

CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the October/November 2012 series

9709 MATHEMATICS

9709/71

Paper 7, maximum raw mark 50

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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Page 2	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – October/November 2012	9709	71

Mark Scheme Notes

Marks are of the following three types:

M Method mark, awarded for a valid method applied to the problem. Method marks are not lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.

A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated method mark is earned (or implied).

B Mark for a correct result or statement independent of method marks.

- When a part of a question has two or more “method” steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly when there are several B marks allocated. The notation DM or DB (or dep*) is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.
- The symbol ∇ implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only. A and B marks are not given for fortuitously “correct” answers or results obtained from incorrect working.
- Note: B2 or A2 means that the candidate can earn 2 or 0.
B2/1/0 means that the candidate can earn anything from 0 to 2.

The marks indicated in the scheme may not be subdivided. If there is genuine doubt whether a candidate has earned a mark, allow the candidate the benefit of the doubt. Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored.

- Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise.
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	GCE A LEVEL – October/November 2012	9709	71

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AEF	Any Equivalent Form (of answer is equally acceptable)
AG	Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
BOD	Benefit of Doubt (allowed when the validity of a solution may not be absolutely clear)
CAO	Correct Answer Only (emphasising that no “follow through” from a previous error is allowed)
CWO	Correct Working Only – often written by a ‘fortuitous’ answer
ISW	Ignore Subsequent Working
MR	Misread
PA	Premature Approximation (resulting in basically correct work that is insufficiently accurate)
SOS	See Other Solution (the candidate makes a better attempt at the same question)
SR	Special Ruling (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)

Penalties

MR –1	A penalty of MR –1 is deducted from A or B marks when the data of a question or part question are genuinely misread and the object and difficulty of the question remain unaltered. In this case all A and B marks then become “follow through” marks. MR is not applied when the candidate misreads his own figures – this is regarded as an error in accuracy. An MR –2 penalty may be applied in particular cases if agreed at the coordination meeting.
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1	$(\frac{m}{2})^2$	M1	$y = \frac{1}{2}x$ (attempt at linear equ with $c = 0$)
	$(\frac{m}{2})^2 = \frac{1}{2}$	M1	$\int_0^m (\frac{1}{2}x)dx = \frac{1}{2}$
	$m = \sqrt{2}$ or 1.41 (3 sfs)	A1 [3]	(Note: $\pm\sqrt{2}$ as final answer scores A0)
2	H_0 : Pop mean = 24.0 H_1 : Pop mean > 24.0	B1	Allow ' μ ' but not just 'mean'
	$\frac{25-24}{\frac{4.8}{\sqrt{150}}}$	M1	Standardise, with $\sqrt{150}$. Ignore cc. Accept sd/var mixes. OR find x_{crit}
	= 2.55(2) Comp $z = 2.054$ or 2.055 Evidence that Hiergro has incr hts	A1 M1 A1ft [5]	For correct z or area or x_{crit} Valid comparison (z values/areas/ x values) Correct conclusion No contradictions (Note 2 tail test can score B0 M1 A1 M1 ($z = 2.326$) A1ft)
3	(i) Mean = $500 + 3 \times 142$ = 926 (cents)	B1	
	SD = 3×35 = 105 (cents)	M1 A1 [3]	Or 9×35^2 seen Accept $\sqrt{11025}$
	(ii) Mean = $6 \times '926' = 5556$ (cents) $6 \times '105'^2$ (= 66150) (SD = $\sqrt{66150}$) = 257 (cents) (3 sf)	B1ft M1 A1 [3]	or SD = $\sqrt{6 \times '105'}$. ft their (i) Accept $\sqrt{66150}$
4	(i) $P(X \leq 1) = (0.75)^{20} + 20(0.75)^{19}(0.25)$ = 0.0243	M1 A1	Attempt correct expression
	$P(X \leq 2) = (0.75)^{20} + 20(0.75)^{19}(0.25) + {}^{20}C_2(0.75)^{18}(0.25)^2$ = 0.0913 or 0.0912	M1 A1	Attempt correct expression OR Find $P(2)$ = 0.0669 or 0.0670
	Critical region is 0 or 1 pkt contain gift or < 2 pkts contain gift oe	A1 [5]	dep M1M1 & their $P(X \leq 1) < 0.05 < \text{their } P(X \leq 2)$ (S.R. Use of Normal: $N(5.3.75^2)$ used B1 $-1.645 = (x + 0.5 - 5)/\sqrt{3.75}$ M1 $x < 1.31$ A1 (3/5))
	(ii) $P(\text{Type I}) = 0.0243$ (3 sfs)	B1ft [1]	ft their $P(X \leq 1)$ dep < 0.05 ft Normal
	(iii) 2 is outside rej reg No evidence to reject claim	M1 A1ft [2]	or $P(X \leq 2) > 0.05$ No contradictions

