CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the October/November 2013 series

9709 MATHEMATICS

9709/71 Paper 7, maximum raw mark 50

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1	$\lambda = \frac{1}{30}$ $1 - e^{-\frac{1}{30}}$ $= 0.0328$ (3 s.f.)	B1 M1 M1 A1 [4]	o.e $1 - P(X = 0)$ by Poisson, any λ allow 1 end error $1 - P(X = 0)$ by Poisson, correct λ no end errors S.R. Binomial with final answer 0.0328 B2 Correct answer, no working scores B2
2	$z = 2.576$ $2 \times z \times \frac{0.17}{\sqrt{n}} = 0.2$ oe $n = (\frac{2 \times 0.17 \times 2.576}{0.2})^2$ oe $(= 19.2)$ Smallest n is 20	B1 M1 M1 A1 [4]	Seen (accept 2.574 to 2.579) Allow without '2 ×' OR with incorrect z Attempt to arrange equ of correct form (with correct z and '2×' into the form n= or $\sqrt{n}$ =
3 (i)	est $(\mu) = 2866$ or 2870 (3 s.f.) est $(\sigma^2) = \frac{1}{49}(410900000 - \frac{143300^2}{50})$ $(= 4126.53)$ $= 4130$ (3 sf)	B1 M1 A1 [3]	Accept 143300/50 o.e. Correct subst in correct formula
(ii)	H_0: Pop mean (or μ) = 2850 H_1: Pop mean (or μ) ≠ 2850 $\frac{\frac{143300}{50} - 2850}{\frac{\sqrt{'4126.53'}}{\sqrt{50}}}$ $= 1.761$ '1.761' < 1.96 No evidence mean distance changed	B1 M1 A1 M1 A1f [5]	Both. Not just 'mean' Allow '4126.53' without $\sqrt{}$, but must have all $\sqrt{50}$ Or correct c.v. (2867.81) for alt method For valid comparison of z values, areas or c.v. Dep 1.96; ft their 1.761 If H_1: $\mu > 2850$ and c.f. 1.645, max B0M1A1M1A0 (c.v. for 1 tail test 2864.94)
4 (i)	$\lambda = 2.8$ $e^{-2.8}(1 + 2.8 + \frac{2.8^2}{2})$ $= 0.469$ (3 s.f.) or 0.47(0)	B1 M1 A1 [3]	seen any λ allow one end error As final answer
(ii)	$e^{-0.7n} \geqslant 0.99$ or $e^{-\lambda} \geqslant 0.99$ $-0.7n \geqslant \ln 0.99$ or $-\lambda \geqslant \ln 0.99$ $n \leqslant 0.01436$ or $\lambda \leqslant 0.01005$ '0.01436' × 150 or '0.01005' × 150 ÷ 0.7 Max period is 2.15 mins (3 sf)	M1 M1 A1 M1 A1 [5]	Allow '=' throughout Attempt ln both sides Can be implied. Accept 3 s.f. Note $e^{-(0.7/150)n} \geqslant 0.99$ scores 1st and 3rd M1 T & I leading to ans 2.2 mins, SC: B2

