

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Level

MARK SCHEME for the May/June 2015 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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	Cambridge International A Level – May/June 2015	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.

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- 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.
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Note: “(3 sfs)” means “answer which rounds to ... to 3 sfs”. If correct ans seen to ≥ 3 sfs, ISW for later rounding. Penalise < 3 sfs only once in paper.

1	$\frac{1}{2}a^2 = 1$	M1	or $\int_0^a x dx = 1$
	$a = \sqrt{2}$	A1	Allow 1.41 or better
	$\int_0^{\sqrt{2}} x^2 dx$	M1	ignore limits
	$= \left[\frac{x^3}{3} \right]_0^{\sqrt{2}}$	A1f	correct integral and limits, but ft their a
	$= \frac{(\sqrt{2})^3}{3} = \text{or } \frac{2^{1.5}}{3} \text{ or } \frac{2.83}{3} \text{ or } 0.9428$ (= 0.943 AG)	A1 [5]	must see this numerical expression, or equiv SR Equating $\int x f(x)$ to 0.943 scores M1 Solving to find $a = 1.41$ scores A1
		[Total 5]	
2 (i)	$H_0: p = 0.2$ or $\mu = 10$	B1 [1]	
	$H_1: p > 0.2$ or $\mu > 10$	B1	
		M1	or $N\left(0.2, \frac{0.2 \times 0.8}{50}\right)$
		A1	For standardising allow with no or wrong cc
		M1f	
(ii)	$N(10, 8)$ seen or implied		
	$\frac{125 - 10}{\sqrt{8}}$ or $\frac{\frac{125}{50} - 0.2}{\sqrt{\frac{0.2 \times 0.8}{50}}}$		
	= 0.884		
	comp 1.282		
	Claim not justified or No evidence to support claim	A1f [5]	Allow area comparison with 0.188 or comp 1.645 if $H_1 p \neq 0.2$ Allow accept H_0 provided correctly defined. Follow through their test statistic ;dep 1–tail test No Contradictions SR; Use of $B(50, 0.2)$ scores B1 provided at least two probabilities calculated. M1 For finding $P(X \geq 13)$ allow one end error. A1 for 0.186
		[Total: 6]	

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3	(i)	34 $2.2^2 + 1.3^2 + 2.6^2 (=13.29)$	B1 B1 [2]	Accept 13.3 or 3.65^2 Allow at early stage
	(ii)	$\frac{33-34'}{\sqrt{\frac{13.29'}{70}}}$ (= -2.295) $\frac{35-34'}{\sqrt{\frac{13.29'}{70}}}$ (= 2.295) $\Phi(2.295) - \Phi(-2.295)$ $= \Phi(2.295) - (1 - \Phi(2.295))$ oe $= 0.978$ (3 sf)	M1 M1 M1 A1 [4]	correct standardisation method for either For attempt to use tables to find the probability between two z values ,may be implied by next line For a correct method to find the area between their two z values
			[Total: 6]	
4	(i)	H_0 : pop mean (or μ) = 12.4 H_1 : pop mean (or μ) > 12.4 $\frac{12.9 - 12.4}{2.1 + \sqrt{50}}$ 1.684 comp cv $z = 1.96$ No evidence that pop mean time has increased	B1 M1 A1 B1f [4]	not just “mean” Allow with 50 instead of $\sqrt{50}$ or $P(z > 1.684) = 0.0461 > 0.025$ Allow accept H_0 if correctly defined. Ft their test statistic. No contradictions
	(ii)	Not reject (or accept) that mean time is unchanged (or is 12.4) oe although mean time has increased (or is more than 12.4) oe	B1 B1 [2]	
	(iii)	True (or new) mean	B1 [1]	
			[Total: 7]	

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5	(i)	$4200/80 (=52.5)$ $= \frac{80}{79} \left(\frac{229\,000}{80} - '52.5'^2 \right) (= 107.595)$ $= 108 \text{ (3 sf)}$	B1 M1 A1 [3]	
	(ii)	$'52.5' \pm z \sqrt{\frac{'107.595'}{80}}$ $z = 2.326$ $49.8 \text{ to } 55.2$	M1 B1 A1f [3]	Correct form – must be z-value – allow one side only Seen fit their 52.5 and 107.595. Must be an interval
	(iii)	49	B1 [1]	
			[Total: 7]	
6	(i)	$e^{-\frac{10}{3}} \times \frac{\left(\frac{10}{3}\right)^2}{2}$ $= 0.198 \text{ (3 sf)}$	M1 A1 [2]	P(2), allow any λ
	(ii)	$1 - e^{-2} \left(1 + 2 + \frac{2^2}{2} \right)$ $= 0.323 \text{ (3 sf)}$	M1 M1 A1 [3]	M1 allow any λ and/or 1 end error Correct expression, correct λ
	(iii)	$N\left(\frac{200}{3}, \frac{200}{3}\right)$ $\frac{49.5 - \frac{200}{3}}{\sqrt{\frac{200}{3}}} (= -2.102)$ $\Phi(-2.102') = 1 - \Phi(2.102')$ $= 0.0178 \text{ (3 sf)}$	M1 M1 A1 [4]	seen or implied For standardising allow <u>either</u> wrong or no cc No sd/var mix For finding area consistent with their working
			[Total: 9]	