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5 (i) $\int_3^5 \frac{k}{x-1} dx = 1$ $[k \ln(x-1)]_3^5 = 1$ $k(\ln 4 - \ln 2) = 1$ $k \ln 2 = 1$ $(k = \frac{1}{\ln 2} \text{ AG})$	M1 A1 M1 A1 [4]	Attempt integ f(x) & ‘= 1’ ignore limits Correctly integrated; ignore limits Subst of limits 3, 5 No errors seen. No decimals seen
(ii) $\frac{1}{\ln 2} \int_3^x \frac{1}{x-1} dx = 0.75$ $\frac{1}{\ln 2} [\ln(x-1)]_3^x = 0.75$ $\frac{1}{\ln 2} (\ln(x-1) - \ln 2) = 0.75$ $\ln(x-1) = (0.75 \times \ln 2 + \ln 2)$ $\ln(x-1) = 1.75 \times \ln 2$ $x-1 = 2^{1.75}$ or $x-1 = 3.36$ $x = 4.36$ (3 sfs)	M1* A1 M1 dep* A1 [4]	Attempt integ f(x), unknown limit, & ‘= 0.75’ or ‘= 0.25’ oe. Fully correct equn after subst limits oe. Correct manipulation of logs to find x
6 (i) Excludes children Excludes people without phones More than one person in some houses Some ex-directory	B1 [1]	or other implying directory excludes some people
(ii) $\text{Var}(p) = \frac{\frac{38}{200}(1 - \frac{38}{200})}{200} (= 0.0007695)$ $z = 2.576$ $\frac{38}{200} \pm z \sqrt{\frac{\frac{38}{200}(1 - \frac{38}{200})}{200}}$ 0.119 to 0.261 (3 sfs)	M1 B1 M1 A1 [4]	Seen For correct form of CI Accept 0.262 Must be an interval
(iii) $z \times \sqrt{0.0007695} = 0.05$ $z = 1.802$ $\Phi(1.802) (= 0.9642)$ $(0.9642 - (1 - 0.9642)) = 0.9284$ $x = 93$ (2 sfs)	M1 A1 M1 A1 [4]	$z \times (\text{their sd of } p) = 0.05$. Allow = 0.1 Attempt $\Phi(\text{their } z)$ and find $2\Phi - 1$
7 (i) $\lambda = 4.8$ $E^{-4.8}(1 + 4.8 + \frac{4.8^2}{2!} + \frac{4.8^3}{3!})$ = 0.294 (3 sfs)	B1 M1 A1 [3]	P(R = 0, 1, 2 or 3), their λ allow one end error

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(ii) $e^{-\lambda} \times \frac{\lambda^4}{4!} = \frac{16}{3} e^{-\lambda} \times \frac{\lambda^2}{2!}$ or without $e^{-\lambda}$ $\frac{\lambda^2}{12} = \frac{16}{3}$ or better $(\lambda = 8)$ $\lambda = 1.6n$ seen or implied $n = '8' \div 1.6$ $= 5$	M1	$\lambda = 1.6n$ seen or implied	B1
	A1	$e^{-1.6n} \times \frac{(1.6n)^4}{4!} = \frac{16}{3} e^{-1.6n} \times \frac{(1.6n)^2}{2!}$	M1
	B1	$\frac{(1.6n)^2}{12} = \frac{16}{3}$ or better	A1
	A1 [4]	$(1.6n = 8)$ $n = 5$	A1
(iii) $T \sim N(64, 64)$ $\frac{75.5 - 64}{\sqrt{64}}$ (= 1.4375) $1 - \Phi('1.4375')$ (= 1 - 0.9247) $= 0.0753$ to 0.0754	B1	May be implied	
	M1	Allow with wrong or no cc. No sd/var mixes	
	M1	Finding correct area consistent with their working	
	A1 [4]		

