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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Statistics 6380

SS04 Statistics unit 4

Mark Scheme

2007 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.

SS04

Q	Solution	Marks	Total	Comments
1(a)	$\bar{x} = 1023.3 \quad s = 525.19$	B1		$1023.3 (1020 \sim 1025)$ and $525.2 (525 \sim 525.5)$
	95% confidence interval for mean $1023.3 \pm 2.306 \times \frac{525.19}{\sqrt{9}}$	B1 B1√ M1		8 df 2.306 – their df $\frac{\text{use of their s.d.}}{\sqrt{9}}$
	i.e. 1023.3 ± 403.7 $(620, 1427)$	m1 A1	6	method for interval $620 (619 \sim 620)$ and $1427 (1426.5 \sim 1427.5)$ or 1430 or $1023.3 (1020 \sim 1025)$ and $403.7 (403 \sim 404)$
(b)	As 1250 lies within the confidence interval, there is no reason to doubt the firm's claim.	B1 B1√	2	accept claim 1250 within interval
	Total		**8**	
2(a)	$H_0 : \mu = 37.3 \quad H_1 : \mu \neq 37.3$	B1		both hypotheses – must use μ or state 'population'
	$\bar{x} = 45.1 \quad s = 9.2039$	B1		45.1 CAO and $9.20 (9.19 \sim 9.21)$
	$t = \frac{45.1 - 37.3}{\frac{9.2039}{\sqrt{10}}}$	M1		$\frac{\text{use of their s.d.}}{\sqrt{10}}$
		m1		correct method for t (ignore sign)
	= 2.68	A1		$2.68 (2.675 \sim 2.685)$
	c.v. $t_9 \pm 2.262$	B1 B1√		9 df $2.262 (2.26 \sim 2.262)$ (ignore sign)
	Reject H_0 : there is significant evidence that mean number of hours worked during the second week of December 2004, by females employed full-time by this store is not equal (greater than) to 37.3	A1√		correct conclusion their figures, requires m1 and comparison with correct tail of t
	SC confidence interval (38.52, 51.68) compare with 37.3 **SC** non-standardised c.v. (30.72, 43.88) compare with 45.1 **SC** p-values compare 0.0126 with 0.025 or 0.0252 with 0.05	A1√	9	conclusion in context – requires previous A1√ and earlier m1
(b)	store likely to be busy before Christmas so staff may work extra hours	E1 E1	2	Christmas any reasonable explanation e.g. busy/longer opening hours
	Total		**11**	

SS04 (cont)

Q	Solution	Marks	Total	Comments
3(a)	$H_0 : p = 0.2 \quad H_1 : p > 0.2$	B1		both hypotheses correct – allow $p = 0.8$, $p < 0.8$ – disallow $\hat{p}$
	$B(150, 0.2) \rightarrow$ normal	B1 B1		B(150,0.2/0.8) – may be implied attempt at normal approx
	mean $150 \times 0.2 = 30$	M1		method for mean
	s.d. $\sqrt{150 \times 0.2 \times 0.8} = 0.48990$ (variance = 24)	M1		method for s.d./variance – allow use of $\hat{p}$
	$z = \dfrac{35.5 - 30}{4.899} = 1.12$	M1		method for z – ignore sign and no or incorrect c.c. – disallow $\hat{p}$
		A1		$1.12 (1.11 \sim 1.13)$ or $1.22 (1.22 \sim 1.23)$, negative needed if $p = 0.8$ used
	c.v. = 1.6449 accept H_0	B1 A1√		1.6449 – ignore sign needs m mark and comparison with correct tail of z
	no significant evidence to reject the credit companies claim	E1	10	In context – needs A1√ mark
	SC p-values compare 0.131 or 0.111 with 0.05 **SC** exact binomial compare 0.1317 with 0.05			allow max B1 B1 B1 B0 … A1√ E1
(b)	$H_0 : p = 0.2 \quad H_1 : p > 0.2$	B1		both hypotheses – don't penalise same mistake as in (a)
	$B(11.0.2)$	B1		B(11, 0.2/0.8)
	P(7 or more) = 1 – 0.9980	M1		attempt to calculate P(7 or more); generous **Note:** 1 – 0.9998 = 0.0002 is P(8 or more), and ∴ incorrect
	= 0.002	A1		$0.002 (0.00195 \sim 0.002)$
	0.002<0.01 reject H_0 : significant evidence to reject the credit companies claim. Conclude less than 80% of European hotels will accept the card	A1√ E1	6	needs correct method for P(7 or more) in context – needs A1√ mark
	SC c.v. 6 or more (nearest to 1%) 7 or more (less than 1%)			only allow first 3 marks if approximations attempted
(c)	Small sample found evidence to reject claim but large sample didn't. This is very unlikely (but not impossible if both tests valid) Sheila's sample probably not random – probably geographically localised and similar price ranges – so second test probably not valid.	E1 E1 E1 E1	4	apparent contradiction possible but unlikely/Sheila's sample not random so second test not valid possible reason why non-random second reason
	Total		**20**	

