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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Statistics 6380

SS04 Statistics Unit 4

Mark Scheme

2007 examination - January 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.

SS04

Question	Solution	Marks	Total	Comments
1(a)	$\hat{p} = 27/85 = 0.31765$	B1		27/85 ACF
	95% confidence interval for $\hat{p}$			
	$0.31765 \pm 1.96\sqrt{\frac{0.31765 \times 0.68235}{85}}$	B1		1.96
		M1		use of $\hat{p} \pm z \times$ their s.d.
		M1		method for s.d.
	0.31765 ± 0.09897	m1		correct method - allow incorrect z
	$0.219 \sim 0.417$	A1	6	0.219(0.218 ~ 0.22) and 0.417(0.416 ~ 0.418) or 0.317(0.316 ~ 0.318) and 0.0990(0.0989 ~ 0.099)
(b)	0.17 below confidence interval - evidence that greater proportion of Simsons matches break.	E1√		below confidence interval / evidence more break
	Bad decision.	E1	2	bad decision
	Total		**8**	
2(a)	$\bar{x} = 260.25 \quad s = 41.337$	B1		260.25 (260 ~ 260.3)
		B1		41.337 (41.3 ~ 41.4)
	90% confidence interval for mean	B1		7 df
	$260.25 \pm 1.895 \times \frac{41.337}{\sqrt{8}}$	B1√		1.895 (1.89 ~1.9)
		M1		use of $\frac{\text{their s.d.}}{\sqrt{8}}$ - generous
		m1		method - allow incorrect t
	260.25 ± 27.70	A1	7	232.6 (232.5 ~ 233) and 287.9 (287.5 ~ 288) or 260.25 (260 ~ 260.5) and 27.7 (27.65 ~ 27.75)
	$232.6 \sim 287.9$			
(b)	times were a random sample from a	E1		random
	normal distribution	E1	2	normal – allow independent
			9	

SS04 (cont)

Question	Solution	Marks	Total	Comments
3(a)	H_0: $p = 0.4$ H_1: $p \neq 0.4$	B1		both hypotheses - accept p as implying population
	B(1240,0.4) → Normal, mean 496	B1		attempt at normal approximation - generous e.g. allow if via Poisson
	s.d. $\sqrt{1240 \times 0.4 \times 0.6} = \sqrt{297.6}$	M1		method for s.d.
	= 17.25	A1		496 CAO and 17.25 (17.2~17.3) may be implied
	$z = \dfrac{476.5 - 496}{17.25}$	M1		method for z - their mean and s.d. - allow no or incorrect c.c - ignore sign
		m1		method for z - disallow incorrect cc - ignore sign
	$= -1.13$	A1		$-1.13\ (-1.12 \sim -1.17)$
	c.v. $\pm$ 1.96	B1		1.96 ignore sign
	accept H_0 → accept that 40% of householders in Birmingham will make a donation when approached.	A1√ A1√	10	conclusion - correct tail compared correct conclusion -their figures in context - not necessarily correct tail.
	SC if exact probabilities used (Binomial 0.129, Poisson mean 496 0.191) allow B1 B0 M0 A0 m0 A0 B1 comparison with 0.025A1√A1√			allow comparison of p-value 0.131 (0.12 ~ 0.132) with 0.025
	SC Poisson approx then normal approx used - allow max B1 B1 M0 A0 M1 m0 A0 B1 A0 A1			
(b)	H_0: $p = 0.005$ H_1: $p > 0.005$	B1		both hypotheses - accept p, etc as implying population
	B(440,0.005) → Poisson mean 2.2	B1 B1√		attempt at appropriate Poisson approx mean 440×0.005
	P(7 or more) = 1 – 0.9925 = 0.0075	M1		attempt to calculate P (7 or more) - generous
		A1		0.0075 (0.0074 ~ 0.0075)
	0.0075 < 0.05 reject H_0 →significant evidence that more than 0.5% of Birmingham householders would agree to make a monthly donation.	A1√ A1√	7	conclusion - their probability compared with 0.05 correct conclusion - their figures - in context last 2 marks require use of p = 0.005
	SC allow critical value 5 or more (closest to 5%) or 6 or more (less than 5%)			
	SC if exact probabilities 0.0073 used allow B1 B0 B0 M1 A0 A1√ A1√			
	SC if normal approx used allow B1 B0 B1 M1 A0 A0√ A0√			

SS04 (cont)

