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General Certificate of Education (A-level)
January 2011

Statistics SS02

(Specification 6380)

Statistics 2

Mark Scheme

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Key to mark scheme abbreviations

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
$\surd$ or ft or F	follow through from previous incorrect result
CAO	correct answer only
CSO	correct solution only
AWFW	anything which falls within
AWRT	anything which rounds to
ACF	any correct form
AG	answer given
SC	special case
OE	or equivalent
A2,1	2 or 1 (or 0) accuracy marks
$-x$ EE	deduct x marks for each error
NMS	no method shown
PI	possibly implied
SCA	substantially correct approach
c	candidate
sf	significant figure(s)
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.

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)	$E(X) = 99\times0.5 + 125\times0.3 + 144\times0.2$ $= 115.8$ $E(X^2) = 99^2\times0.5 + 125^2\times0.3 + 144^2\times0.2 = 13735.2$ $V(X) = 13735.2 - 115.8^2 = 325.56$ s.d. $= \sqrt{325.56} = 18.04$	M1 A1 M1 A1	 4	B2 115.8 (115.5 ~ 116) or M1 A1 B2 18.04 (18 ~ 18.1) or M1A1
(b)(i)	$E(Y) = 79\times0.25 + 99\times0.375 + 125\times0.225 + 144\times0.15 = 106.6$	M1 A1	 2	M1 method A1 107 ag
(ii)	 $106.6\times1.2 = 127.92 > 115.8$ hence increase in customers will mean increase in the total takings on tea bags despite the lower mean.	M1 m1 A1	 3	M1 Any calculation which could be helpful in answering the question m1 attempt at a valid comparison A1 correct conclusion based on correct calculations — allow use of 107 for $E(Y)$
(c)	Extra customers in shop for cheap teabags may make additional purchases.	E1	1	E1 Any sensible point
	Total		**10**	
2(a)(i)	P(2 or fewer) = 0.5184	B1	1	B1 0.518 (0.518 ~ 0.519)
(ii)	P(> 3) = 1 – P(3 or fewer) = 1 – 0.7360 = 0.264	M1 A1	 2	M1 method A1 0.264 (0.2635 ~ 0.2645)
(iii)	P(4) = P(4 or fewer) – P(3 or fewer) = 0.8774 – 0.7360 = 0.1414	M1 A1	 2	M1 method A1 0.1414 (0.141 ~ 0.142)
(b)	Poisson mean 13 P(15 or fewer) – P(9 or fewer) = 0.7636 – 0.1658 = 0.598	B1 M1 m1 A1	 4	B1 poisson mean 5×2.6 M1 method — generous m1 correct method A1 0.598 (0.597 ~ 0.6)
	Total		**9**	

SS02(cont)

Q	Solution	Marks	Total	Comments
3(a)	1574.25 1578.5 + graph	M1 A1 A1	 3	M1 4-point m.a. attempted A1 1574 (1570 ~ 1575) and 1578.5 (1578 ~ 1580) A1 both points plotted accurately
(b)	on graph	B1	1	B1 trend line — generous
(c)	on graph	M1 A1	 2	M1 method A1 reasonably accurate plot by eye
(d)	Estimate of seasonal effect for Q1 (–295 – 275)/2 = –285	M1 m1 A1	 3	M1 attempt to find deviations from trend line or centred m.a. m1 mean of 2 or 3 deviations — ignore sign A1 –285 (–265 ~ –295)
(e)	1700 – 285 = 1415	B1 M1 A1	 3	B1 1700 (1675 ~ 1725) M1 method — their figures (must be below trend line) A1 1415 (1390 ~ 1440)
(f)	Method appears to be effective	E1	1	E1 method effective
(g)	The further ahead the forecast the less accurate/effective the forecast is likely to be. The worldwide recession in 2009 means that projecting an upward trend in expenditure into the future is unlikely to provide a good forecast	E1 E1	 2	E1 the further ahead the forecast the less accurate it is likely to be E1 expenditure on shoes cannot continue to increase indefinitely/effect of recession/any sensible comment
	Total		**15**	

SS02 (cont)

