

General Certificate of Education June 2010

Statistics SS02

Statistics 2

Mark Scheme

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			
В	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**.

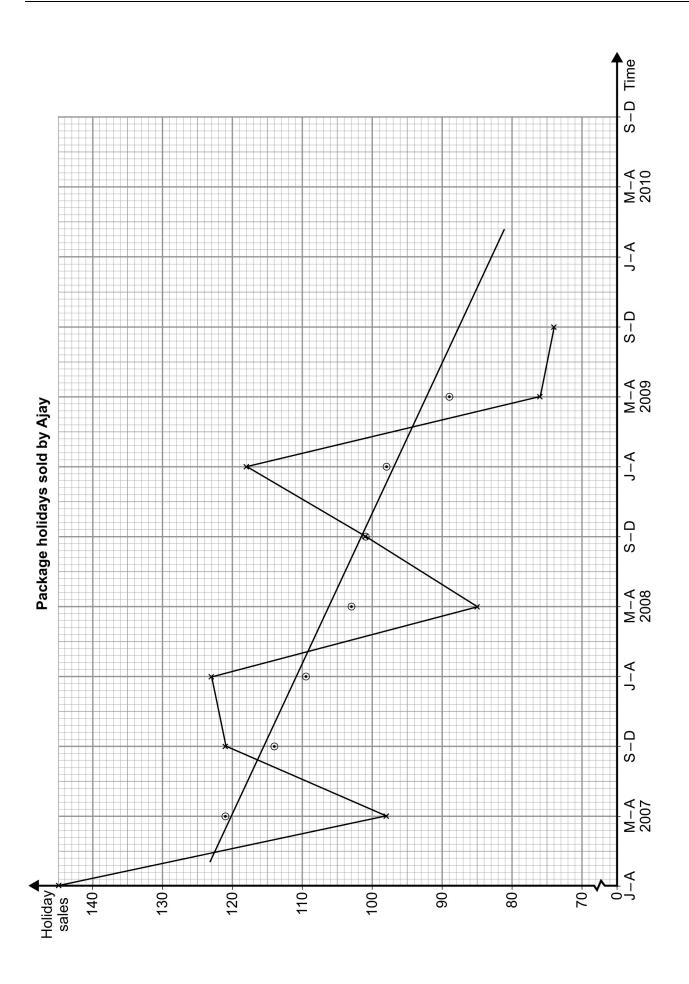
Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

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.

SS02

5502	0.1.4	M	TC 4 1	C .
Q	Solution	Marks	Total	Comments
1(a)	$E(X) = 40 \times 0.37 + 70 \times 0.18 + 100 \times 0.14$	M1		M1 method for E(X)
(i)	$+140 \times 0.12 + 190 \times 0.19$ = 94.3			
(ii)	$E(X^{2}) = 40^{2} \times 0.37 + 70^{2} \times 0.18 +100^{2} \cdot 0.14 +140^{2} \times 0.12 + 190^{2} \times 0.19 = 12085$	M1		M1 method for E(X ²) ag
(iii)	$V(X) = 12085 - 94.3^{2} = 3192.51$ s.d. = $\sqrt{3192.51} = 56.5$	M1 m1A1	5	M1 method for variance m1 method for s.d. A1 56.5 (56.4 – 56.6)
(b)(i)	0.31	B1		B1 0.31 CAO
(ii)	0	B1	2	B1 0
(c)	Smaller, 0 is less than the mean of fare-paying passengers.	B1 B1	2	B1 smaller B1 0 < 94.3 or equivalent
	Total		9	
2(a)	2007 2008 J-A M-A S-D J-A M-A S-D 121.3 114 109.7 103 101.3 2009	M1 B1		M1 method for m.a. B1 3-point m.a. used
	J-A M-A S-D 98.3 89.3	A1	3	A1 all correct nearest whole number
(b)	On insert	M1 A1 B1	3	M1 their m.a. in correct position A1 accurate plot - allow one small slip B1 trend line - generous
(c)(i)	Estimated J-A seasonal effect $(13.3 + 19.7)/2 = 16.5$	M1 A1		M1 method for seasonal effect - allow inclusion of 2007. Attempt to find mean deviation from their trend/regression line A1 16.5 ($16 \sim 19$) Needs all previous M marks
	Forecast 83+16.5 = 100	M1M1	5	M1 attempt to find estimate of J-A 2010 moving average from their trend line. M1 method for forecast – their forecast moving average + their seasonal effect A1 100 (95 ~ 105) – needs all previous M's. Allow non-integer SC Correct answer, no working or
(ii)	110 allow '110 or more'	M1A1	2	using May-August only B2 M1 their (c)(i)+ 10% A1 110 (104~116)
(d)	82 does not allow for seasonal variation. 130 does not allow for downward trend. Fairest target would be 110 which allows for both seasonal	E1 E1	2	B1 their answer to (c)(ii) E1 82 omits seasonal variation
	variation and trend.	B1	3	E1 130 omits trend.
	Total		16	



