



## **General Certificate of Education**

# **Statistics 6380**

**SS05      Statistics unit 5**

## **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.**

## SS05

Q	Solution	Marks	Total	Comments
1(a)(i)	$P(0.8 \leq X \leq 1.2) = \frac{1.2 - 0.8}{2 - 0}$ $= \frac{0.4}{2} = 0.2$	M1	2	probability raised to power of 3 CAO
		A1		
(a)(ii)	$P(X = 1) = 0$	B1	1	
(b)(i)	$P(X \geq 0.6) = \frac{2 - 0.6}{2} = \frac{1.4}{2} = 0.7$ P(all three $\geq 0.6$ ) $= (0.7)^3$ $= 0.343$	B1	3	
		M1		
		A1		
(ii)	P(remnant less than 1 metre long) $= \frac{1 - 0.6}{2 - 0.6} = \frac{0.4}{1.4}$ $= 0.286$ (3 sf) or $P(X < 1   X \geq 0.6)$ $= \frac{P(0.6 \leq X < 1)}{P(X \geq 0.6)} = \frac{0.2}{0.7}$ $= 0.286$	M1	2	
		A1		
		(M1)	(2)	
		(A1)		
<b>Total</b>			<b>8</b>	

## SS05 (cont)

Q	Solution	Marks	Total	Comments
2(a)(i)	$v = 9$	B1		here or in (ii)
	$t = \pm 2.262$	B1		$S^2 \times \frac{10}{9}$ : withhold last A mark in 1 part
	95% confidence limits for mean are: $446.9 \pm 2.262 \times \frac{13.9}{\sqrt{10}}$	M1 m1		use of formula standard error
	95% confidence interval is: (437, 457) grams	A1	5	(436.9 to 437, 456.8 to 457)
(ii)	$\chi^2 = 2.700, 19.023$	B1		both
	95% confidence limits for variance are: $\frac{9 \times 13.9^2}{19.023}$ , $\frac{9 \times 13.9^2}{2.700}$	M1 A1✓		correct values substituted ft on incorrect $x^2$ values
	(95% CI is (91.410, 644.03)) 95% CI for standard deviation is: $\left( \sqrt{\frac{9 \times 13.9^2}{19.023}} \text{ , } \sqrt{\frac{9 \times 13.9^2}{2.700}} \right)$ = (9.56, 25.4) grams	M1 A1	5	(9.5 to 9.6, 25.3 to 25.4) CAO
(b)	Damien's claim seems to be correct upper CL for mean is less than 460	B1 E1	2	must say <b>above</b> CI
(c)	taking lower CL for mean (437) and upper CL for SD (25.4) 350 is more than 3 SDs below mean making it plausible that Damien made a mistake	E1 E1 E1	3	SC E1 for plausible because 350 well below CI for mean
	<b>Total</b>		<b>15</b>	

SS05 (cont)

Q	Solution	Marks	Total	Comments
3(a)	Morning: $s_x^2 = 12.136$ or $s_x = 3.48$	B1	9	12.1 to 12.2; AWRT 35.0 to 35.1; AWRT } or equivalent 2.86 to 2.89 (0.344 to 0.349) ft on sample variances both, either way round accept 0.368 (0.271 to 0.272) if used $H_1$ with $\neq$ must have $F = 4.823$ ft on variance ratio and CV
	Evening: $s_y^2 = 35.045$ or $s_y = 5.92$	B1		
	$H_0: \sigma_x^2 = \sigma_y^2$	B1		
	$H_1: \sigma_x^2 < \sigma_y^2$	B1		
	Ratio of variances = $\frac{35.045}{12.136}$	M1		
	= 2.89 (or 0.346)	A1✓		
	$v_1 = 9; v_2 = 7$	B1		
	Critical value of $F = 3.677$	B1		
	(or $\frac{1}{3.677} = 0.272$ )			
	$2.89 < 3.677$ (or $0.346 > 0.272$ ) There is not sufficient evidence at the 5% level to support Sandeep's belief	A1✓		
(b)	$H_0: \mu_M - \mu_A = 1$	B1	7	$\mu_M, \mu_A$ reversed, lose first B1 and last A1 } or equivalent If $H_1 \neq$ must have 1.96 accept 1.64, 1.645 or $P(Z > 1.94) = 0.2619$ difference of means over sd correct form of sd CAO; AWRT ft on sample value and CV
	$H_1: \mu_M - \mu_A > 1$	B1		
	CV of $z = 1.6449$	B1		
	sample value of $z = \frac{(61.7 - 58.9) - 1}{2.1 \sqrt{\frac{1}{9} + \frac{1}{12}}}$	M1 m1		
	= 1.94	A1		
	$1.94 > 1.6449$ so reject $H_0$ . There is sufficient evidence at the 5% level to support the trainer's claim	A1✓		
<b>Total</b>			<b>16</b>	

## SS05 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	$P(X < 2) = 1 - e^{-0.4 \times 2}$ $= 1 - e^{-0.8} = 0.551$	M1 A1	2	or by integration AWRT
	(ii) $P(2 \leq X \leq 5) = F(5) - F(2)$ $= (1 - e^{-2}) - (1 - e^{-0.8})$ $= 0.314$	M1 A1		2
(b)	for median $m$ , $F(m) = 0.5 (= 1 - F(m))$	B1	4	may be implied
	$F(1.7) = 1 - e^{-0.68} = 0.493$ $(e^{-0.68} = 0.507)$	B1		
	$F(1.8) = 1 - e^{-0.72} = 0.513$ $(e^{-0.72} = 0.487)$	B1		
	0.5 lies between 0.493 and 0.513 so median lies between 1.7 and 1.8	E1		
	or $e^{-0.4m} = 0.5$ $-0.4m = \ln(0.5)$ $m = \frac{0.693}{0.4} = 1.73$ so median lies between 1.7 and 1.8	(M1) (m1) (A1) (E1)		
	<b>Total</b>		<b>8</b>	