5 (i)	$\int_0^2 k(x-2)^2 \,dx = 1$ $\left(\left[\frac{k(x-2)^3}{3}\right]_0^2 = 1\right)$ $k\,[0-(-\frac{8}{3})] = 1$ $k = \frac{3}{8}$ **AG**	M1 A1 [2]	Attempt to integrate f(x) with correct limits and = 1 Must see this line or better, e.g. $k \times \frac{8}{3} = 1$
(ii)	$\frac{3}{8}\int_d^2 (x-2)^2 \,dx = 0.2$ $\left(\frac{3}{8}\left[\frac{(x-2)^3}{3}\right]_d^2 = 0.2\right)$ $\frac{3}{8}\left[0-\frac{(d-2)^3}{3}\right] = 0.2$ oe $((d-2)^3 = -1.6)$ $d = 0.83(0)$ (3 s.f.)	M1 M1 A1 [3]	$\int f(x)dx$ with limits d and 2 or 0 and d, and = 0.2 or =0.8 Condone missing 'k' Reasonable attempt to integrate from a correct expression, with limits substituted to give expression in d^3. Condone missing 'k'
(iii)	$\frac{3}{8}\int_0^2 x(x-2)^2 \,dx$ $(= \frac{3}{8}\int_0^2 x^3 - 4x^2 + 4x\,dx)$ $= \frac{3}{8}\left[\frac{x^4}{4} - \frac{4x^3}{3} + 2x^2\right]_0^2$ $= \frac{1}{2}$	M1 A1 A1 [3]	Attempt integ $xf(x)$; ignore limits, condone missing k $(\frac{3}{8}\left[x \times \frac{(x-2)^3}{3} - \int \frac{(x-2)^3}{3}\,dx\right]_0^2)$ $= \frac{3}{8}\left[x \times \frac{(x-2)^3}{3} - \frac{(x-2)^4}{12}\right]_0^2$ Correct integration & limits, condone missing k
6 (i)	P(Type I) = 1 - P($\geq$ 4 assuming $p = 0.7$) $1-({}^6C_4 \times 0.7^4 \times 0.3^2 + {}^6C_5 \times 0.7^5 \times 0.3 + 0.7^6)$ $(= 1 - 0.744)$ $= 0.256$ (3 s.f.)	M1 M1 A1 [3]	or P($\leq$ 3 assuming $p = 0.7$) May be implied ${}^6C_3 \times 0.7^3 \times 0.3^3 + {}^6C_2 \times 0.7^2 \times 0.3^4 + {}^6C_1 \times 0.7 \times 0.3^5 + 0.3^6$ Allow one end error = 0.256 (3 s.f.) SR if zero scored allow B1 for use of B(6, 0.7) in any two or more terms
(ii)	P(Type II) = P($\geqslant$ 4 assuming $p = 0.35$) $= {}^6C_4 \times 0.35^4 \times 0.65^2 +$ $\quad {}^6C_5 \times 0.35^5 \times 0.65 + 0.35^6$ $= 0.117$	M1 M1 A1 [3]	May be implied Allow one end error SR if zero scored allow B1 for use of B(6, 0.35) in any two or more terms
(iii)	Type 1 They will reject Luigi's belief, although it might be true.	B1 B1 [2]	 In context

7 (i)	N(10.61, 0.1017) $\frac{11-'10.61'}{\sqrt{'0.1017'}}$ (= 1.223) Φ('1.223') = 0.889 (3 s.f.)	B1 M1 M1 A1 [4]	o.e. Stated or implied (accept in un-simplified form) Allow without √ For attempt to find correct area consistent with their working
(ii)	P($K - 1.2A > 0$) Var = $0.0576 + 1.2^2 \times 0.0441$ (= 0.121104) N(–0.324, 0.121104) $\frac{0-(-0.324)}{\sqrt{'0.121104'}}$ (= 0.931) 1 – Φ('0.931') = 0.176 (3 s.f.)	M1 B1 B1 M1 M1 A1 [6]	Or similar stated or implied o.e. May be implied (accept in un-simplified form) Allow without √ For attempt to find correct area consistent with their working

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1	Est(μ) = 1.8775 or 1.88 (3 sf)	**B1**		Accept 751/400 (not 150.2/80)
	Est(σ^2) = $\frac{80}{79}\left(\frac{820.24}{80} - "1.8775"^2\right)$	**M1**		Correct subt'n in correct formula 1/79 (820.24 – 150.2^2/80)
	= 6.81316 or 6.81 (3 sf)	**A1**		
	z = 1.96	**B1**		Seen
	"1.8775" $\pm z \times \sqrt{\frac{"6.81316"}{80}}$	**M1**		
	= 1.31 to 2.45 (3 sf)	**A1**	**6**	Must be an interval. NB use of biased var can still score A1.
Total			**[6]**	
2 **(i)**	Assume sd unchanged or sd = 10.4	**B1**		Oe e.g. var unchanged
	H_0: Pop mean speed (or μ) = 62.3 H_1: Pop mean speed (or μ) < 62.3	**B1**		Both. Not just "Mean . . "
	$\frac{59.9-62.3}{\frac{10.4}{\sqrt{75}}}$	**M1**		Accept sd/var mixes, but must have √ 75
	= – 1.999 or – 2.00 (allow + or –)	**A1**		Correct z value (or correct critical value)
	Compare – 2.054 or –2.055	**M1**		Valid comparison of z`s/areas/critical values
	No evidence that mean speed decreased	**A1 ft**	**6**	No contradictions. Do not ft 2-tail test.
(ii)	Pop distribution unknown	**B1**		
	Yes	**B1**	**2**	
Total			**[8]**	
3 **(i)**	$\int_0^{10} \frac{1}{2500}\left(100t^3 - t^5\right)\mathrm{d}t$	**M1**		Attempt integ t^2f(t)
	$(= \frac{1}{2500}\left[25t^4 - \frac{t^6}{6}\right]_0^{10} = \frac{100}{3})$			
	"$\frac{100}{3}$" – $(\frac{16}{3})^2$	**M1**		For E (T^2) – (E (T))^2
	= $\frac{44}{9}$ or 4.89 (3 sf)	**A1**	**3**	
(ii)	$\int_n^{10} \frac{1}{2500}\left(100t - t^3\right)\mathrm{d}t$	**M1**		Attempt integ f(t), ignore limits
	$\frac{1}{2500}\left[50t^2 - \frac{t_4}{4}\right] = 0.1$	**M1**		Attempt integ f(t), limits n to 10 or 0 to n Equated to 0.1 or 0.9. Not need to be matched
	$\frac{1}{2500}\left[2500 - \left(50n^2 - \frac{n^4}{4}\right)\right] = 0.1$	**M1**		0.1/0.9 matched to correct limits and used
	($n^4 - 200n^2 + 9000 = 0$)	**M1**		Correct method of solution of a QE in n^2
	($n^2 = 68.3772$, $n = 8.27$) n = 8	**A1**	**5**	Must be single ans only
Total			**[8]**	

