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General Certificate of Education (A-level)
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Statistics SS04

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Statistics 4

Final

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 students' 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 students' 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.

Q	Solution	Marks	Total	Comments
1	$\bar{x}$ = 130.625 s = 51.994 H_0: μ = 115 H_1: μ > 115 t = (130.625 – 115)/(51.994/√8) = 0.850 cv t_7 1.895 Accept H_0 There is no significant evidence that the mean time from leak being reported to engineer arriving exceeds 115 minutes p = 0.212 compare with 0.05	B1 B1 M1m1 A1 B1 B1√ A1√ A1√	 9	B1 130.625 (130 ~ 131) and 51.994 (51.9 ~ 52.1) B1 both hypotheses M1 use of their sd/√8 m1 method for t - ignore sign A1 0.850 (0.849 ~ 0.851) B1 7df B1√ 1.895 - their df A1√ conclusion must be compared with upper tail of t and not inconsistent with their H_0. Allow arithmetic errors and incorrect t-values only A1√ in context - needs previous A1√ mark. Final A1√A1√ - allow for 2-sided test
	Total		**9**	
2(a)(i)	Binomial n = 80 p = 0.0025 → Poisson, mean 80×0.0025 = 0.2 P(≥ 2) = 1 – 0.9825 = 0.0175	B1 B1 M1 A1	 4	B1 B(80, 0.0025) B1 Poisson mean 80 × 0.0025 M1 method - allow wrong tail A1 0.0175 (0.017 ~ 0.018)
(ii)	Buy new tyres. There was a very low probability of this occurring if the tyres were in good condition.	E1 E1	 2	E1 buy new tyres - must be consistent with their (a)(i) E1 low probability or other sensible comments
(b)(i)	Binomial n = 60 p = 0.32 → Normal, mean 19.2 sd = √60 × 0.32 × 0.68 = 3.61 z = (10.5 – 19.2)/3.61 = –2.41 P(10 or fewer) = 1 – 0.9920 = 0.0080	B1 B1 M1 m1 m1 A1	 6	B1 B(60,0.32) B1 attempt at normal approximation M1 method for mean and sd m1 method for z - ignore sign and cc m1 correct attempt at cc - ignore sign A1 0.0080 (0.0079 ~ 0.0082)
(ii)	Probability of chain coming off only 3 times if it needs replacing is very low. Don't replace.	E1 E1	 2	E1 don't replace - must be consistent with their (b)(i) E1 low probability - clearly stated or other sensible comments
	Total		**14**	

Q	Solution	Marks	Total	Comments
3(a)	p = 48/98 = 0.48980 95% confidence interval for p $0.4898 \pm 1.96\sqrt{0.4898 \times 0.5102/98}$ 0.4898 ± 0.0990 0.391 ~ 0.589	B1 M1 B1 m1 A1	 5	B1 48/98 ACF M1 method for sd B1 1.96 m1 method - allow incorrect z-value A1 0.391 (0.39 ~ 0.392) and 0.589 (0.588 ~ 0.59) allow in $\pm$ form
(b)	H_0: $p = 0.4$ H_1: $p > 0.4$ B(50, 0.4) $P(\geq 25) = 1 - 0.9022 = 0.0978$ Accept H_0 since $0.0978 > 0.05$ Conclude no significant evidence that more than 40% of those students who have attempted a DIY job have used cutlery instead of the proper tools	B1 B1 M1 A1 A1√ A1	 6	B1 hypotheses B1 attempted use of B(50, 0.4) M1 attempt to find $P(\geq 25)$ using B(50, 0.4) A1 0.0978 (0.0975 ~ 0.098) A1√ Conclusion - their figures by correct method A1 Conclusion in context - probability must be compared with 0.05 for final mark and needs previous two A marks
(c)	Of students applying for accommodation, the proportion who claimed to have attempted a DIY job was probably between 0.39 and 0.59. Even if students who do not claim to have attempted a DIY job are excluded the evidence that more than 40% have used kitchen utensils is not significant. The company claimed that result referred to 'people' while sample is restricted to students applying for accommodation.	 E1 E1 E1	 3	E1 Only about half of students had attempted DIY E1 even for those who had evidence is not significant. E1 companies claim refers vaguely to 'people'. The data is for a subset of students E1 claim unconvincing E1 other sensible comment *maximum 3 marks*
	Total		**14**	