Q	Solution	Marks	Total	Comments
4(a)	H_0: $\mu = 25$ H_1: $\mu < 25$	B1B1		B1 one correct hypothesis B1 both hypotheses correct
	$\bar{x}$ = 23.4875	B1		B1 23.4875 (23.48 ~ 23.5)
	z = (23.4875 – 25)/(2.3/√8) =	M1m1		M1 Use of 2.3/√8 m1 method for z — ignore sign
	–1.86	A1		A1 –1.86 (–1.85 ~ –1.87)
	c.v. –1.6449	B1		B1 –1.6449 — ignore sign
	Reject H_0	A1√		A1√ conclusion — must be compared with correct tail of normal
	Conclude that there is significant evidence that the mean % by which the contents exceed the nominal quantity is less than 25.	A1√	9	A1√ in context
(b)	A Type 1 error would be to conclude the mean increase in contents was less than	E1		E1 idea of Type 1 error
	25% when in fact it was equal to 25%	E1	2	E1 in context
(c)	Risk of Type 1 error is set at any required level and is not affected by the sample	E1		E1 claim incorrect E1 risk of Type 1 error unaffected by
	size.	E1	2	sample size
	Total		**13**	

SS02 (cont)

Q	Solution	Marks	Total	Comments
5(a)	Number medical staff from 000 to 389. Choose 3-digit random numbers. Ignore repeats and > 389 Continue until 39 obtained. Choose corresponding medical staff. In the same way select 22 ancillary staff, 14 administrative staff and 7 managers.	E1 E1 E1 E1 E1 E1	6	E1 valid numbering of one strata E1 3-digit random numbers E1 ignore repeats E1 ignore > 389 *or equivalent for another strata* E1 similarly for other strata E1 39,22,14,7
(b)(i)	Number medical staff 000 to 389, ancillary staff 390 to 609, administrative staff 610 to 749 and managers 750 to 819 Select a random number between 000 and 027. Choose this number and every 8th number thereafter until 100 have been selected. Choose corresponding staff.	E1 E1 E1 E1		E1 valid numbering E1 choose random starting point (not necessarily in range 000 to 027) E1 idea of systematic sampling E1 choose every 8th
(ii)	Because 820 is not exactly divisible by 100. (In the sample described above numbers 000 to 027 have different chances of being selected the rest have a 1 in 8 chance.)	E1	5	E1 820 not exactly divisible by 100 or equivalent
(c)	Other survey suggests that there is no point in stratifying by employment category as all categories have similar views. A sample stratified by sex would be the best. Neither the stratified sample above nor the systematic sample necessarily contain a representative proportion of each sex.	 E1 E1 E1	3	E1 stratifying by category pointless E1 representative proportion of each sex desirable E1 stratified by category not necessarily representative of sexes E1 systematic not necessarily representative of sexes *maximum 3*
	Total		**14**	

SS02 (cont)

Q	Solution	Marks	Total	Comments
6(a)	9000	B1B1	2	B1 9 B1 thousand
(b)	The population of England is about 10 times as large as that of Scotland.	E1		E1 There are more part-time than full-time students in each country.
	However there are about 20 times as many full-time students in England as in Scotland	E1		E1 Scotland has a smaller proportion of population in full-time education
	The proportion of part-time students to the population is similar in both countries.	E1	3	E1 Scotland has a similar proportion of the population in part-time education.
(c)(i)	22.5 + 1.5×(22.5 – 16.8) = 31.05 older than 31.05 years	B1	1	B1 31.05 (31 ~ 31.1) allow 32
(ii)	The ages of individual students are not known. There are so many outliers that all the ∗s would be superimposed on one another	E1	1	E1 exact ages not known E1 too many outliers *maximum 1 mark*
(d)(i)	Total, thousands, full-time students in Scotland 45.1. 45.1÷2 = 22.55 1.5 + 8.7 + 9.7 = 19.9 aged 17 or less (ie < 18.0)	M1		M1 attempt to compare cumulative frequency with 45.1/2
	19.9 < 22.55 19.9 + 6.9 = 26.8 aged 18 or less (ie < 19.0)	M1		M1 a correct method
	26.8 > 22.55. Hence median lies between 18.0 and 19.0	A1	3	A1 Correct conclusion based on correct calculations. ag
(ii)	on figure 2	M1A1	2	M1 method for box and whisker — generous A1 reasonably accurate plot
(iii)	Similar Both positive skew	E1		E1 any valid comment
	Scotland slightly lower variability as measured by interquartile range. Scotland slightly higher median	E1	2	E1 any further valid comment
	Total		**14**	
	TOTAL		**75**	