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General Certificate of Education (A-level)
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Mathematics MS04

(Specification 6360)

Statistics 4

Final

Mark Scheme

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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(a)	$s_1^2 = \frac{4.68}{12} = 0.39 \quad s_2^2 = \frac{8.10}{9} = 0.9$	B1	1	Both
(b)	$H_0 : \sigma_X^2 = \sigma_Y^2 \quad H_1 : \sigma_Y^2 > \sigma_X^2$	B1		Both
	$F_{calc} = \frac{0.9}{0.39} = 2.31$ AWRT	M1A1		
	$\nu_1 = 9$, $\nu_2 = 12$	B1		Both; (df can be implied by correct CV).
	$F_{crit} = 2.796$	B1		
	Insufficient evidence to reject H_0, so conclude that variability of heights is the same.	E1√	6	
	Total		**7**	
2(a)	$\frac{4}{p} = \frac{1-p}{p^2}$	M1A1		
	$\Rightarrow 5p^2 = p \Rightarrow p = 0.2 \qquad (p \neq 0)$	A1	3	
(b)(i)	$P(X > 7 \mid X > 4) = \frac{0.8^7}{0.8^4}$	M1m1		0.8^3 written down – using memory property is B2.
	$= 0.512$	A1	3	
(ii)	$0.8^n < 0.0001$ or $1.25^n > 10000$	M1		
	$\Rightarrow n > \frac{\log 10000}{\log 1.25}$	M1m1		
	Least n is 42.	A1	4	Answer from calculator B4 (CAO).
	Total		**10**	
3(a)	$\nu = 7$	B1		(df can be implied by correct CV)
	$CV = 1.415$	B1		
	$\frac{0.1625}{\left(\frac{s}{\sqrt{8}}\right)} = 1.415$	M1A1		AWFW [1.415, 1.420]
	$\Rightarrow s = 0.3248$	A1	5	Accept AWFW [0.324, 0.325].
(b)	$\nu = 7 \Rightarrow CVs = 1.69 \ , \ 16.01$	B1B1		(df can be implied by correct CV)
	$\frac{0.3248\sqrt{7}}{\sqrt{16.01}} < \sigma < \frac{0.3248\sqrt{7}}{\sqrt{1.690}}$	M1 A1√		Or for interval in terms of variances.
	$\Rightarrow (0.215 \ , 0.661)$	A1	5	CAO (**not** variances here.)
	Total		**10**	

Q	Solution	Marks	Total	Comments
4(a)	$1-\mathrm{e}^{-\frac{1}{\mu}x}=\frac{1}{4}$, $\frac{3}{4}$	M1		Either.
	$\mathrm{Q}_1=\mu\ln\left(\frac{4}{3}\right)$	M1A1		M1 for attempting either Q_1 or Q_3.
	$\mathrm{Q}_3=\mu\ln 4$	A1		
	$\mathrm{IQR}=\mu\ln 3$	A1	5	CAO
(b)	$\mathrm{E}\left(X^2\right)=\int_0^\infty \frac{1}{\mu}x^2\mathrm{e}^{-\frac{1}{\mu}x}\,\mathrm{d}x$	M1		Knowledge of formula.
	$=\left[-x^2\mathrm{e}^{-\frac{1}{\mu}x}\right]_0^\infty+\int_0^\infty 2x\mathrm{e}^{-\frac{1}{\mu}x}\,\mathrm{d}x$	M1A1		Using integration by parts.
	$=0+2\mu.\mu=2\mu^2$ (AG)	A1	4	
(c)	$\mathrm{SD}=\sqrt{2\mu^2-\mu^2}=\mu$	B1		
	$\ln 3>1\Rightarrow$ SD < IQR	M1A1	3	
	Total		**12**	
5(a)	Normal distribution. Common variance.	E1 E1	2	
(b)	$\mathrm{H}_0:\mu_m-\mu_e=0$ $\mathrm{H}_1:\mu_m-\mu_e>0$	B1		Both
	$\overline{m}-\overline{e}=25.5-18=7.5$	B1		
	$s^2=\frac{470+300}{10+8-2}=48.125$	M1A1		Accept [48.12,48.13] M1 requires a decent go at **both** numerator and denominator.
	$\frac{7.5-0}{\sqrt{48.125(8^{-1}+10^{-1})}}=2.28$	M1A1		
	$\nu=16$ $t_{\mathrm{crit}}=2.121$	B1B1		(df can be implied by correct CV)
	Sufficient evidence at 2.5% level to reject H_0 and believe that morning journeys are longer, on average.	A1√	9	
	Total		**11**	

Q	Solution	Marks	Total	Comments
6(a)	$\text{Mean} = \frac{220}{100} = 2.2$	B1	1	
(b)	19.67 10.81 4.76 2.49	M1 A2	3	−1 EE (no negative marks). Accept 19.66 and 10.82 from graphics calculator. Allow '1 – rest' for 2.49, *if implied by correct following working*.
(c)	H_0: Po(2.2) is a suitable model. (OE)	B1		2.2. not required. Cf. qn re Gwyneth's belief.
	Combine last two classes.	M1		Expected frequencies below 5.
	$\chi^2_{\text{calc}} = 3.58$ to 3.61	M1A1		AWFW
	$\nu = 6 - 2 = 4$	B1		(df can be implied by correct CV)
	$\chi^2_{\text{crit}} = 7.779$	B1		
	Retain H_0: Po(2.2) is a suitable model. (OE) (OE) ≡ a statement about Gwyneth's belief. Cf Qn.	E1√	7	2.2. not required. Cf. qn re Gwyneth's. belief
	Total		**11**	
7(a)(i)	$\text{E}\left(\frac{3R}{2}\right) = \frac{3}{2}\text{E}(R)$	M1		
	$= \int_0^\gamma \frac{3r^2}{\gamma^2}\text{d}u = \left[\frac{r^3}{\gamma^2}\right]_0^\gamma$	M1A1		
	$= \gamma$	A1	4	
(ii)	$\text{Var}\left(\frac{3R}{2}\right) = \frac{9}{4} \times \frac{\gamma^2}{18} = \frac{\gamma^2}{8}$	M1A1	2	
(b)(i)	$\text{E}(kT) = \gamma \Rightarrow \frac{3k}{4}\gamma = \gamma \Rightarrow k = \frac{4}{3}$	M1A1	2	
(ii)	$\text{Var}\left(\frac{4}{3}T\right) = \frac{16}{9}\text{Var}(T) = \frac{16}{9} \times \frac{3}{16}\gamma^2 = \frac{\gamma^2}{3}$	M1A1		
	$\text{RE}\left(\frac{3}{2}R \text{ wrt } \frac{4}{3}T\right) = \frac{\text{Var}\left(\frac{4}{3}T\right)}{\text{Var}\left(\frac{3}{2}R\right)} = \frac{\gamma^2}{3} \times \frac{8}{\gamma^2} = \frac{8}{3}$	M1A1	4	
(iii)	Since this is greater than 1, prefer $\frac{3}{2}R$.	M1A1	2	Allow 'because $\frac{3}{2}R$ has the smaller variance'. Award M1 for comparing **their** RE with 1, or comparing variances. A1 is CSO and requires the previous A marks.
	Total		**14**	
	TOTAL		**75**	