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	= 2.55(2) Comp $z = 2.054$ or 2.055 Evidence that Hiergro has incr hts	A1 M1 A1ft [5]	For correct z or area or x_{crit} Valid comparison (z values/areas/ x values) Correct conclusion No contradictions (Note 2 tail test can score B0 M1 A1 M1 ($z = 2.326$) A1ft)
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	A1	$e^{-1.6n} \times \frac{(1.6n)^4}{4!} = \frac{16}{3} e^{-1.6n} \times \frac{(1.6n)^2}{2!}$	M1
	B1	$\frac{(1.6n)^2}{12} = \frac{16}{3}$ or better	A1
	A1 [4]	$(1.6n = 8)$ $n = 5$	A1
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Total			[3]	
2 (i)	μ $\frac{\sigma^2}{n}$	B1 B1	[2]	(as an expression) (as an expression) SC If B0B0 scored, $N(\mu, \frac{\sigma^2}{n})$ scores B1
(ii)	$\frac{176-177.8}{6.1}$ (= -1.022) $\frac{1}{\sqrt{12}}$ $\Phi(-1.022) = 1 - \Phi(1.022)$ = 0.153 (3 sfs)	M1 M1 A1	[3]	Standardise with $\sqrt{12}$ Accept 'totals' method. No mixed methods. (2112 – 2133.6) / $\sqrt{(6.1^2 \times 12)}$ Correct area (consistent with working)
(iii)	No; X norm distr'd or pop norm distr'd Or hts norm distr'd Or original dist normal	B1	[1]	Need 'No' stated or implied AND correct reason NB 'No, because small sample' scores B0 NB 'it is normally distr'd' scores B0
Total			[6]	
3 (i)	$\left(\frac{5}{6}\right)^{25} + 25\left(\frac{5}{6}\right)^{24}\left(\frac{1}{6}\right)$ = 0.0629 final answer Sig level = 6.29%	M1 A1 B1ft	[3]	Allow end errors, but just P(2) implies M0 Accept p/q mix ft their $P(X \leq 1)$ with Binomial used. Allow 6.3% or 6%
(ii)	Var (p) $\approx \frac{0.09 \times 0.91}{100}$ (= 0.000819) $z = 1.96$ $0.09 \pm z\sqrt{\frac{0.09 \times 0.91}{100}}$ = 0.034 to 0.146 (3 dps)	M1 B1 M1 A1	[4]	For pq /100 seen (any p/q) (must be probs) For correct form of C.I. (any p/q) (must be probs)
Total			[7]	

Page 5	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – October/November 2012	9709	73