SS02 (cont)

3(a) Inear trend linear trend linear trend B1 linear may be earned in (b) linear trend 4 4 4 B1 linear may be earned in (b) linear trend to part and the prescribed to the part and the prescribed linear trend in (b) all part and the part and the prescribed linear linear trend in (b) all part and the par	SS02 (cont) Q	Solution	Marks	Total	Comments
linear trend Short term variation about a downward B1 B1 B1 B1 B1 B1 B1 B	_ `		B1		
Innear trend B1 4 B1 short term/cyclical		linear trend	B1		B1 random
Image: 4 = 135.0 H ₁ : μ ≠ 135.0 B1B1 B1B1 $\bar{x} = 135.556$ B1 B1 one correct hypothesis $z = (135.556 - 135)/(0.45/\sqrt{9}) = 3.70$ B1 B1 one correct hypothesis B1 both hypotheses correct B1 135.556 (135.5 ~135.6) M1 Use of $0.45/\sqrt{9}$ M1 Use of $0.45/\sqrt{9}$ mIn method for z - ignore sign A1 √ A1 √ conclusion - must be compared with correct tail of normal. Disallow for contradiction A1 √ conclusion - must be compared with correct tail of normal. Disallow for contradiction A1 √ conclusion - must be compared with correct tail of normal. Disallow for contradiction A1 √ conclusion - must be compared with correct tail of normal. Disallow for contradiction A1 √ conclusion - must be compared with correct tail of normal. Disallow for contradiction A1 √ conclusion - must be compared with correct tail of normal. Disallow for contradiction A1 √ conclusion - must be compared with correct tail of normal. Disallow for contradiction A1 √ conclusion - must be compared with correct tail of normal. Disallow for contradiction A1 √ conclusion - must be compared with correct tail of normal. Disallow for contradiction A1 √ conclusion - must be compared with correct tail of normal. Disallow for contradiction	(b)	short term variation about a downward	B1		B1 downward and upward in (i)
4(a) H_0 : $\mu = 135.0 H_1$: $\mu \neq 135.0$ $\Xi = 135.556$ $\Xi = (135.556 - 135)/(0.45/\sqrt{9}) = 3.70$ $\Xi = (135.556 - 135.5)/(0.45/\sqrt{9}) = 3.70$ $\Xi = (135.556 - 135.5)/(0.45/\sqrt{9}) = 3.70$ $\Xi = (135.56 - 135)/(0.45/\sqrt{9}) = 3.70$ $\Xi = (135.56 - 1$		linear trend	B1	4	
$ \overline{x} = 135.556 $ $ z = (135.556 - 135)/(0.45/\sqrt{9}) = 3.70 $		Total		4	
$\overline{x} = 135.556$ $\overline{x} = (135.556 - 135)/(0.45/\sqrt{9}) = 3.70$ $\overline{A}1$ $\overline{A}1$	4(a)	H_0 : $\mu = 135.0 H_1$: $\mu \neq 135.0$	B1B1		B1 one correct hypothesis
$ z = (135.556 - 135)/(0.45/\sqrt{9}) = 3.70 $ C.v. ± 1.96 Reject H ₀ Conclude that there is significant evidence that the mean length of components on that Monday was not equal to/greater than 135cm p-value 0.00022 compare with 0.025 or 0.00011 compare with 0.025 A Type 1 error would be to conclude the mean length of components was not 135cm when in reality it was 135cm. Total 5(a)(i) 327 million tonnes (iii) 1254 - 776 = 478 million tonnes allow 1254 - 479 - 298 = 477 (b) Maximum reserves are lower in 2006 than in 1995 Probable reserves are a smaller proportion of the total in 2006 than 1995 Possible reserves about the same (abit 1995) MI III MI Use of $0.45/\sqrt{9}$ ml method for z - ignore sign A1 3.70 (3.7 ~ 3.74) B1 ± 1.96 - ignore sign A1.√ on conclusion - must be compared with correct tail of normal. Disallow for contradiction A1.√ in context needs previous A1.√ A1 → 1 in context needs previous A1.√ i					B1 both hypotheses correct
and the properties of the proportion of the total in 2006 than in 1995 Reject H₀ Conclude that there is significant evidence that the mean length of components on that Monday was not equal to/greater than 135cm c.i. 135.26 ~135.85 compare with 133.0 p-value 0.00022 compare with 0.05 or 0.00011 compare with 0.05 or 0.00011 compare with 0.025 A Type 1 error would be to conclude the mean length of components was not 135cm when in reality it was 135cm. Total 5(a)(i) 327 million tonnes (iii) 1254 - 776 = 478 million tonnes allow 1254 - 479 - 298 = 477 (iii) 1215/77 = 16 M1 A1 M1 A1 Total 11 S(a)(i) 327 million tonnes allow 1254 - 479 - 298 = 477 (iii) 1215/77 = 16 M1 A1 A1 A1 A1 A1 A1 A1 A1 A1 B1		$\bar{x} = 135.556$	B1		B1 135.556 (135.5 ~135.6)
