-)(-)	% non-conforming			
	Less chance of accenting batch with	F1		advantage (b) compared to (a)
	high % non-conforming	LI		udvantage (b) compared to (a)
(;;)	Paquiras more components to be	E1	2	disadvantage (b) compared to (a)
(11)	tested	L'I	5	disadvantage (b) compared to (a)
	lested			
	Total		11	
5(a)(i)	O M R Tot			
	A 42 29 19 90			
	B 37 33 24 94			
	C 24 29 18 71			
	D 25 22 13 60			
	Tot 128 113 74 315			
	$\Sigma x^2 = 9019$			
	Between Models SS			
	$(00^2 + 0.4^2 + 71^2 + (0^2)) = 215^2$	M1		mathed hotzeon models SS
	$\left \frac{90+94+71+60}{-315}\right - \frac{315}{-256.92}$	IVI I		method between models 55
	Between Campers SS			
	$(128^2 + 112^2 + 74^2) = 215^2$			
	$\left \frac{128 + 113 + 74}{128 + 113 + 74} \right - \frac{313}{12} = 388.5$	M1		method between campers SS
	315 ²	M1		method total SS
	Total SS = $9019 - \frac{10}{12} = 750.25$			
	12			
	Source SS DF MIS	M1		method Error SS
	Models 230.92 5 83.04 Commons 289.50 2 104.25	B1		df 3.2.6
	Campers 388.30 2 194.25	m1		MS - their df
	Error 104.83 6 17.47			
	10tal /50.25 11			
	H _o : no difference between models			
	F = 85.64/17.47 = 4.90	M1		method for E - their positive SS and df
	$cv F_{Fr,cl}$ is 4.757 reject H_{a-} not all	1111		memou for r - mem positive 55 and dr
	models take same time to nitch on	D1		4.757 and 5.142 (2 dm)
	average	DI		4.757 and 5.145 (2up)
	Ho: no difference between compary	A 1 ./		and the star of the star
	F = 10A 25/17 A7 = 11.1	AIN		conclusion - must be compared
	1 = 177.25(17.7) = 11.1			with upper tail of F
	$v r_{[2,6]}$ is 3.143 reject n_0 - not all	M1		method for F - their positive SS
	on overage			and df
	on average	A1		4.90 (4.85 - 4.95) and 11.1(11.0 to 11.2)
		A1√		conclusion- must be compared with
		'		upper
		. 1		with upper tail of F
		AI√		both conclusions in context – needs both
				previous A1 $$ marks
				providuo III (munto

Q		Solutio)n	Marks	Total	Comments
5(a)(ii)	D appears to take least time to pitch but			B1		D CAO
	this could be because it is always pitched					
	last after pract	tice on oth	er models.	E1		because always pitched last
(b)(i)	<u>Source</u>	SS	DF			
	Order	577.5	3			
	Camper	198.5	3			
	Model	611.5	3	B1		df correct - allow omission of total df
	<u>Error</u>	134.5	6	D1		
	Total	1522.0	1 15	B1	2	134.5 (134 to 135)
(ii) (iii)	H ₀ : no difference be $F = (611.3)^{-1}$ = 203.8 $cv F_{[3,6]} 4.75$ $Reject H_0 + 1$ difference be Totals A	ence betwe 5/3)/(134.5 33/22.417 7 - there is e etween mo - 128 - 93	een models 5/6) = 9.09 evidence of a dels.	M1 A1 B1 A1√	4	method for F - their df and SS 9.09 (9 \sim 9.15) 4.757 (4.75 \sim 4.76) conclusion - requires cv from F tables
	C - 137 D - 162			B1		В
	model B appears to take the least time to pitch.		E1	2	comparison of totals or means	
(iv)	Latin Square enables 3-factors at n levels to be examined using only n^2 trials. If a Latin Square is to be used and there are only 4 models to be compared		E1 E1	2	cannot be more campers than models comment on advantages of Latin Squares	
	then only 4 campers can be included.					
	Total				25	
			TOTAL		75	

SS06 (cont)