A-Level

Statistics

SS04

Final Mark scheme

6380

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Mark schemes are prepared by the Lead Assessment Writer 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 associates 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 associate understands and applies it in the same correct way. As preparation for standardisation each associate 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, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' 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.

Further copies of this mark scheme are available from aqa.org.uk

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 (a)	Mean = 39 Using $mean \pm z\sqrt{mean/k}$ with k=6 with z=2.5758 39 ± 6.57 or (32.4, 45.6) **Alternative** Total births over 6 weeks = 234 Using $total \pm z\sqrt{total}$ with z=2.5758 (= 234 ± 39.4) Divide their CI by 6 39 ± 6.57 or (32.4, 45.6)	B1 M1 m1 B1 A1 (B1) (M1) (B1) (m1) (A1)		CAO Their mean; using z = 2.58, 2.33, 1.96, 1.64; allow k=1 2.57 ~ 2.58 (6.5 ~ 6.6) (32.4 ~ 32.5, 45.5 ~ 45.6) Their total; z as above. 2.57 ~ 2.58
			5	
(b)	The mean (1.5) or total (9) is too small for a normal approximation to the Poisson distribution to be valid.	E1 E1		Mean (or total, must = 9 if stated) is too small Normal not a good approximation E's are independent Both marks require use of a z-value in part (a)
			2	
		Total	**7**	

Q	Solution	Marks	Total	Comments
2 (a)	$\bar{x} = 59.3(33)$ $s = 8.53(16)$	B1		For 59.3~59.4 and $s_{n-1} = 8.53 \sim 8.54$ or s_n=8.16(84) (8.16 ~ 8.17) (ignore labels). PI
	$H_0 : \mu = 53.4$ $H_1 : \mu > 53.4$	B1		Both. Allow population mean for μ.
	$(t =)\dfrac{59.3 - 53.4}{8.53/\sqrt{12}}$	M1		M1 for use of $\dfrac{s_{n-1}}{\sqrt{n}}$ *or* $\dfrac{s_n}{\sqrt{n-1}}$ in test statistic formula. Ignore sign.
		m1		Correct formula, ignore sign. Or $(t =)\dfrac{59.3 - 53.4}{8.17/\sqrt{11}}$
	= 2.41 (2.409128)	A1		2.39 ~ 2.44. Must be positive. or p = 0.0173 (0.016 ~ 0.018)
	Critical value $t_{11} = 2.718$	B1 B1		For 11 df (may be implied by 1.363, 1.796, 2.201, 2.718, 3.106) For 2.71 ~ 2.72 CAO Or if t<0, CV = -2.718 Or 0.0173 compared (B1) with 0.01 (B1)
	Do not reject H_0 at 1% level. There is **no evidence** that **mean** (or average) **mark** (or score or grade) for students **drink**ing (or *Herbicola)* **exceeds** 53.4	E1dep		Correct conclusion in context. Dependent on all previous marks. Disallow if too definite conclusion.
			8	
(b)	• The exam may be easier • Students may be more able this year • The sample is self-selected or not random • Only mathematics is considered • Only one university considered • Only first year students considered • Students may have all used other performance-enhancing substances.	E1 E1		Any two sensible comments. Not sample too small Not "only for one year" Not just the effect of chance Disallow Herbicola may just act as a placebo (OE).
			2	

(c)	• Compare those using *Herbicola* with those not using it (or mention control group) or use of a blind trial/placebo (which will imply a comparison of groups) • Randomly select students for *Herbicola* • Use some sort of blocking to balance males/females or maths ability or learning strategy for example • Take a bigger sample • Use wider range of subjects • Use more than one university • Extend to students from later years.	E1 E1		Any two sensible comments. Disallow reference to initial scores.
			2	
		Total	**12**	