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7	(i)	$7E(X) + 5E(Y) - 2$ $(= 7 \times 8 + 5 \times 3) - 2$ $= 69$	M1 A1 [2]	allow incorrect means
	(ii)	$\text{Var}(X) = 1.6, \text{Var}(Y) = 3$ $16\text{Var}(X) + 9\text{Var}(Y)$ $(= 16 \times 1.6 + 9 \times 3)$ $= 52.6$	B1 M1 M1 A1 [4]	both M1 for mult by 16 and 9; allow with '+ 3' M1 for add without '+ 3'; allow incorrect multipliers
	(iii)	$X = 10, Y = 2 \text{ and } X = 9, Y = 0$ $0.8^{10} \times e^{-3} \times \frac{3^2}{2} \text{ or } 10 \times 0.8^9 \times 0.2 \times e^{-3}$	B1 M1 M1	both pairs seen or implied or 0.0241 or 0.0134 (3sf) one correct product
		$0.8^{10} \times e^{-3} \times \frac{3^2}{2} + 10 \times 0.8^9 \times 0.2 \times e^{-3}$ $= 0.0374/5$	A1 [4]	all correct
			[Total: 10]	

[Total for paper 50]

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1	$\text{Var} = 16 \times 9 + 25 \times 36 \quad (= 1044)$ $\text{sd} = 32.3 \text{ or } 6\sqrt{29} \text{ or } \sqrt{1044}$	B1 M1 A1	M1 for 16 (or 4^2) & 25 (or 5^2) used M1 for add any multiples of 9 and 36 only
	Total	3	
2 (i)	$H_0: \lambda = 0.5$ $H_1: \lambda > 0.5$	B1 1	or Pop mean = 0.5, not just Mean = 0.5 or Pop mean (per m^2) = 0.1 Accept μ instead of λ
(ii)	$1 - e^{-0.5}(1 + 0.5)$ $= 0.0902 \text{ (3 sf)}$ comp 0.1 Claim justified or there is evidence to support claim	M1 A1 M1 A1 ^{1/2} 4	$1 - P(X = 0, 1)$ attempted, any λ . Allow 1 end error Allow 0.09 Valid comparison NB $0.9098 > 0.9$ recovers M1A1 M1 oe Accept 'Reject H_0 ' if correctly defined No contradictions.
	Total	5	
3	$\lambda = 5 \times 0.15 \quad (= 0.75)$ $E(\text{amount}) = 200 \times 0.75 = 150$ $\text{Var}(\text{weekly no of hole-in-ones}) = 0.75$ $\text{Var}(\text{amount}) = 200^2 \times 0.75$ $= 30,000$	M1 A1 B1 ^{1/2} M1 A1 5	Allow $200^2 \times$ their variance (with nothing added/subtracted at any stage) (SR probability table can score M1A0 srB1 if var rounds to 30,000 (2sf))
	Total	5	
4 (i)	Conclude flight times affected when in fact they have not been.	B1 B1 2	Or accept pop mean changed from 6.2 although pop mean has not changed from 6.2
(ii)	$H_0: \text{Pop mean (or } \mu) = 6.2$ $H_0: \text{Pop mean (or } \mu) \neq 6.2$ $\frac{5.98 - 6.2}{0.8}$ $\frac{0.8}{\sqrt{40}}$ $= -1.739 \text{ (}\pm\text{) Accept (}\pm\text{)1.74}$ comp $z = 1.96$ No evidence that flight times affected	B1 M1 A1 B1 ^{1/2} 4	Allow with 40 instead of $\sqrt{40}$ Allow SD/Var mix (CV method 5.952 or 6.2279 M1 A1) For valid comparison or $P(z < -1.739) = 0.041 > 0.025$ or $5.98 > 5.952$ or $6.2 < 6.228$ and correct conclusion
(iii)	H_0 was not rejected oe Type II	B1* B1*dep 2	If in (ii) H_0 was rejected, then: H_0 rejected B1; Type I B1dep
	Total	8	

