RECOGNISING ACHIEVEMENT

Oxford Cambridge and RSA Examinations

Advanced Subsidiary General Certificate of Education
Advanced General Certificate of Education

MEI STRUCTURED MATHEMATICS
STATISTICS 2, S2

4767

MARK SCHEME

Qu	Answer	Mark	Comment
1(i)	$H_0 : \rho = 0$, $H_1 : \rho \neq 0$ [where ρ is the population correlation coefficient]	B1 B1 **[2]**	For H_0 For H_1
1(ii)	$S_{xy} = \Sigma xy - n\overline{xy} = 35\ 212.5 - 20 \times 34.55 \times 50.9 = 40.6$ $S_{xx} = \Sigma x^2 - n\overline{x}^2 = 23\ 917 - 20 \times 34.55^2 = 42.95$ $S_{yy} = \Sigma y^2 - n\overline{y}^2 = 51\ 904 - 20 \times 50.9^2 = 87.8$ $r = \frac{40.6}{\sqrt{42.95 \times 87.8}}$ *or* $\frac{2.03}{\sqrt{2.1475}\sqrt{4.39}} = 0.66$ (2 s.f.) For $n = 20$, 1% critical value = 0.5614 Since $0.5614 < 0.661$ we reject H_0: There is sufficient evidence at the 1% significance level to suggest there is correlation between head circumferences and lengths of babies. Background population is *bivariate Normal*.	B1 B1 B1 M1 A1 M1,A1 M1 A1 E1 **[10]**	S_{xy} or covariance S_{xx} S_{yy} Structure of r cao Critical value Comparison Conclusion in words in context Explanation
1(iii)	$\sum x = 708$, $\sum y = 1001$, $\sum x^2 = 25\ 362$, $\sum y^2 = 50\ 459$, $n = 20$, $\sum xy = 35\ 212.5$ $\Rightarrow S_{xy} = -222.9$ and so $\rho < 0$.	B3 B1 **[4]**	All 6 correct (B2 for any 4 correct, B1 for any 2 correct) Or $\rho = -0.681$
1(iv)	The incorrect pair produce an *extreme* point to the *right and* *below* existing cluster, producing a negative correlation. **(Or** There will be a large change in the summary statistics, which will make the covariance negative.**)**	E1 E1 **(**E1 E1**)** **[2]**	Extreme point Relative position For large change For negative cov.

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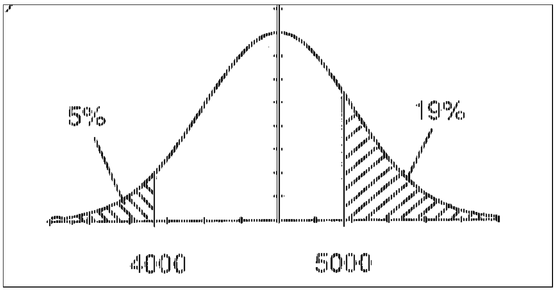
2(i)		B1 B1 **[2]**	Correct overall shape Tails with area of right-hand tail *larger* than the left-hand tail area
2(ii)	$\text{P}(X > 5000) = 0.19 \Rightarrow 5000 = \mu + 0.8779\sigma$ $\text{P}(X < 4000) = 0.05 \Rightarrow 4000 = \mu - 1.645\sigma$ Solving: $1000 = 2.523\sigma$ $\Rightarrow \sigma = \frac{1000}{2.523} = 396$ (3 s.f.) Hence: $\mu = 4000 + 1.645 \times 396 = 4650$ (3 s.f.)	B1 M1 M1 B1 A1 **[5]**	Both *z*-values Attempt at one equation with *z*-value Attempt at finding σ σ μ
2(iii)	$\text{P}(4250 < X < 4750) = \text{P}(-1 < Z < 0.25)$ $= 0.5987 - (1 - 0.8413)$ $= 0.4400$	M1 M1 A1 **[3]**	Standardisations Probability calculations cao
2(iv)	$\text{P}(X > 5450) = \text{P}(Z > 2)$ $= 1 - 0.9772 = 0.0228$	B1 **[1]**	cao
2(v)	$\text{P}(Z > -2.326) = 0.99$ $\Rightarrow x = 4650 - 2.326 \times 400 = 3719.6$ hence should quote 3700 hours	B1 M1 A1 **[3]**	± 2.326 Calculation cao
2(vi)	P(0 or 1 bulbs need replacing) $= 0.8413^6 + 6 \times 0.8413^5 \times 0.1587$ $= 0.76$ (2 s.f.)	M1 M1,A1 A1 **[4]**	0 or 1 Sum of 2 terms cao

