



## **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.

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
A <sub>2,1</sub>	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.**

Jan 07

SS04

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

**SS04 (cont)**

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

**SS04 (cont)**

Question	Solution	Marks	Total	Comments
<b>3(c)</b>	part (a) suggests that 40% would make a single donation.	E1	3	40% single donation/more than 0.5% monthly donation - must be based on correct work $\frac{40}{80} = 0.5$ monthly donations more profitable
	monthly donations worth 80 times as much. $40/80 = 0.5$ .	E1		
	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		
<b>Total</b>			<b>20</b>	
<b>4(a)</b>	$z = \frac{15 - 11.4}{2.4} = 1.5$ probability > 15 minutes = $1 - 0.93319$ = 0.0668	B1 M1 A1	3	method for z - ignore sign  completely correct method 0.0668 (0.0668 ~ 0.0669)
	<b>(b)</b> time for 3 games → normal mean $3 \times 11.4 = 34.2$ s.d. $\sqrt{3 \times 2.4^2} = 4.157$ $z = \frac{30 - 34.2}{4.157} = -1.010$ probability < 30 minutes = $1 - 0.84375$ = 0.156	B1 M1  m1 m1 A1		
<b>(c)</b> Time for 3 games – time to library → normal mean $34.2 - 45 = -10.8$ s.d. $\sqrt{3 \times 2.4^2 + 4.1^2} = 5.839$ $z = \frac{-10.8}{5.839} = -1.850$ probability Gwyneth back at hostel before 3 games completed is $1 - 0.96783 = 0.0322$	M1 B1 m1  m1 A1	5	attempt to find s.d of (3 games – time to library) –10.8 ignore sign - may be implied method for s.d. or variance - their value in (b)  method - allow wrong tail  0.0322 (0.032 ~ 0.0323)	
<b>(d)</b> very little chance of going to library and returning in time to play. Must either play and pay fine or go to library and miss turn	E1 E1✓			2
<b>Total</b>			<b>15</b>	

SS04 (cont)

Question	Solution	Marks	Total	Comments
5(a)	$H_0: \mu = 5.00$ $H_1: \mu \neq 5.00$ $\bar{x} = 5.132 \quad s = 0.8611$	B1		both hypotheses - $\mu$ or population needed
	$t = \frac{5.132 - 5.00}{\frac{0.8611}{\sqrt{11}}}$ $= 0.508$ c.v. $t_{10}$ are $\pm 2.228$	B1		5.132 (5.13 ~ 5.135) and 0.8611 (0.861 ~ 0.8615)
	accept $H_0$ : i.e. accept mean weight of potatoes in bags is 5kg	M1		use of their $\frac{s}{\sqrt{11}}$
	SC critical values $\frac{5.00 \pm 2.228 \times 0.8611}{\sqrt{11}}$ $5.00 \pm 0.578$ $4.42 \sim 5.58$ confidence interval $\frac{5.132 \pm 2.228 \times 0.8611}{\sqrt{11}}$ $5.132 \pm 0.578$ $4.55 \sim 5.71$	m1		method for $t$ - ignore sign
		A1		0.508 (0.507 ~ 0.508)
		B1		10 df
		B1		2.228 - ignore sign
		A1✓		correct conclusion their figures - <b>AG</b>
		A1✓	9	correct conclusion their figures in context
(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)	$H_0: \mu = 5.00$	B1	4	both hypotheses - don't penalise for same reason as (a) 4.71 (4.66~4.72) allow use of $0.12 \times \frac{\sqrt{50}}{49}$ 1.96 ignore sign - or 2.01 (2.009 ~ 2.01) conclusion based on correct method of calculation and c.v. from $z$ or $t$ tables
	$H_1: \mu \neq 5.00$	B1		
	$z = \frac{5.08 - 5.00}{\frac{0.12}{\sqrt{50}}} = 4.71$	B1 B1✓		
	c.v. $\pm 1.96$ reject $H_0$ : significant evidence mean weight of potatoes in bags packed by Sybil $\neq$ (greater than) 5kg			
	SC critical values $\frac{5.00 \pm 1.96 \times 0.12}{\sqrt{50}}$ 4.967 ~ 5.033 confidence interval $\frac{5.08 \pm 1.96 \times 0.12}{\sqrt{50}}$ 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	3	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		Maxwell unsatisfactory
	<b>Total</b>		<b>23</b>	
	<b>TOTAL</b>		<b>75</b>	