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.

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.

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.
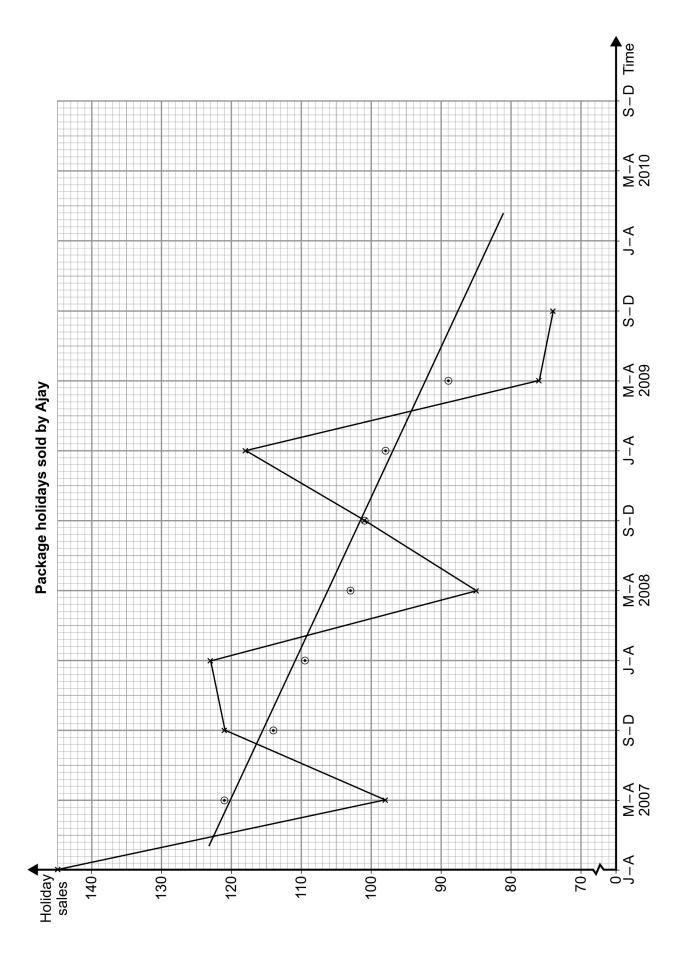
Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **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.

SS02

Q	Solution	Marks	Total	Comments
1(a) **(i)** **(ii)** **(iii)**	$E(X) = 40 \times 0.37 + 70 \times 0.18 + 100 \times 0.14$ $+140 \times 0.12 + 190 \times 0.19$ $\qquad = 94.3$ $E(X^2) = 40^2 \times 0.37 + 70^2 \times 0.18$ $+100^2 \, 0. \times 14 + 140^2 \times 0.12 + 190^2 \times 0.19$ $\qquad = 12085$ $V(X) = 12085 - 94.3^2 = 3192.51$ s.d. $= \sqrt{3192.51} = 56.5$	M1 M1 M1 m1A1	 5	M1 method for $E(X)$ M1 method for $E(X^2)$ ag M1 method for variance m1 method for s.d. A1 56.5 (56.4 – 56.6)
(b)(i) **(ii)**	0.31 0	B1 B1	 2	B1 0.31 CAO 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** $\qquad\qquad$ **2008** **J-A M-A S-D J-A M-A S-D** 121.3 114 109.7 103 101.3 **2009** **J-A M-A S-D** 98.3 89.3	M1 B1 A1	 3	M1 method for m.a. B1 3-point m.a. used 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 Forecast 83+16.5 = 100	M1 A1 M1M1 A1	 5	M1 method for seasonal effect - allow inclusion of 2007. Attempt to find mean deviation from their trend/regression line A1 16.5 (16 ~ 19) Needs all previous M marks 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 using May-August only B2
(ii)	110 allow '110 or more'	M1A1	2	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 variation and trend.	E1 E1 B1	 3	B1 their answer to (c)(ii) E1 82 omits seasonal variation E1 130 omits trend.
	Total		**16**	

Package holidays sold by Ajay

SS02 (cont)

Q	Solution	Marks	Total	Comments
3(a)	random variation about an upward linear trend	B1 B1		B1 linear - may be earned in (b) B1 random
(b)	short term variation about a downward linear trend	B1 B1	4	B1 downward and upward in (i) B1 short term/cyclical
	Total		**4**	
4(a)	$H_0: \mu = 135.0$ $H_1: \mu \neq 135.0$	B1B1		B1 one correct hypothesis B1 both hypotheses correct
	$\overline{x} = 135.556$ $z = (135.556 - 135)/(0.45/\sqrt{9}) = 3.70$	B1 M1m1 A1		B1 135.556 (135.5 ~135.6) M1 Use of $0.45/\sqrt{9}$ m1 method for z - ignore sign A1 3.70 ($3.7 \sim 3.74$)
	c.v. ± 1.96	B1		B1 ± 1.96 - 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 0.025*	A1√ A1√	9	A1√ conclusion - must be compared with correct tail of normal. Disallow for contradiction A1√ in context needs previous A1√
(b)	A Type 1 error would be to conclude the mean length of components was not 135cm when in reality it was 135cm.	E1 E1	2	E1 idea of Type 1 error E1 in context
	Total		**11**	
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	M1A1	2	M1 1254 - 776 (or - 479 - 298) A1 478 or 477 million tonnes - only penalise omission of million tonnes once
(iii)	1215/77 = 16	M1 A1 B1	3	M1 1215/77 or 1162/77 A1 16 (15.5 ~ 16) B1 16 CAO
(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 and 2006	E1 E1 E1	3	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 2006/ total about double in 1995 - max 2 marks for 3 similar points
	Total		**10**	

SS02 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	1 - 0.8946 = 0.105	M1		M1 P(6 or more) = 1 - P(5 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 extremely unlikely occurrence prior to the change of policy. Hence it is likely that the change of policy has improved attendance.	E1 E1 E1	3	E1 Policy effective E1 Attempt at reference to relevant probability 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
	Total		**13**	
7(a)	Number shops 000 to 419 Select 3-digit random numbers Ignore repeats and > 419 Select corresponding shops	E1 E1 E1 E1	4	E1 number 000 to 419 or equivalent E1 3-digit random numbers E1 ignore >419 - consistent with their numbering E1 ignore repeats
(b)(i)	(A) stratified (random) (B) equally likely (C) not all subsets possible	E1 E1 E1	3	E1 stratified E1 equally likely Allow 'yes,'disallow 'likely' 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 sensible to audit these first	E1 E1	2	E1 shops with largest consumption selected E1 largest potential saving
	Total		**12**	
	TOTAL		**75**	