C.v. ± 1.96 B1 B1 B1 E1.96 - ignore sign A1 3.70 (3.7 ~ 3.74)		$z = (135,556 - 135)/(0.45/\sqrt{9}) = 3.70$			M1 Use of $0.45/\sqrt{9}$
Reject H₀ Conclude that there is significant evidence that the mean length of components on that Monday was not equal to/greater than 135cm c.i. 135.26 ~135.85 compare with 135.0 p-value 0.00022 compare with 0.05 or 0.00011 compare with 0.025 A Type 1 error would be to conclude the mean length of components was not 135cm when in reality it was 135cm. Total 5(a)(i) 327 million tonnes (ii) 1254 - 776 = 478 million tonnes allow 1254 - 479 - 298 = 477 (iii) 1215/77 = 16 (b) Maximum reserves are lower in 2006 than in 1995 Proven reserves are about the same (a bit larger) proportion of the total in 2006 than 1995 Prossible reserves about same in 1995 Possible reserves about same in 1995		(A1		m1 method for z - ignore sign
Reject H ₀ Conclude that there is significant evidence that the mean length of components on that Monday was not equal to/greater than 135cm c.i. 135.26 ~135.85 compare with 135.0 p-value 0.00022 compare with 0.05 or 0.00011 compare with 0.05 or 0.00011 compare with 0.05 or 0.00011 compare with 0.05 135cm Total 11 11 135cm E1 in context E1					
Reject H₀ Conclude that there is significant evidence that the mean length of components on that Monday was not equal to/greater than 135cm c.i. 135.26 −135.85 compare with 135.0 p-value 0.00022 compare with 0.025 A Type 1 error would be to conclude the mean length of components was not 135cm when in reality it was 135cm. E1 E1 idea of Type 1 error the mean length of components was 135cm. E1 E1 in context E1		$c.v. \pm 1.96$	D.1		, ,
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Conclude that there is significant evidence that the mean length of components on that Monday was not equal to/greater than 135cm c.i. 135.26 ~135.85 compare with 1.35.0 p-value 0.00022 compare with 0.025 or 0.00011		Reject H ₀	A 1 A		
components on that Monday was not equal to/greater than 135cm c.i. 135.26 ~135.85 compare with 135.0 p-value 0.00022 compare with 0.05 or 0.00011 compare with 0.025 (b) A Type 1 error would be to conclude the mean length of components was not 135cm when in reality it was 135cm. Total 5(a)(i) 327 million tonnes (ii) 1254 - 776 = 478 million tonnes allow 1254 - 479 - 298 = 477 (iii) 1215/77 = 16 M1 M1 M1 M2 M3 M3 M3 M3 M1 M1 M3 M1 M1 M1			A1√		
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(ii) 1215/77 = 16					
(ii) 1215/77 = 16					
(b) A Type 1 error would be to conclude the mean length of components was not 135cm when in reality it was 135cm. Total 5(a)(i) 327 million tonnes Total 5(a)(i) 327 million tonnes B1 B1 2 B2 327 million tonnes acf allow B1 for 327 (ii) 1254 - 776 = 478 million tonnes allow 1254 - 479 - 298 = 477 (iii) 1215/77 = 16 M1 A1 A1 A1 B1 A1 B1 A1 B1 B2 B2 327 million tonnes acf allow B1 for 327 M1 1254 - 776 (or - 479 - 298) A1 478 or 477 million tonnes - only penalise omission of million tonnes once M1 1215/77 or 1162/77 A1 16 (15.5 ~ 16) B1					
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Total B1		-	EI		E1 III context
S(a)(i) 327 million tonnes B1 B1 B2 327 million tonnes acf allow B1 for 327				11	
(ii) 1254 - 776 = 478 million tonnes allow 1254 - 479 - 298 = 477 (iii) 1254 - 776 = 478 million tonnes allow 1254 - 479 - 298 = 477 (iii) 1215/77 = 16 (iii) 1215/77 = 16 (b) Maximum reserves are lower in 2006 than in 1995 Proven reserves are about the same (a bit larger) proportion of the total in 2006 than in 1995 Probable reserves are a smaller proportion of the total in 2006 than 1995 Possible reserves about same in 1995 Possible reserves about same in 1995 B1	5(a)(i)		R 1	11	R2 327 million tonnes acf
