Version 1.0

General Certificate of Education
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Statistics SS05

Statistics 5

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.

Set and published by the Assessment and Qualifications Alliance.

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.

SS05

Q	Solution	Marks	Total	Comments
1(a)	$\lambda = 1/\text{mean} = 1/0.8$ $= 1.25$	E1	1	E1 1/0.8 ag
(b)	$P(X < 0.5) = 1 - e^{-1.25 \times 0.5}$ $= 1 - e^{-0.625} = 1 - 0.535$ $= 0.465$	B1 M1A1	3	B1 1.25 × 0.5 M1 method – allow wrong tail A1 0.465 (0.464 ~ 0.466)
(c)(i)	$P(X > 0.7) = e^{-1.25 \times 0.7}$ $= e^{-0.875}$ $= 0.417$	M1 m1 A1	3	M1 attempt to find > 0.7 from exponential parameter 1.25 m1 method – allow wrong tail A1 0.417 (0.416 ~ 0.418)
(ii)	$P(X < 1.4 \mid X > 0.7)$ $= P(X < 0.7)$ $= 1 - 0.417 = 0.583$	M1 A1	2	M1 1 – their (c)(i) A1 0.583 (0.582 ~ 0.584)
	Total		**9**	
2(a)	$\bar{x} = 76.928 \quad s_x = 2.588896$ $\bar{y} = 73.0625 \; s_y = 2.243045$ $H_0: \mu_x = \mu_y \quad H_1: \mu_x \neq \mu_s$ pooled variance estimate $s^2 = (6 \times 2.588896^2 + 7 \times 2.243045^2)/13$ $= 5.80254 \quad (s = 2.4088)$ $t = \dfrac{76.928 - 73.0625}{\sqrt{5.80254\left(\frac{1}{7} + \frac{1}{8}\right)}}$ $= 3.8655/1.2467$ $= 3.10$ c.v. $t_{13} = \pm 3.012$ Reject H_0. Conclude that mean water temperature after 5 hours for flask A is different from (higher than) for flask B	B1 B1 B1 M1 m1 M1m1 A1 B1B1 A1√ A1√	12	B1 76.9 (76.9~77), 73.1 (73~73.1) 2.59 (2.58~2.6), 2.24 (2.24~2.25) B1 one correct hypothesis – generous B1 both correct – ungenerous M1 attempt at pooled variance m1 correct method for pooled variance M1 difference of means/their standard deviation m1 correct method for t A1 3.10 or –3.10 (3.09 ~ 3.11) B1 13 df B1 3.012 or 3.01 ignore sign A1√ conclusion – must be compared with correct tail of t A1√ in context – requires previous A1√
(b)	Conditions not controlled e.g. background temperature, amount of water in flask. Conditions may differ between first 7 days and last 8 days.	E1 E1	2	E1 conditions not controlled E1 order of experiments not randomised or balanced one mark for any sensible point
	Total		**14**	

SS05 (cont)

Q	Solution	Marks	Total	Comments
3(a)(i)	Salt content (grams) of all Tommos served by this restaurant	B1	1	B1
(ii) (A)	99% confidence interval for mean salt content $2.4 \pm 3.355 \times 0.2739/\sqrt{9}$ 2.4 ± 0.306 $2.094 \sim 2.706$	B1 B1√ M1m1 A1	5	B1 8df –can be earned in (ii)(B) B1√ 3.355 (3.35~3.36) M1 use of their s.d./√9 m1 method for interval A1 2.1 (2.09~2.1) and 2.706 (2.7~2.71) allow in ± form
(ii) (B)	99% confidence interval for standard deviation given by $1.344 < 8 \times 0.2739^2/\sigma^2 < 21.955$ $0.6/21.955 < \sigma^2 < 0.6/1.344$ $0.02733 < \sigma^2 < 0.4464$ $0.165 < \sigma < 0.668$	M1m1 B1m1 A1	5	M1 any correct expression – generous; allow small slip, incorrect χ^2, m1 correct expression allow incorrect χ^2 B1 1.344 (1.34 ~ 1.35) and 21.955 (21.9~22) m1 correct method for interval for σ (or σ^2 provided it is clearly called σ^2 or variance) A1 0.165 (0.16 ~ 0.17) and 0.668 (0.66 ~ 0.67)
(iii)	No pizzas in sample have salt content > 3g Mean salt content well below 3g because upper limit of confidence interval is 2.71. Some pizzas could still have salt content above 3g – confidence intervals suggest that say, mean 2.5g, s.d. 0.5g would not be unlikely which would give about 15% above 3g.	E1 E1 E1	3	E1 all sample below 3g E1 mean below 3g E1 some could still be above 3g E1 numerical support for some above 3g max 3
(b)	H_0: $\sigma_Y = \sigma_W$ H_1: $\sigma_Y > \sigma_W$ $F = 0.3795^2/0.2403.^2 = 2.49$ c.v. $F_{[9,7]}$ is 3.677 (or compare 0.402 with 0.272) Accept H_0. No significant evidence that Mario's preparation times are more variable than Emilio's *$p = 0.121$ compare with 0.05*	B1 M1A1 B1B1 A1√ A1√	7	B1 both hypotheses M1 method for F A1 2.49 (2.49~2.5) B1 9 and 7 d.f. B1 3.677 (3.67~3.68) A1√ accept H_0 must be compared with correct tail of F A1√ in context – needs previous A1√ mark
	Total		**21**	