Q	Solution	Marks	Total	Comments
4(a)(i)	Total time is normal mean 74 + 28 + 126 = 228 mins sd $\sqrt{(4.6^2 + 5.3^2 + 7.2^2)}$ = 10.05 m (variance = 101.09)	B1 B1 M1 A1		B1 normal - may be implied by later use B1 228 CAO M1 method for sd or variance A1 10.05 (10 ~ 10.1) or 101.09 (101 ~ 101.2)
(ii)	z = (240 – 228)/10.05 = 1.19 P(journey > 4 hours) = 1 – 0.884 = 0.116	M1 A1	6	M1 method - their mean and sd allow wrong tail - needs consistent units A1 0.116 (0.115 ~ 0.118) *lose 1 mark if cc used*
(b)(i)	z = (15 – 11)/2.9 = 1.38 Probability Bergitte arrives at harbour before 10 am = 0.916	M1 A1	2	M1 method - allow wrong tail A1 0.916 (0.914 ~ 0.917) *lose 1 mark if cc used*
(ii)	Mean journey time for Bergitte 0.916 × 243 + 0.084 × 483 = 263 mins	M1 m1 A1	3	M1 method for mean journey time if boat missed - allow if time from 10 am used. m1 method their probability A1 263 (262 ~ 264)
(iii)	Advise Bergitte to leave home a little earlier to avoid the small but non-trivial probability of a 4 hour delay in the journey.	E1	1	E1 leave home earlier
	Total		**12**	
5(a)	$\bar{x}$ = 63.18 s = 8.097 95% confidence interval for mean 63.18 ± 2.228 × 8.097/√11 ie 63.18 ± 5.44 57.74 ~ 68.62	B1 M1 m1 B1 B1√ A1	6	B1 63.18 (63.15 ~ 63.2) and 8.097 (8.09 ~ 8.1) M1 their sd/√11 m1 method for interval - allow incorrect t-value or arithmetic error only B1 10 df B1√ 2.228 their df A1 57.7 (57.7 ~ 57.8) and 68.6 (68.6 ~ 68.7) allow in ± form
(b)	Statement 1: A. Statement 2: D. The confidence interval is certain to contain the mean time taken by members of the sample Statement 3: C. There is no reason why this should be true since confidence interval is for mean not individual values. It could conceivably be true by chance.	B1 B1 E1 B1 E1	5	B1 A B1 D E1 explanation B1 C - allow D if accompanied by a reasonably good explanation E1 explanation
	Total		**11**	

Q	Solution	Marks	Total	Comments
6(a)	H_0: $\mu = 2$ H_1: $\mu < 2$ (or 30) Poisson mean 30 $\rightarrow$ Normal mean 30 sd $\sqrt{30} = 5.477$ $z = (24.5 - 30)/5.477 = -1.00$ (or $(24 - 30)/5.477 = -1.10$) cv -1.2816 Accept H_0 Conclude there is no significant evidence that mean is less than 2 viewers per week. $p = 0.159$ or 0.136 compare 0.1	B1 B1 M1 m1 A1 B1 A1 A1	 8	B1 hypotheses B1 Poisson mean 30 M1 attempt at normal approx sd $\sqrt{30}$ m1 method for z - ignore sign and incorrect cc A1 -1.00 ($-1.00 \sim -1.01$) or -1.10 ($-1.09 \sim -1.10$) B1 -1.2816 - ignore sign A1 conclusion - must be compared with lower tail of normal - consistent with their figures A1 in context - needs previous A
(b)	H_0: $\mu = 1.6$ H_1: $\mu > 1.6$ (or 8) Poisson mean 8 P(10 or more) = 1 – 0.7166 = 0.283 Since 0.283 > 0.05, accept H_0 Conclude there is no significant evidence that mean is more than 1.6 viewers per week.	B1 M1 B1 A1 A1	 5	B1 hypotheses M1 attempt at P(10 or more) using Po(8) B1 0.283 (0.283 ~ 0.284) A1 accept H_0 A1 in context - needs completely correct method including comparison with 0.05
(c)	Some evidence but not significant that Lorraine's mean < 2 and Imran's mean > 1.6. Tests provide no conclusive evidence either way	E1 E1	 2	E1 no conclusive evidence either way E1 some evidence Lorraine < 2 (or Imran >1.6) E1 evidence not significant E1 other sensible comment *maximum 2 marks*
	Total		**15**	
	TOTAL		**75**	