## SS05 (cont)

Q	Solution	Marks	Total	Comments																																
5(a)	$P(X < 304) = \Phi\left(\frac{304-310}{4}\right)$ $a = \Phi(-1.5) = 0.0668 \text{ (or 0.0667)}$ $b = 0.0918 \text{ (or 0.0919)}$ $c = 0.0918 \text{ (or 0.0919)}$ $d = 0.0668 \text{ (or 0.0667)}$	M1	4	attempt to find a probability																																
		A1		one missing value found																																
		B1		second value found by any method																																
		B1		remaining values correct																																
		(b)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th><math>O</math></th> <th><math>E</math></th> <th><math>\frac{(O-E)^2}{E}</math></th> </tr> </thead> <tbody> <tr><td>5</td><td>6.68</td><td>0.42</td></tr> <tr><td>13</td><td>9.19</td><td>1.58</td></tr> <tr><td>10</td><td>14.99</td><td>1.66</td></tr> <tr><td>18</td><td>19.15</td><td>0.07</td></tr> <tr><td>25</td><td>19.15</td><td>1.79</td></tr> <tr><td>20</td><td>14.99</td><td>1.68</td></tr> <tr><td>5</td><td>9.19</td><td>1.91</td></tr> <tr><td>4</td><td>6.68</td><td>1.08</td></tr> <tr><td></td><td></td><td>10.2</td></tr> </tbody> </table> <p> <math>H_0</math>: can be modelled by <math>N(310, 4^2)</math>  <math>H_1</math>: Not <math>H_0</math>  <math>\nu = 8 - 1 = 7</math>  <math>\chi_{10\%}^2 = 12.017</math>  <math>10.2 &lt; 12.017</math>  Accept <math>H_0</math> at 10% level. There is not sufficient evidence to reject the model </p>	$O$	$E$	$\frac{(O-E)^2}{E}$	5	6.68	0.42	13	9.19	1.58	10	14.99	1.66	18	19.15	0.07	25	19.15	1.79	20	14.99	1.68	5	9.19	1.91	4	6.68	1.08			10.2			If $E = 12.5$ throughout, just second M1 available
				$O$	$E$	$\frac{(O-E)^2}{E}$																														
				5	6.68	0.42																														
				13	9.19	1.58																														
				10	14.99	1.66																														
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25	19.15			1.79																																
20	14.99			1.68																																
5	9.19			1.91																																
4	6.68			1.08																																
		10.2																																		
M1	probabilities $\times 100$																																			
M1	use of formula																																			
A1	at least 4 values correct (AWRT)																																			
A1	$\sum E \neq 100$ : lose this and final A1																																			
	total correct; AWRT																																			
B1	both																																			
B1																																				
B1	any grouping of categories: lose final A1																																			
A1✓	fit on calculated value and cv																																			
(c)	(1) Reasonable claim as model has mean 310. (Does not say much about one punnet) (2) Looks a safe claim. Only 5 punnets in sample $< 304$ g; shape of normal distribution suggests few, if any, will be $< 300$ g (3) At least 5 punnets in sample $< 305$ g and shape suggests claim could be wrong for about 10% of punnets	E1	8																																	
		E1		reference to relevant figure from sample in (2) or (3)																																
		E1	reference to property of normal in (2) or (3)																																	
		E1	appropriate assessment of possibilities must use data <b>and</b> model for E4																																	
	<b>Total</b>		<b>16</b>																																	

## SS05 (cont)

Q	Solution	Marks	Total	Comments
6	<p>assume weights selected by Amy and Ben are normally distributed with common variance independence between samples</p> <p><math>H_0: \mu_A = \mu_B</math> <math>H_1: \mu_A \neq \mu_B</math></p> <p>pooled estimate of variance</p> $= \frac{(10 \times 3.24^2) + (8 \times 2.71^2)}{10 + 8}$ <p>= 9.096 <math>\nu = 18</math> <math>t = \pm 2.878</math></p> <p>sample statistic = <math>\frac{41.6 - 38.4}{\sqrt{9.096 \left( \frac{1}{11} + \frac{1}{9} \right)}}</math></p> <p>= 2.36</p> <p>2.36 &lt; 2.878 so accept <math>H_0</math></p> <p>There is not enough evidence at the 1% level to say that the earlier assessment was wrong</p>	<p>B1 B1</p> <p>M1</p> <p>B1</p> <p>M1</p> <p>A1 B1 B1</p> <p>M1 A1</p> <p>A1✓</p> <p>A1✓</p>	<p>12</p>	<p>any two</p> <p>attempt to use t-test for difference of means</p> <p>both</p> <p>accept 9.09 to 9.10</p> <p>correct values substituted</p> <p>ft on standard error; AWRT</p> <p>ft on sample statistic and <math>t</math> depends on first and last M1</p>
	<b>Total</b>		<b>12</b>	
	<b>TOTAL</b>		<b>75</b>	