4	Use of $X_1 - 2X_2$ or similar $E(X_1 - 2X_2) = 180 - 360 (= -180)$ $\text{Var}(X_1 - 2X_2) = 5 \times 1550$ or 7750 $\frac{0 - (-180)}{\sqrt{7750}}$ or $\frac{0 - 180}{\sqrt{7750}}$ $(= \pm 2.045)$ $1 - \Phi(2.045)$ $= 0.0205$ or 0.0204 Ans 0.041 (2 sf)	B1 M1 A1 M1 M1 A1 B1ft	[7]	Or use of $\frac{1}{2} X_1 - X_2$ $E(2X_1 - X_2) = 360 - 180 (= 180)$ Or $E(\frac{1}{2} X_1 - X_2) = 90 - 180 = (-90)$ for $1550 + 4 \times 1550$ or $\frac{1}{4} \times 1550 + 1550$ 7750 or 1937.5 Allow incorrect var (dep > 0 & $\neq 1550$), no $\sqrt{}$ Standardising – no mixed methods Or $\pm (0 - -90) / \sqrt{1937.5}$ For finding correct area (consistent with working) Allow double their prob
Total			[7]	
5 (i)	Est(μ) = 2.3 Est(σ^2) = $\frac{200}{199} \left(\frac{1636}{200} - \left(\frac{460}{200} \right)^2 \right)$ = 2.90 (3 sf) or 2.91 or 578/199	B1 M1 A1	[3]	Allow $\sqrt{\frac{200}{199} \left(\frac{1636}{200} - \left(\frac{460}{200} \right)^2 \right)}$ or 1.7043 for M1 Or $1/199 (1636 - 460^2/200)$
(ii)	H_0: Pop mean wt loss = 2 kg H_1: Pop mean wt loss > 2 kg $\frac{2.3 - 2}{\sqrt{\frac{2.9045}{200}}}$ = 2.489 or ± 2.49 or 0.0064 / 0.9936 for area comparison or $x_{\text{crit}} = 2.28(03)$ comp $z = 2.326$ Evidence that mean wt loss > 2 kg	B1 M1 A1 M1 A1ft	[5]	Allow 'μ' but not just 'mean' $\frac{2.3 - 2}{\sqrt{\frac{1.7043}{200}}}$ Stand'ise with $\sqrt{200}$. Accept sd/var mixes Or $x_{\text{crit}} = 2 + 2.326\sqrt{(2.9045/200)}$ For valid comparison (z or area or x_{crit}) No contradictions Reject H_0 / accept H_1 only if H_0 / H_1 correctly defined If $\frac{200}{199}$ not used in (i): var = 2.89, sd = 1.7, cr $z = 2.496$ can score all marks
Total			[8]	

Page 6	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – October/November 2012	9709	73

6 (i)	$f(x) \geq 0$ for all x defined	B1		
	$\int_0^a \frac{2}{a^2} x dx$	M1		Attempt $\int f(x) dx$ with limits 0, a . Must be a .
	$\left(= \left[\frac{2x^2}{2a^2} \right]_0^a \right)$	A1		Or equivalent methods (e.g. by areas)
	$= 1$		[3]	
(ii)	$\int_0^a \frac{2}{a^2} x^2 dx (= 8)$	M1		Attempt $\int x f(x) dx$, ignore limits
	$\frac{2}{a^2} \left[\frac{x^3}{3} \right]_0^a (= 8)$	A1		Correct integrand and limits
	$\left(\frac{2a}{3} = 8 \right)$	A1		
	$a = 12$		[3]	
(iii)	$1 - \int_0^6 \frac{2}{144} x dx$ or $\int_6^{12} \frac{2}{144} x dx$	M1		Correct expr'n incl limits; ft their ' a '
	$= 1 - 1 - \frac{1}{72} \left[\frac{x^2}{2} \right]_0^6$ or	A1 ft		Correct integrand and limits; ft their ' a '
	$\frac{1}{72} \left[\frac{x^2}{2} \right]_6^{12}$			
	$= \frac{3}{4}$	A1 ft	[3]	ft their ' a ', dep $0 < \text{ans} < 1$
Total			[9]	

Page 7	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – October/November 2012	9709	73

7 (i)	$n > 50$	B1		Accept n large
	$np = 0.8$, which is < 5	B1	[2]	Accept p small
(ii)	$\lambda = 9.6$	B1		
	$e^{-9.6} \left(\frac{9.6^3}{3!} + \frac{9.6^4}{4!} + \frac{9.6^5}{5!} \right)$	M1		Any λ Accept end errors.
	$= 0.0800$ (3 sfs)	A1	[3]	Allow 0.08
(iii)	H_0 : Pop mean for 10 days = 8 H_1 : Pop mean for 10 days < 8	B1		or Pop mean for 1 day = 0.8 Pop mean for 1 day < 0.8 Allow λ or μ but not just 'mean'
	$e^{-8} \left(1 + 8 + \frac{8^2}{2!} \right)$	M1		Any λ . Accept end errors. NB P(2) only used scores M0M0
	$= 0.0138$ or 0.0137	A1		Accept CR method CR = 0, 1, 2 all working must be shown
	Compare 0.02 Evidence that mean number of absentees has decreased	M1 A1ft		Valid comparison with 0.02 or CR No contradictions Reject H_0 / accept H_1 only if H_0 / H_1 correctly defined
			[5]	
Total			[10]	
	Total for paper		[50]	