SS04 (cont)

Q	Solution	Marks	Total	Comments
4(a)	$z = \frac{90-63}{18} = 1.5$	M1		method for z – ignore sign
	probability > 90 = 1 – 0.93319	m1		completely correct method
	= 0.0668	A1	3	$0.0668 (0.0668 \sim 0.067)$
(b)(i)	total time is normal			
	mean $3\times63 = 189$	M1		method for mean
	s.d. $\sqrt{3\times18^2} = 31.177$ (variance 972)	M1		method for s.d./variance
(b)(ii)	$z = \frac{135-189}{31.177} = -1.732$	m1		method for z – ignore sign
	probability < 135	m1		completely correct method
	= 0.9584 = 0.0416	A1	5	$0.0416 (0.0415 \sim 0.042)$
(c)	$Q_3 - Q_7 \rightarrow$ normal	M1		attempt to find distribution of difference between 3 normal checkouts and 7 express checkouts
	mean $3\times63 - 7\times25 = 14$	M1		method for mean and s.d. of 7 at express checkout (may be implied)
		M1		method for mean $Q_3 - Q_7 / Q_7 - Q_3$
	standard deviation $\sqrt{3\times18^2 + 7\times8^2}$	M1		method for s.d./variance $Q_3 - Q_7$ their answer to (b)(i)
		m1		method for s.d./variance $Q_3 - Q_7$
	= 37.68 (variance = 1420)			
	$z = \frac{14-0}{37.68} = 0.3715$	m1		correct method – ignore sign of z
	probability time for 3 exceeds time for 7 is 0.645	A1	7	$0.645 (0.643 \sim 0.646)$
(d)	amount in baskets of queue members/ attractiveness/speed/demeanour of checkout assistant/presence of noisy children in queue	E1		sensible suggestion
		E1	2	sensible suggestion
	Total		**17**	

SS04 (cont)

Q	Solution	Marks	Total	Comments
5(a)	95% confidence interval	B1		1.96
	$136 \pm 1.96\sqrt{136}$	B1		s.d. $\sqrt{136}$
	136 ± 22.86	M1		correct method – allow incorrect z
	$(113,\ 159)$	A1	4	$113(113 \sim 113.2)$ and $159(158.8 \sim 159)$ or 136 and $22.9(22.8 \sim 23)$
(b)	$\hat{p} = \frac{22}{136} = 0.16176$	B1		$\frac{22}{136}$ ACF
	99% confidence interval			
	$0.16176 \pm 2.5758 \times \sqrt{0.16176} \times \frac{0.83823}{136}$	B1		2.5758
		M1		use of $\hat{p} \pm z \times$ their s.d.
		M1		method for s.d.
	0.16176 ± 0.08133	m1		completely correct method – allow incorrect z
	$(0.080,\ 0.243)$	A1	6	$0.080(0.080 \sim 0.081)$ and $0.243(0.2425 \sim 0.2435)$ or $0.162(0.161 \sim 0.162)$ and $0.0813(0.081 \sim 0.0815)$
(c)	$\mathrm{B}(170, 0.25) \rightarrow$	B1		$\mathrm{B}(170, 0.25)$ may be implied
	normal mean $170 \times 0.25 = 42.5$	B1		attempt at normal approx
	s.d. $\sqrt{170 \times 0.25 \times 0.75} = 5.6458$ (variance 31.875)	M1		method for mean and s.d./variance
	$z = \frac{60.5 - 42.5}{5.6458} = 3.188$	M1		method for z – allow no or incorrect c.c.
	probability > 60 is $1 - 0.99928$	m1		completely correct method
	$= 0.0007$	A1	6	$0.0007(0.00069 \sim 0.00074)$
	SC exact binomial 0.00104 allow B1 B1 only			
(d)	Assumes more than average number of customers will enter bank (170 above c.i. in (a)) and more than average proportion of these will require a senior member of staff (0.25 above c.i. in (b)).	E1		above *average* number of customers assumed/above *average* proportion require senior member of staff
		E1		outside confidence interval
	Even on these assumptions there is a very small chance that insufficient senior staff will be available. Barnabas is being very cautious.	E1	3	very small probability of insufficient senior staff being available/Barnabas very cautious
	Total		**19**	
	TOTAL		**75**	