Q	Solution	Marks	Total	Comments
3(a)(i)	No. of fish caught per hour (X) has Po(3.2) dist. $P(X \geq 5) = 1 - 0.7806$ $= 0.219(4)$	 M1 A1		 Allow 1 – 0.8946 = 0.1054 0.219~0.22
(ii)	No. caught in 45 mins (Y) has Po(2.4) dist. $P(Y \leq 3) = 0.7787$	B1 B1		For λ = 2.4. PI 0.778~0.779
			4	
(b)	No. caught in 10 hours (W) has Po(32) dist. which is approx. N(32,32) $P(W > 40) = P\left(Z > \frac{40.5-32}{\sqrt{32}}\right)$ $= P(Z > 1.50(2))$ =1 – 0.933(5) = 0.066(5)	B1 M1 m1 A1 A1		For λ = 32. PI Normal approx. **used**, PI Standardising with 32 and $\sqrt{32}$; allow 39.5 or 40 for 40.5 PI 1.49~1.51 0.066~0.068
Notes	(i) No CC gives z =1.41, P = 0.079; wrong CC (39.5) gives z =1.33, P = 0.092 for max B1M1m1 (ii) Exact Poisson probability is 0.07066 for B1 only.			
			5	
(c)(i)	Independent trials in context. Eg *Whether Ken catches at least 5 fish in an afternoon/visit is independent between afternoons/visits.* Prob (success) same for each day in context n = 90 p=0.219	E1 E1 B1 B1ft		"Visits" are independent is enough. Disallow *probability* or *number* caught independent Disallow fish caught independently of each other. "*Success*" needs to be clearly "*at least 5 fish caught*" CAO ft answer to (a)(i) correct to 2dp
			4	
(ii)	Dist of U: $N(90 \times 0.219, 90 \times 0.219 \times 0.781)$ $= N(19.71, 15.3935)$ $P(U < 25) = P\left(Z < \frac{24.5-19.7}{\sqrt{15.39}}\right)$ $= P(Z < 1.21(089))$ =0.887	M1 B1ft B1 m1 A1 A1		Normal approx. **used**, soi 19.7~19.8 OR 90 × their (a)(i) AWRT 15.4 (no ft) (or SD = AWRT 3.9) Standardising with their mean and SD (using 24.5, 25 or 25.5) must be based on their probability in (a)(i) PI 1.21~1.23 0.886~0.89(0)
Notes	(i) No CC gives z=1.34, P = 0.910; wrong CC (25.5) gives z=1.47, P= 0.929 for max M1B1ftB1m1 (ii) Exact binomial probability is 0.885(3) for 0/6			
			6	
		Total	**19**	

Q	Solution	Marks	Total	Comments
4(a)	Use of t_4 = 2.132 (for 90% CI)	B1		2.13 ~ 2.14 PI
	Use of t_4 = 4.604 (for 99% CI)	B1		4.6 ~ 4.61 PI
	$198.8 \pm t \times \frac{1.4}{\sqrt{5}}$	M1		Seen or implied for either interval. Allow M1 for *t*-value from df = 5 or 95% confidence or one-tailed. *(See note.)*
	90% CI: 198.8 ± 1.33 OR (197.47, 200.13)	A1		**Either** 198.8 ± AWRT 1.3 **Or** AWRT (197.5. 200.1)
	99% CI: 198.8 ± 2.88 OR (195.92, 201.68)	A1		**Either** 198.8 ± AWRT 2.9 **Or** AWRT (195.9, 201.7)
	Special Case If 0/5 award B1 for stated 90% CI (197 or 198, 200) and award B1 for stated 99% CI (196, 202)			
Note	*Other acceptable t-values for M1: 1.533, 2.776, 3.747, 1.476, 2.015, 2.571, 3.365, 4.032*			
			5	
(b)(i)	0.10	B1		OE
(ii)	0.90	B1		OE
			2	
(c)	(1 – 0.9) × (1 – 0.99)	M1		Seen or implied
	= 0.001	A1		OE
			2	
		Total	**9**	

Q	Solution	Marks	Total	Comments
5(a)(i)	$H_0 : \pi = 0.1$ $H_1 : \pi > 0.1$	B1		For both H_0 and H_1. Allow p or "proportion" for π. If B0 here, award B1 for H_0 and H_1 in part (ii)
	Find $P(X \geq 10)$ from B(50, 0.10)	M1		Tables or correct expression to calculate from B(50, 0.10 or 0.90) formula. Allow for 9 or 11 in place of 10 in this expression (see **note** below) If M0 here, award M1 for use of B(30, 0.10 or 0.90) in part (ii)
	= 1 – 0.9755 = 0.0245 This is < 0.05 so reject H_0. There **is evidence** that **more than 10%** of **elite male** players are **left handed**.	A1 m1 E1dep		0.024 ~ 0.025 **or** 0.975 ~ 0.976 *if* comparing with 0.95 (Reject H_0)+ (Prob = 0.024~0.025 or 0.057~0.058 or 0.009~0.01) + (comparison with 0.05). Condone > or = for <. Or equiv comparisons with 0.95. Conclusion in context. Dependent on M1A1m1. Disallow if too definite conclusion.
Note	$P(X \geq 9)$ = 1 – 0.9421 = 0.0579 **or** $P(X > 10) = P(X \geq 11)$ = 1 – 0.9906 = 0.0094. For max 2/5 B1M1.			
			5	
(a)(ii)	$H_0 : \pi = 0.1$ $H_1 : \pi > 0.1$			Not awarded here (see part (i))
	Find $P(X \geq 4)$ from B(30, 0.10)			Not awarded here (see part (i)) Allow for 3 or 5 for 4 in this expression (see **note** below)
	= 1 – 0.6474 = 0.3526 This is > 0.05 so accept H_0. There is **no evidence** that **more than 10%** of **amateur male** players are **left handed**.	A1 m1 E1dep		0.352 ~ 0.353 **or** 0.647 ~ 0.648 *if* comparing with 0.95 (Accept H_0) + (prob= 0.352~0.353 or 0.588~0.589 or 0.175~0.176) +(comparison with 0.05) Condone > or = for <. Or equiv comparisons with 0.95. Conclusion in context. Dependent on M1A1m1. Not too definite.
Note	$P(X \geq 3)$ = 1 – 0.4114 = 0.5886 **or** $P(X > 4) = P(X \geq 5)$ = 1 – 0.8245 = 0.1755 for m1.			
			8	