Question	Solution	Marks	Total	Comments
3(c)	part (a) suggests that 40% would make a single donation.	E1		40% single donation/more than 0.5% monthly donation - must be based on correct work
	monthly donations worth 80 times as much.40/80 =0.5.	E1		$\frac{40}{80} = 0.5$
	hence if more than 0.5% would make a monthly donation this would be more profitable in the long run. Part (b) provides significant evidence that this is the case.	E1	3	monthly donations more profitable
	Total		**20**	
4(a)	$z = \frac{15-11.4}{2.4} = 1.5$	B1		method for z - ignore sign
	probability > 15 minutes			
	= 1 – 0.93319	M1		completely correct method
	= 0.0668	A1	3	0.0668 (0.0668 ~ 0.0669)
(b)	time for 3 games → normal			
	mean $3 \times 11.4 = 34.2$	B1		mean 34.2
	s.d. $\sqrt{3 \times 2.4^2} = 4.157$	M1		method for s.d (or variance) - even if not called s.d.
	$z = \frac{30-34.2}{4.157} = -1.010$	m1		method for z - ignore sign
	probability < 30 minutes			
	= 1 – 0.84375	m1		completely correct method
	= 0.156	A1	5	0.156 (0.156 ~ 0.157)
(c)	Time for 3 games – time to library→ normal	M1		attempt to find s.d of (3 games – time to library)
	mean 34.2 – 45 = – 10.8	B1		–10.8 ignore sign - may be implied
	s.d. $\sqrt{3 \times 2.4^2 + 4.1^2} = 5.839$	m1		method for s.d. or variance - their value in (b)
	$z = \frac{-10.8}{5.839} = -1.850$			
	probability Gwyneth back at hostel before 3 games completed is	m1		method - allow wrong tail
	1 – 0.96783 = 0.0322	A1	5	0.0322 (0.032 ~ 0.0323)
(d)	very little chance of going to library and returning in time to play.	E1		small chance of both
	Must either play and pay fine or go to library and miss turn	E1√	2	choose one or other
	Total		**15**	

SS04 (cont)

Question	Solution	Marks	Total	Comments
5(a)	H_0: $\mu = 5.00$ H_1: $\mu \neq 5.00$	B1		both hypotheses - μ or population needed
	$\bar{x} = 5.132 \quad s = 0.8611$	B1		5.132 (5.13 ~5.135) and 0.8611(0.861 ~ 0.8615)
	$t = \frac{5.132-5.00}{\frac{0.8611}{\sqrt{11}}}$	M1		use of their $\frac{s}{\sqrt{11}}$
		m1		method for t - ignore sign
	= 0.508	A1		0.508 (0.507 ~ 0.508)
	c.v. t_{10} are ±2.228	B1		10 df
		B1		2.228 - ignore sign
	accept H_0: i.e. accept mean weight of	A1√		correct conclusion their figures - **AG**
	potatoes in bags is 5kg	A1√	9	correct conclusion their figures in context
	SC critical values $\frac{5.00 \pm 2.228 \times 0.8611}{\sqrt{11}}$ 5.00 ± 0.578 $4.42 \sim 5.58$ confidence interval $\frac{5.132 \pm 2.228 \times 0.8611}{\sqrt{11}}$ 5.132 ± 0.578 $4.55 \sim 5.71$			
(b)	contents much less than 5kg will lead to customer complaints, contents much greater than 5kg will use more potatoes than necessary.	E1	1	reason – either
(c)	H_0: $\mu = 0.7$ H_1: $\mu > 0.7$	B1		both hypotheses - don't penalise for same reason as (a)
	$z = \frac{0.88-0.7}{\frac{0.52}{\sqrt{60}}} = 2.68$	B1		2.68 (2.65 ~ 2.69) - allow use of $\frac{0.52 \times \sqrt{60}}{59}$
	c.v. 2.3263	B1		2.3263 (2.326 ~ 2.33) or 2.39 (2.39 ~ 2.392)
	reject H_0: Evidence mean magnitude of differences greater than 0.7	B1√	4	conclusion based on correct method of calculation and c.v. from z or t-tables
	SC critical value $0.7 + 2.3263 \times \frac{0.52}{\sqrt{60}} = 0.856$ confidence interval $0.88 \pm 2.3263 \times \frac{0.52}{\sqrt{60}}$ $0.724 \sim 1.036$			

SS04 (cont)

Question	Solution	Marks	Total	Comments
5(d)(i)	H_0: $\mu = 5.00$ H_1: $\mu \neq 5.00$	B1		both hypotheses - don't penalise for same reason as (a)
	$z = \frac{5.08-5.00}{\frac{0.12}{\sqrt{50}}} = 4.71$	B1		4.71 (4.66~4.72) allow use of $0.12\times\frac{\sqrt{50}}{49}$
	c.v. ± 1.96	B1		1.96 ignore sign - or 2.01 (2.009 ~ 2.01)
	reject H_0: significant evidence mean weight of potatoes in bags packed by Sybil $\neq$ (greater than) 5kg	B1√	4	conclusion based on correct method of calculation and c.v. from *z* or *t* tables
	SC critical values $\frac{5.00\pm1.96\times0.12}{\sqrt{50}}$ 4.967 ~ 5.033 confidence interval $\frac{5.08\pm1.96\times0.12}{\sqrt{50}}$ 5.047 ~ 5.113			
(d)(ii)	to test H_0: $\mu = 0.7$; H_1: $\mu > 0.7$ the critical value would be positive but the test statistic would be negative hence H_0 must be accepted.	B2, 1	2	both marks for a clear explanation
(e)	there is evidence that Sybil's mean is a little over 5kg while Maxwell's may equal 5kg	E1		comparison of means
	but on average Sybil's bags are much closer to 5kg.	E1		comparison of variability
	Maxwell's bags are erratic and therefore unsatisfactory	E1	3	Maxwell unsatisfactory
	Total		**23**	
	TOTAL		**75**	