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General Certificate of Education (A-level)
January 2011

Statistics SS04

(Specification 6380)

Statistics 4

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 events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process 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 standardisation each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

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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
√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.

SS04

Q	Solution	Marks	Total	Comments
1(a)	p = 114/250 = 0.456 90% confidence interval for p $0.456 \pm 1.6449\sqrt{0.456\times0.544/250}$ 0.456 ± 0.0518 0.404 ~ 0.508	B1 M1B1 m1 A1	5	B1 114/250 acf M1 method for s.d. B1 1.6449 (1.64 ~ 1.65) m1 method — allow incorrect z-value A1 0.404 (0.4035 ~ 0.4045) and 0.508 (0.507 ~0.508) allow in ± form
(b)	Values > 0.5 lie in the interval, as do values less than 0.5. Claim may or may not be true.	E1√ E1	2	E1√ 0.5 (><) lies in interval E1 claim unproven
	Total		**7**	
2(a)	$\bar{x}$ = 22.45 s = 2.034 95% confidence interval for mean $22.45 \pm 2.262\times2.034/\sqrt{10}$ 22.45 ± 1.455 (1.45 to 1.46) 21.0 ~ 23.9	B1 B1B1 M1m1 A1	6	B1 22.45 (22.4 ~ 22.5) and 2.034 (2.03 ~ 2.04) B1 9df B1 2.262 M1 method for c.i — their s.d. and t-value m1 correct method for c.i. their t-value A1 21.0 (20.95 ~ 21.05) and 23.9 (23.85~23.95) allow in ± form
(b)	95% confidence interval for mean $18.27 \pm 1.96\times1.638/\sqrt{55}$ 18.27 ± 0.433 17.9 ~ 18.7	 B1 M1 A1	3	B1 1.96 or 2.004 ~ 2.009 M1 method for c.i A1 17.9 (17.8 ~ 17.9) and 18.7 (18.65 ~ 18.75) allow in ± form
(c)	Evidence to support Olivia's claim for this rodent as lower limit of confidence interval for rodents on island is above upper limit of confidence interval on mainland. Only one island examined and no evidence for other species	E1 E1 E1	3	E1 statement supported for this rodent E1 relevant comparison of confidence intervals E1 note of caution
	Total		**12**	
3(a)	H_0: p = 0.3 H_1: p < 0.3 B(20, 0.3) P(≤ 4) = 0.2375 Accept H_0, since 0.2375 > 0.1 No significant evidence to support newspapers articles claim.	B1 B1 M1m1 A1√ A1√	6	B1 hypotheses B1 attempted use of B(20,0.3) M1 attempt to find P(≤ 4) m1 0.2375 (0.237 ~ 0.238) A1√ Conclusion — their figures A1√Conclusion in context
(b)	p may not be constant — may depend on cyclist/speed/weather. Events may not be independent — 2 cyclists may arrive together	E1	1	E1 relevant suggestion
	Total		**7**	

SS04(cont)

Q	Solution	Marks	Total	Comments
4(a)	H_0: $\mu_x = 1.85$ H_1: $\mu_x > 1.85$ $t = (1.915 - 1.85)/(0.182/\sqrt{8})$ $= 1.01$ c.v. t_7 1.415 Accept H_0 There is no significant evidence that the mean weight of fleece obtained with electric shears is greater than 1.85 kg.	B1 M1m1 A1 B1 A1√	6	B1 both hypotheses M1 use of their sd./√8 m1 method for *t* — ignore sign A1 1.01 (1 ~1.02) B1 1.415 — ignore sign A1√ conclusion, ts must be compared with upper tail of *t* and not inconsistent with their H_0.
(b)	H_0: $\mu_y = 13.5$ H_1: $\mu_y < 13.5$ $t = (12.09 - 13.5)/(1.240/\sqrt{8})$ $= -3.22$ c.v. t_7 –2.998 Reject H_0. There is significant evidence that the mean shearing time with electric shears is less than 13.5 minutes	B1 M1 A1 A1√	4	B1 both hypotheses — do not penalise same mistake twice M1 method for t — ignore sign A1 – 3.22 (–3.21 ~ –3.22) A1√ Conclusion in context ts must be compared with lower tail of *t* and not inconsistent with their H_0. *Interchange mark schemes for (a) and (b) if more favourable to candidate*
(c)(i)	Davina's advice would save time but may not increase the weight of fleece	E1√ E1	2	E1√ one point consistent with their calculations E1 both correct points
(ii)	Cost of buying/running electric shearer; need for power source; effect on advertising; well being of sheep etc	E1 E1	2	E1 a sensible factor E1 another sensible factor
	Total		**14**	