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3(i)(*A*)	$\text{P}(X \geq 2) = 1 - \text{P}(X \leq 1)$ $= 1 - \text{e}^{-1.63}(1 + 1.63)$ $= 1 - 0.515 = 0.485$ (3 s.f.)	M1 M1,A1 A1 **[4]**	Sum of 2 probs. 1 – sum of 2 probs.
3(i)(*B*)	$\text{P}(X = 1) \times \text{P}(Y = 1)$ $= (\text{e}^{-1.63} \times 1.63) \times (\text{e}^{-1.17} \times 1.17)$ $= 0.116$ (3 s.f.)	M1 M1 A1 **[3]**	2 probabilities Product
3(i)(*C*)	Using $\lambda = 1.63 + 1.17 = 2.8$: $\text{P}(X + Y = 5) = 0.9349 - 0.8477 = 0.087$ (2 s.f.) **(***or* $\text{P}(X + Y = 5) = \text{e}^{-2.8} \times \frac{2.8^5}{5!} = 0.087$ (2 s.f.) **)**	M1,A1 M1 A1 **[4]**	λ = 2.8 For calculation cao
3(ii)	Two reasons why proposed model might not be suitable: Poisson parameter unlikely to be same for each team; lack of independence between the variables.	E1 E1 **[2]**	For one reason For second reason
3(iii)	$\lambda = 19 \times 1.63 = 30.97$, hence suitable approximating distribution is N(30.97, 30.97) P(more than 35 goals in a season) $= \text{P}(X > 35.5) = \text{P}(Z > \frac{35.5 - 30.97}{\sqrt{30.97}})$ $= \text{P}(Z > 0.814)$ $= 1 - 0.792$ $= 0.208$ (3 s.f.)	M1,A1 B1 M1 A1 **[5]**	Use of Normal approx. Continuity corr. Calculation

Qu	Answer	Mark	Comment
4(a)(i)	$H_1 : \mu < 40.5$	B1 **[1]**	Hypothesis
4(a)(ii)	$n = 12, \sum x = 485.4 \Rightarrow \bar{x} = 40.45$	M1,A1	Mean value
	Test statistic is $\dfrac{40.45 - 40.5}{\frac{0.2}{\sqrt{12}}} = -0.866$	M1 M1 A1	Numerator Denominator
	Since $-0.866 > -1.645$, the result is not significant, and it is reasonable to accept that $\mu = 40.5$	B1 M1 A1 **[8]**	'1.645' Comparison Conclusion in words
4(b)	H_0: There is no association between inoculation and the occurrence of influenza	B1	
	H_1: There is an association between inoculation and the occurrence of influenza	B1	
	Expected frequencies:	M1,A1	Expected frequencies

		Influenza Yes	Influenza No	*Total*
Inoculated	Yes	14.333	11.667	**26**
	No	28.667	23.333	**52**
Totals		**43**	**35**	**78**

Answer	Mark	Comment
$X^2 =$ $\dfrac{(8-14.333)^2}{14.333} + \dfrac{(18-11.667)^2}{11.667} + \dfrac{(35-28.667)^2}{28.667} + \dfrac{(17-23.333)^2}{23.333}$	M1	Calculation of the test statistics
$= 9.35$ (3 s.f.)	A1	cao
Since $9.35 > 3.84$, the result is significant, and therefore it seems there is association between incidence of inoculation and influenza	B1 M1 A1 **[9]**	3.84 Comparison Conclusion in words

Total: 72

AO	Range	Total	Question Number 1	2	3	4
1	14-22	15	7	1	2	5
2	14-22	16	2	6	4	4
3	18-26	20	5	9	5	1
4	7-15	12	2	-	4	6
5	3-11	9	2	2	3	2
	Totals	**72**	18	18	18	18