



# **General Certificate of Education**

## **Statistics 6380**

**SS04      Statistics 4**

## **Mark Scheme**

*2008 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
<b>1(a)</b>	$B(120, 0.01)$	B1	1	
<b>(b)</b>	$X$ = Number of donors with group AB negative $X \sim B(120, 0.01) \approx \text{Po}(1.2)$ $P(X \geq 4) = 1 - P(X \leq 3)$ $= 1 - 0.9662$ $= 0.0338$	B1 M1 A1	3	AWRT B1 for exact binomial (0.0330)
	<b>Total</b>		<b>4</b>	
<b>2(a)</b>	$H_0: \mu = 14.5$ $H_1: \mu < 14.5$ $\bar{x} = 14.325$ , $s = 0.2493$ $v = 8 - 1 = 7$ $t_{\text{crit}} = -1.895$ Test statistic = $\frac{14.325 - 14.5}{\frac{0.2493}{\sqrt{8}}}$ $= -1.985(6)$ $-1.985(6) < -1.895$ There is evidence at the 5% significance level to claim that Katrina has achieved Target 1	B1 B1 B1 B1 M1 m1 A1 E1 A1✓	9	Both 14.3 to 14.33; accept 0.249 Ignore sign Use of formula for ts Their sd divided by $\sqrt{8}$ -2 to -1.9 ft on ts and cv; dep on M1 and m1
<b>(b)</b>	$H_0: p = 0.25$ $H_1: p < 0.25$ $X$ = Number of failed attempts Under $H_0$ , $X \sim B(15, 0.25)$ $P(X \leq 1) = 0.0802$ $0.0802 > 5\%$ so $H_0$ cannot be rejected There is not enough evidence at the 5% level to claim that Katrina has achieved Target 2	B1 B1 B1 M1 A1	5	Both May be implied Attempt to reach conclusion by comparing probability with 5%
	<b>Total</b>		<b>14</b>	

## SS04 (cont)

Q	Solution	Marks	Total	Comments
<b>3(a)(i)</b>	Plants randomly distributed Constant average density over the field Independent occurrence of plants $P(\text{two plants in same position}) = 0$ Size of plant can be treated as negligible	B2,1,0	2	B1 each for any two distinct conditions Must be in context for full marks
<b>(ii)</b>	$X \sim \text{Po}(23) \approx N(23, 23)$ $P(X < 30) = \Phi\left(\frac{29.5 - 23}{\sqrt{23}}\right)$ $= \Phi(1.355) = 0.912$	B1 M1 m1 A1 A1✓	5	attempted cc correct cc 0.911 to 0.914 ft on no cc (0.928) or 30.5 (0.941)
<b>(b)(i)</b>	Normal approximation with $\text{sd} = \sqrt{79}$ $z = 1.96$ 95% confidence limits are $79 \pm 1.96\sqrt{79}$ giving (61.6, 96.4)	B1 B1 M1 A1	4	May be implied Up to 3 if 92 used instead of 79 AWRT
<b>(ii)</b>	Original mean per $4\text{m}^2$ was 92 <b>or</b> CI for mean per $\text{m}^2$ is (15.4, 24.1) Original mean lies within 95% CI for new mean Not enough evidence to support Roy's claim	B1 E1 B1	3	Maximum of 2 if roles of 92, 79 reversed
<b>(iii)</b>	Normal approximation used SD estimated from count of plants in sample area Assumption that area was randomly selected may not be justified	E2,1,0	2	Any two
<b>Total</b>			<b>16</b>	