SS05 (cont)

Q	Solution	Marks	Total	Comments
4(a)	Number of Incidents O prob E 0 26 0.2019 19.180 1 28 0.3230 30.685 2 17 0.2585 24.557 3 11 0.1378 13.091 4 8 0.0551 5.234 ≥5 5 0.0237 2.251 { ≥4 13 0.0788 7.486}	M1 B1 M1 A1 m1 m1		M1 method for probabilities – generous B1 last class ≥ ; may be implied by probabilities or Es M1 their probabilities×95 A1 4 correct Es ± 0.05 m1 attempt to pool classes m1 correct pooling
	H_0: Poisson distribution is adequate model H_1: Poisson distribution is not adequate model	B1		B1 hypotheses – may be earned in conclusion
	$\Sigma(O-E)^2/E = 6.82^2/19.18 + 2.685^2/30.685 + 7.557^2/24.557 + 2.091^2/13.091 + 5.514^2/7.486$ $= 9.38$	M1 A1		M1 attempt at $\Sigma(O-E)^2/E$; their Es A1 9.38 (9.3 ~ 9.45)
	c.v. χ_3^2 is 7.815	B1√ B1√		B1√ 3df – their grouping B1√ 7.815 – their df
	Significant evidence that the Poisson distribution is not an adequate model for the recorded incidents of damage to vehicles.	A1√ A1√	13	A1√conclusion – needs correct method for Es and comparison with upper tail of χ^2 A1√conclusion in context – needs previous A1√
(b)	Constant mean – mean may be higher when traffic is heavy/ weather bad Incidents occur independently – more than one vehicle may be involved in an incident No upper limit – Only a limited number of vehicles, hence there is an upper limit to the number of incidents.	E1 E1 E1 E1	4	E1 property of Poisson eg Constant mean, independence, upper limit, random E1 plausible example ×2 only allow 'constant rate' if qualified by example
	Total		**17**	

SS05 (cont)

Q	Solution	Marks	Total	Comments
5(a)	H_0: $\mu_V = \mu_W + 2$ H_1: $\mu_V > \mu_W + 2$	B1 B1	 2	B1 one correct hypothesis B1 both correct
(b)	$\dfrac{15.43 - 11.16 - 2}{\sqrt{\dfrac{2.7^2}{20} + \dfrac{3.6^2}{20}}}$ (2.256)	B1 B1	 2	B1 numerator correct (ignore sign) B1 denominator correct
(c)	5%	B1	1	
	Total		**5**	
6(a)	1/6	M1 A1	 2	M1 method – allow for 3/8 A1 1/6 or 0.166~0.167
(b)(i)	$(1/3)^3 = 1/27$	M1A1	2	M1 their probability to power 3 A1 1/27 or 0.0369~0.0371
(ii)	probability > 10 on day is 5/6 probability all >10 $(5/6)^3 = 0.579$ probability at least one <10 on day $1 - (5/6)^3 = 91/216 = 0.421$	M1 M1 m1 A1	 4	M1 prob >10 5/6 or equiv; allow 7/8 M1 prob all >10 m1 prob at least one < 10 A1 91/216 or 0.42~0.422
(c)	equal numbers in each year/ births equally spaced throughout year.	E1	1	E1 any valid point
	Total		**9**	
	TOTAL		**75**	