(ii) 1254 - 776 = 478 million tonnes allow 1254 - 479 - 298 = 477 (iii) 1215/77 = 16 (b) Maximum reserves are lower in 2006 than in 1995 Proven reserves are about the same (a bit larger) proportion of the total in 2006 than in 1995 Probable reserves are a smaller proportion of the total in 2006 than 1995 Possible reserves about same in 1995 M1A1 2 M1 1254 - 776 (or - 479 - 298) A1 478 or 477 million tonnes once M1 1215/77 or 1162/77 A1 16 (15.5 ~ 16) B1 16 CAO E1 lower in 2006 E1Proven similar (a bit larger) proportion in 2006 E1 Probable smaller proportion/ possible larger proportion in 2006 Also allow a mark for numerical statements e.g. proven about a third in	S(a)(1)	327 million tollies		2	
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allow 1254 - 479 - 298 = 477 (iii) 1215/77 = 16 M1 A1 B1 A1 B1 A1 B1 B1 A1 B1 B1 A1 B1 B1 B1 B1 B1 A1 B1	(ii)	1254 - 776 = 478 million tonnes	M1A1		M1 1254 - 776 (or - 479 - 298)
(iii) 1215/77 = 16 M1 A1 B1 A1 B1 A1 B1 A1 B1 A1 B1	(11)		1/1111	2	, , , , , , , , , , , , , , , , , , ,
(iii) 1215/77 = 16 M1 A1 A1 B1 A1 B1 A1 B1 A1 B1 A1 B1 B1 A1 B1					
(iii) 1215/77 = 16					*
(b) Maximum reserves are lower in 2006 than in 1995 Proven reserves are about the same (a bit larger) proportion of the total in 2006 than in 1995 Probable reserves are a smaller proportion of the total in 2006 than 1995 Possible reserves about same in 1995 Al 16 (15.5 ~ 16) B1 16 CAO E1 lower in 2006 E1Proven similar (a bit larger) proportion in 2006 E1 Probable smaller proportion/possible larger proportion in 2006 Also allow a mark for numerical statements e.g. proven about a third in	(iii)	1215/77 = 16	M1		
(b) Maximum reserves are lower in 2006 than in 1995 Proven reserves are about the same (a bit larger) proportion of the total in 2006 than in 1995 Probable reserves are a smaller proportion of the total in 2006 than 1995 Possible reserves about same in 1995 E1 E1 lower in 2006 E1 Proven similar (a bit larger) proportion in 2006 E1 Probable smaller proportion/ possible larger proportion in 2006 Also allow a mark for numerical statements e.g. proven about a third in	` ′		A1		
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2006 than in 1995 Probable reserves are a smaller proportion of the total in 2006 than 1995 Possible reserves about same in 1995 E1 3 proportion in 2006 E1 Probable smaller proportion/possible larger proportion in 2006 Also allow a mark for numerical statements e.g. proven about a third in			Г1		F1D : 1 (1:41)
Probable reserves are a smaller proportion of the total in 2006 than 1995 Possible reserves about same in 1995 E1 Probable smaller proportion/possible larger proportion in 2006 Also allow a mark for numerical statements e.g. proven about a third in			El		
proportion of the total in 2006 than 1995 Possible reserves about same in 1995 possible larger proportion in 2006 Also allow a mark for numerical statements e.g. proven about a third in			<u>F</u> 1	2	
1995 Also allow a mark for numerical statements e.g. proven about a third in			151)	
Possible reserves about same in 1995 Also allow a mark for numerical statements e.g. proven about a third in					possible larger proportion in 2000
Possible reserves about same in 1995 statements e.g. proven about a third in		1770			Also allow a mark for numerical
		Possible reserves about same in 1995			
i aliu ZUUO — I — I — I — I — I — JUUn/ TOTAI ANOIIT CIOINIE IN 1995 - may		and 2006			2006/ total about double in 1995 - max
2 marks for 3 similar points					
Total 10		Total		10	