## SS04 (cont)

Q	Solution	Marks	Total	Comments
4(a)	$\hat{p} = \frac{19}{50} = 0.38$ Normal approximation with sd $\sqrt{\frac{0.38 \times (1 - 0.38)}{50}}$ $z = 2.5758$ 99% confidence limits for $p$ are $0.38 \pm 2.5758 \times \sqrt{\frac{0.38 \times 0.62}{50}}$ giving (0.203, 0.557)	B1  M1 A1 B1  M1 A1	      6	Correct values substituted Accept 2.58   AWRT
(b)	There is not enough evidence to say there is a difference in the proportion of patients suffering the side effect as 25% = 0.25 lies within the confidence interval	B1 E1	2	
(c)	Patients who suffer stomach pains more likely to volunteer than those who do not. Pre-knowledge could cause imaginary pains. The confidence interval could indicate a reduction in proportion if sample drawn mainly from population of those suffering the side effect. Pre-knowledge may have exaggerated sample proportion.	E1  E1	 2	Likely effect on sample or effect of knowing purpose of trial  Possible effect on assessment
<b>Total</b>			<b>10</b>	
5(a)	$X + Y \sim N(24.3, 14.92)$ $P(X + Y < 30) = \Phi\left(\frac{30 - 24.3}{\sqrt{14.92}}\right)$ $= \Phi(1.476) = 0.930$	B2 M1 A1	 4 4	B1 mean; B1 sd  0.929 to 0.931
(b)	$3X \sim N(3 \times 5.8, 3^2 \times 1.4^2)$ $= N(17.4, 17.64)$ $Y - 3X \sim N(18.5 - 17.4, 3.6^2 + 17.64)$ $= N(1.1, 30.6)$ $P(Y > 3X) = P(Y - 3X > 0)$ $= 1 - \Phi\left(\frac{0 - 1.1}{\sqrt{30.6}}\right)$ $= 1 - \Phi(-0.199) = 0.579$	B2 M1 A1 M1 m1 A1	     7	B1 mean; B1 sd Means subtracted; sds added CAO
<b>Total</b>			<b>11</b>	

## SS04 (cont)

Q	Solution	Marks	Total	Comments
<b>6(a)(i)</b>	$H_0: p = 0.4$ $H_1: p > 0.4$	B1		Both
	Under $H_0$ , $X \sim B(60, 0.40)$ $\approx N(24, 14.4)$	B2 B1		B1 normal, B1 parameters Accept 1.64, 1.645
	$z = 1.6449$			
	Test statistic = $\frac{32.5 - 24}{\sqrt{14.4}}$ $= 2.24$	M1 A1		
	<b>or</b> $= \frac{33 - 24}{\sqrt{14.4}}$ $= 2.37$	(M1) (A1)		<b>or</b> $se = \sqrt{\frac{0.4 \times 0.6}{60}}$ (M1A1)  $ts = \frac{0.55 - 0.40}{\sqrt{\frac{0.4 \times 0.6}{60}}} = 2.37$ (M1A1)
	2.24 (2.37) > 1.6449 so there is enough evidence at the 5% significance level to claim that the proportion who make a donation is greater than 40%	E1 A1✓	8	Exact binomial: 0.0133 < 5% gets full marks ft on ts and cv
	<b>(ii)</b> $\frac{18}{45} = 0.4$ so sample proportion is exactly 40% Hypothesis test would lead to accepting $H_0$ at any sensible significance level	B1 E1	2	
	<b>(b)(i)</b> $v = 9$ ; $t_{crit} = 2.262$ 95% confidence limits for $\mu$ are $59.5 \pm 2.262 \times \frac{19.21}{\sqrt{10}}$ giving (45.8, 73.2)	B1 M1 m1 A1	4	sd divided by $\sqrt{10}$ AWRT
	<b>(ii)</b> Both notices seem to have increased the mean donation to about the same level. Evidence of increased proportion of motorists donating in A but not in B. Total likely to have increased more in A than in B.	B1 B1 B1 B1	4	
	<b>(iii)</b> £1 recommendation could lead to truncation. Could be higher frequency for £1 but mean $\neq$ £1 so distribution not symmetrical. Recommended donation means amount given not random / independent variable.	E2,1,0	2	
	<b>Total</b>		<b>20</b>	
	<b>TOTAL</b>		<b>75</b>	