4	**(i)**				
	(a)	$e^{-2.1} \times \frac{2.1^3}{3!}$ alone	**M1**		Allow any λ. Allow sum of 3 or 4 rel products, e.g. P (3, 0)
		= 0.189	**A1**	**2**	
	(b)	$e^{-1.2} \times \frac{1.2^3}{3!} \times e^{-0.9}$	**M1**		P (Fem = 3) × P (Opp = 0) or P (Fem = 2) × P (Opp = 1)
		$+ e^{-1.2} \times \frac{1.2^2}{2!} \times e^{-0.9} \times 0.9$	**M1**		P (3, 0) + P (2, 1)
		= 0.115	**A1**	**3**	As final answer
	(ii)	N (30, 30)	**B1**		seen or implied
		$\frac{34.5-30}{\sqrt{30}}$ (= 0.8216)	**M1**		standardising with their N (λ, λ)
		$1 - \Phi$("0.822")	**M1**		Allow with no or incorrect cc or no √
		= 0.206 (3sf)	**A1**	**4**	Area consistent with their working
Total					
5	**(i)**	E (X)= 3.5	**B1**		21/6
		$(1^2 + 2^2 + 3^2 + 4^2 + 5^2 + 6^2) \div 6 -$ "3.5"^{2} $(= \frac{35}{12}$ **AG**)	**B1**	**2**	oe, must see correct expression and no incorrect working
	(ii)	Attempt P ($X < 3$) or 1 – P($X \geq 3$)	**M1**		seen or implied
		N (3.5, $\frac{35}{12}/50$)	**M1**		seen or implied
		$\frac{3-"3.5"}{\sqrt{\frac{35}{12}/50}}$ (= –2.070)	**M1**		or $\frac{2.99-"3.5"}{\sqrt{\frac{35}{12}/50}}$ (= –2.111)
		Φ ("–2.070") = 1 – Φ("2.070") = 0.0192	**M1**		Φ ('–2.111') = 1 – Φ ('2.111') = 0.0174 or 0.0173 Consistent area
		as final answer	**A1**		As final answer or valid total method
				5	Allow with incorrect cc (e.g. 2.5) OR no √.Must have ÷50
	(iii)	Die is biased (towards lower numbers)	**B1 indep**		Comment implying die is biased
		Mean of 50 throws $\geq$ 3 (Allow > 3) or Equal nos of high and low scores or More high scores	**B1 indep**	**2**	Comment implying results of exp't do not indicate bias (or indicate bias towards higher numbers) Both must be in context
Total				**[9]**	

6	**(i)**	N(5100, 5×45^2) or N(5100, 10125)	**B1**		seen or implied
		$\frac{5200-"5100"}{\sqrt{"10125"}}$ (= 0.994)	**M1**		standardising with their new mean and new var area consistent with their working with normal
		Φ ("0.994")	**M1**		
		= 0.840 (3 sf)	**A1**	**4**	
	(ii)	Use of $E - 3L$ or similar	**M1**		
		E ($E - 3L$) = –260	**B1**		2800 – 3 x 1020
		Var ($E - 3L$) = $52^2 + 9 \times 45^2$ or 20929	**B1**		
		$\frac{0-("-260")}{\sqrt{"20929"}}$ (= 1.797)	**M1**		with a pos var with 45^2 and 52^2 combined
		1 – Φ ("1.797")	**M1**		consistent area, must clearly be φ
		= 0.0361 (3 sf) or 0.0362	**A1**	**6**	
					P ($3L - E < 0$): similar scheme SR: use of 3E – L, M1, 7380 B1, 26361 B1 stand 0 with these values M1, M0A0 max 4/6
Total				**[10]**	