SS02 (cont)

SS02 (cont) O	Solution	Marks	Total	Comments
6(a)(i)	1 - 0.8946 = 0.105	M1		M1 P(6 or more) = $1 - P(5 \text{ or fewer})$
(ii)	0.0408	A1 M1 A1	4	A1 0.105 (0.105 ~ 0.106) M1 Attempt to find P(0) A1 0.0408 (0.0407 ~ 0.041)
(b)(i)	0.2689	B1	·	B1 0.269 (0.2688 ~ 0.269)
(ii)	Poisson mean $3.2 + 3.8 = 7$ P(<2) = P(1 or fewer) = 0.0073	M1 m1 A1	4	M1 attempt to use Poisson mean 3.2 + 3.8 or equivalent m1 completely correct method A1 0.0073 (0.007 ~ 0.0073)
(iii)	In this week the total of the number who did not attend on Tuesday and the number who did not attend on Thursday was 1. As shown in part (b) this was an	E1		E1 Policy effective
	extremely unlikely occurrence prior to the change of policy. Hence it is likely that the change of	E1		E1 Attempt at reference to relevant probability
	policy has improved attendance.	E1	3	E1 complete answer
(c)(i)	Poisson has no upper limit. Number of absentees cannot exceed size of squad (probably about 16)	E1		E1 no upper limit
(ii)	Same member may miss both sessions due to illness/holiday	E1	2	E1 reason
(11)	Total	LI	13	Li icason
7(a)	Number shops 000 to 419 Select 3-digit random numbers Ignore repeats and > 419 Select corresponding shops	E1 E1 E1 E1		E1 number 000 to 419 or equivalent E1 3-digit random numbers E1 ignore >419 - consistent with their numbering E1 ignore repeats
			4	
(b)(i)	(A) stratified (random)(B) equally likely(C) not all subsets possible	E1 E1		E1 stratified E1 equally likely Allow 'yes,'disallow 'likely'
		E1	3	E1 reason
(ii)	(A) systematic(B) equally likely(C) not all subsets possible	E1 E1 E1	3	E1 systematic E1 equally likely. E1 reason
(iii)	Shops with largest electricity consumption are likely to have the largest potential savings. Therefore	E1	3	E1 reason E1 shops with largest consumption selected
	sensible to audit these first	E1	2	E1 largest potential saving
	Total		12	
	TOTAL		75	