(b)	Females do **not** support Dev's theory Males **do** support Dev's theory	E1 E1dep		 Dep on accept H_0 in part (a)(ii) **and** reject H_0 in part (a)(i).
Notes	*For each E1:* (i) The comparison made may be implied and not specified but, if it is specified, it **must** be a comparison of elite v amateur players – **not** elite or amateur players v the general population. (ii) Must not **only** refer to elite or amateur players (iii) Ignore additional irrelevant comments.			
			2	
(c)	Because 4/50 is less than 10% (so it's going the "wrong way").	E1		OE
			1	
		Total	**11**	

Q	Solution	Marks	Total	Comments
6(a)	$T = P_1 + P_2 + P_3 \sim N(3\times300, 3\times625)$			
	$= N(900, 1875)$	B1		900 CAO
		B1		1875 CAO
	Then $P(T > 1000) = P(Z > \frac{1000-900}{\sqrt{1875}})$	M1		Standardising with their mean and variance. Needs square root. Ignore sign. May be implied.
	$= P(Z > 2.31) = 0.0105$	A1		0.010~0.011 (0.010461)
			4	
Note	In (a), (b) and (c)(i) for full marks, means and variances must be seen, not implied, but allow $(SD)^2$ (eg 43.3^2 for 1875). **Special Case** If means and variances not seen but answers correct allow B3 for (a) B4 for (b) and B3 for (c)(i)			
(b)	If $U = O_1 + O_2 + \ldots + O_7$			
	Then $U \sim N(840, 700)$			
	Difference $X = T - U \sim N(900-840, 1875+700)$	M1		Difference in random variables involving potatoes and onions used. **Special case** If M0, award B1 for N(840, 700) seen or implied.
	$= N(60, 2575)$	B1		60 CAO (or –60 from 840–900)
		B1		2575 CAO
	Then $P(X > 0) = P(Z > \frac{0-60}{\sqrt{2575}})$	m1		As in (a)
	$= P(Z > -1.18) = 0.881$	A1		0.881~0.882 (0.881476)
			5	
(c)(i)	If swede weight $S \sim N(600, 400)$ then, after peeling, swede weight $S' = 0.9 \times S$			
	and $S' \sim N(0.9 \times 600, 0.9^2 \times 400)$	M1		Method for mean or variance
	$= N(540, 324)$	B1		Both 540 and 324 CAO
	Then $P(S' > 550) = P(Z > \frac{550-540}{\sqrt{324}})$	m1		As in (a)
	$= P(Z > 0.56) = 0.288$ (0.28774 from tables)	A1		0.287~0.2899 (0.289257 from z = 0.5555…)
	Alternative			
	Required swede weight before peeling is 550/0.9 (= 611.111…)	(B1)		
	Using this value with N(600, 400)	(M1)		
	Then $P\left(S > \frac{550}{0.9}\right) = P(Z > \frac{\frac{550}{0.9}-600}{\sqrt{400}})$	(M1)		As in (a)
	$= P(Z > 0.56) = 0.288$ (0.28774 from tables)	(A1)		0.287~0.2899
			4	

6(c)(ii)	$P' \sim N(0.9 \times 300, 0.9^2 \times 625) = N(270, 506.25)$ $S' \sim N(540, 324)$ $O' \sim N(0.95 \times 120, 0.95^2 \times 100) = N(114, 90.25)$	B1 B1		Expression for one mean PI Eg 0.9×300 or 270 or $3 \times 0.9 \times 300$ or 810 seen Or 0.95×120 or 114 or $7 \times 0.95 \times 120$ or 798 seen Expression for one variance PI Eg $0.9^2 \times 625$ or 506.25 or 506.25×3 or 1518.75 seen Or $0.95^2 \times 100$ or 90.25 or 7×90.25 or 631.75 seen
	Then mean of total weight is: $3 \times 270 + 540 + 7 \times 114 = 2148$ And variance of total weight is: $3 \times 506.25 + 324 + 7 \times 90.25 = 2474.5$ Must be rounded to 4sf.	B1 B1		2148 CAO Accept 2474 or 2475
			4	
		Total	**17**	