SS04(cont)

Q	Solution	Marks	Total	Comments
5(a)(i)	B(85,0.62)	B1	1	B1 n=85 p=0.62 — may be implied later
(ii)	B(85,0.62) $\to$ Normal mean 52.7 s.d. = $\sqrt{85\times0.62\times0.28}$ = 4.475 (variance = 20.026) z = (50.5 – 52.7)/4.475 = –0.492 P(>50) = 0.689	B1 M1 m1m1 A1	5	B1 52.7 cao M1 method for s.d. or variance m1 method for z — ignore cc m1 attempt at cc A1 0.689 (0.687 ~ 0.69)
(b)(i)	H_0: $\lambda = 7$ H_1: $\lambda < 7$ P($X \le 3$) = 0.0818 0.0818 < 0.1 reject H_0: significant evidence to support Mervin's belief that there has been a decrease in the number of volunteers.	B1 M1 A1 A1√	4	B1 hypotheses M1 attempt to calculate P($X \le 3$) using Poisson A1 0.0818 A1√ conclusion
(b)(ii)	H_0: $\lambda = 42$ H_1: $\lambda < 42$ Po(42)$\to$ Normal mean 42 s.d. = $\sqrt{42}$ = 6.481 (variance = 42) z = (33.5 – 42)/6.481 = –1.31 [(33 – 42)/6.481 = –1.39] c.v. z = –2.3263 Accept H_0: No significant evidence to show mean less than 7 per week. Carmen should not authorise advert. *Exact Poisson P(≤33) = 0.0912* *allow B1 M0 m0 m0 A0 B1A1√A1√*	B1 M1 m1 m1 A1 B1 A1√ A1√	8	B1 hypotheses — allow $\lambda = 7$ etc; do not penalise same mistake twice M1 attempt at normal approximation to Poisson m1 s.d. = $\sqrt{42}$ m1 method for z — ignore incorrect sign/cc A1 –1.31 (–1.3 ~ –1.4) B1 use of sig level ≤ 5% A1√ conclusion, their sig level — must be compared with lower tail of z A1√ in context
(iii)	Concluding there has been a decrease in the number of applications when there has not	B1 B1	2	B1 idea of Type I error B1 in context
(iv)	Carmen wants very convincing evidence, so low risk of Type I error required.	E1 E1	2	E1 ≤ 1% used E1 justification
	Total		**22**	

SS04(cont)

Q	Solution	Marks	Total	Comments
6(a)				
	T_2:			
(i)	mean = 0.25 + 0.25 = 0.5	B1	1	B1 0.5 cao
(ii)	variance = $0.02^2 + 0.02^2$ = 0.0008	B1	1	B1 method ag
(iii)	T_5: normal mean = 5×0.25 = 1.25 variance = 5×0.02^2 = 0.002 s.d. = 0.04472	M1A1	2	M1 method for variance or s.d. A1 1.25 and 0.002 cao (or 0.0447 (0.0447~0.045)
(b)(i)	z = (1.2 – 1.25)/0.04472 = –1.118 probability less than coffee used less than 1.2 litres 1 – 0.868 = 0.132	M1 A1	2	M1 method — allow wrong tail A1 0.132 (0.131 ~ 0.134)
(ii)	$T_5 - 0.5Y$ is normal mean 1.25 – 1.2 = 0.05 variance 0.002 + $0.5^2\times0.15^2$ = 0.007625 z = (0 – 0.05)/√0.007625 = –0.573 probability Manesh uses less than half the coffee = 1 – 0.717 = 0.283	B1 M1m1 m1 M1 m1 A1	7	B1 0.05 cao M1 use of $0.5^2\times0.15^2$ m1 method for variance or s.d. — their (a)(iii) m1 completely correct method for variance or s.d. M1 attempting $T_5 - 0.5Y < 0$, their mean and s.d. m1 completely correct method — disallow wrong tail A1 0.283 (0.28 ~ 0.285)
	Total		**13**	
	TOTAL		**75**	