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5	(i)	$\frac{14800}{50} \text{ or } 296$ $\frac{50}{49} \left(\frac{4390000}{50} - '296'^2 \right) (= 187.755)$ $= 188 \text{ (3 sf)}$	B1 M1 A1 3	Oe
	(ii)	$2 \times z \times \sqrt{\frac{'187.755'}{50}} = 5.45 \text{ oe}$ $z = 1.406 \text{ or } 1.405$ $\Phi('1.406') (= 0.92 \text{ or } 0.9199)$ $\alpha = 84 \text{ (2 sf)} \quad \text{allow } 83.98$	M1 A1 M1 A1 4	If '2 ×' omitted: $z \times \sqrt{\frac{'187.755'}{50}} = 5.45$ M1 $z = 2.812 \text{ or } 2.810$ A0 $\Phi('2.812') (= 0.9975)$ $\alpha = 99.5 \text{ or } 99 \text{ or } 100$ M1 A0 For complete method to find α SR use of biased var(184) scores M1A1(1.4205) A=84.5 M1A1
	(iii)	0.96^4 $= 0.849 \text{ (3 sf)}$	M1 A1 2	
	Total		9	
6	(i)	$k \int_0^{15} (225 - t^2) dt = 1$ $k \left[225t - \frac{t^3}{3} \right]_0^{15} = 1$ $k \times [3375 - 1125] = 1 \text{ or } k \times 2250 = 1$ $(k = \frac{1}{2250} \text{ AG})$	M1 A1 A1 3	Attempt integ $f(x)$ and = 1. Ignore limits Correct integration and limits No errors seen
	(ii)	$\frac{1}{2250} \int_0^{15} (225 - t^2) dt$ $= \frac{1}{2250} \left[225t - \frac{t^3}{3} \right]_0^{15}$ $= \frac{1}{2250} [2250 - (2250 - \frac{1000}{3})]$ $= \frac{4}{27} \text{ or } 0.148 \text{ (3 sf)}$	M1 A1 A1 3	Attempt integ, ignore limits Or $1 - \int_0^{10}$ Correct integration and limits. Condone missing k
	(iii)	$\frac{1}{2250} \int_0^{15} (225t - t^3) dt$ $= \frac{1}{2250} \left[\frac{225t^2}{2} - \frac{t^4}{4} \right]_0^{15}$ $= \frac{1}{2250} \left[\frac{50625}{2} - \frac{50625}{4} \right]$ $= \frac{45}{8} \text{ or } 5.625 \text{ or } 5.63 \text{ (3 sf)}$	M1* A1 M1*dep A1 4	Attempt integ $xf(x)$, ignore limits Correct integration and limits. Condone missing k Sub correct limits into their integral Accept 5 mins 37 or 38 secs
	Total		10	

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7	(i)	Poisson (Actually binomial with) $n > 50$ and np (or λ) ($= 2.1$) which is < 5	B1 B1 B1	3	Allow without “binomial” Accept n large Accept p small ($p < 0.1$)
	(ii)	$\lambda = 2.1$ $e^{-2.1} \left(1 + 2.1 + \frac{2.1^2}{2} + \frac{2.1^3}{3!} \right)$ $= 0.839$ (3 sf)	B1 M1 A1	3	Attempt $P(0,1,2,3)$ any λ allow 1 end error SR ₁ Ft Normal $N(2.1, 2.1)$ B1 standardising M1 0.833 A1 SR ₂ Ft Binomial $B(10500, 0.0002)$ B1 calculating binomial prob $P(0,1,2,3)$ M1 = 0.8386 A1
	(iii)	$P(X \geq 1) = 1 - e^{-2.1}$ ($= 0.87754$) $P(X = 1, 2, 3) = e^{-2.1} \left(2.1 + \frac{2.1^2}{2} + \frac{2.1^3}{3!} \right)$ ($= 0.71619$) $\frac{P(X = 1, 2, 3)}{P(X > 1)}$ ($= \frac{0.71619}{0.87754}$) $= 0.816$ (3 sf)	M1 M1 M1 A1	4	Any λ Or ‘0.839’ – $e^{-2.1}$ Any λ Allow any attempted $\frac{P(X = 1, 2, 3)}{P(X > 1)}$ Any λ SR ₁ Ft Normal $P(>0.5) = 0.86523$ M1 $P(1, 2, 3) = 0.698$ M1 $0.698/0.86523 = 0.807$ M1 A1 SR ₂ FT Binomial M1 M1 M1 A1
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	(ii)	2–digits ignore > 82 (anything too big) Ignore repeats	B1 B1 B1 [3]	
			[Total 5]	
2	(i)	$H_0: P(\text{correct}) = \frac{1}{8}$ $H_1: P(\text{correct}) > \frac{1}{8}$	B1 [1]	Or $H_0 p = 1/8$ $H_1 p > 1/8$
	(ii)	$1 - \left(\left(\frac{1}{8} \right)^{10} + 10 \left(\frac{1}{8} \right)^9 \left(\frac{7}{8} \right) + {}^{10}C_2 \left(\frac{1}{8} \right)^8 \left(\frac{7}{8} \right)^2 \right)$ $= 0.120 \text{ (3 sf) or } 0.119$	M1 A1 A1 [3]	M1 for attempt at correct expression accept 1 error only, e.g. 1 term extra, omitted or wrong, or omit “1–” or incorrect p/q Correct expression Note Use of Poisson in (ii) could score M1 only for expression $1 - P(0,1,2) \lambda = 1.25$
	(iii)	12%	B1f [1]	fit their (ii) Must be a probability
			Total 5	
3	(i)	$\text{Var}(p_s) = \frac{0.22 \times (1 - 0.22)}{100}$ $\left(= \frac{429}{250\,000} \text{ or } 0.001716 \right)$ $0.22 \pm z \sqrt{\frac{429}{250\,000}}$ $z = 2.17 \text{ or } 2.168/9 \text{ or } 2.171$ $0.13(0) \text{ to } 0.31(0) \text{ (2 sf)}$	M1 M1 B1 A1 [4]	pq/100 Expression of correct form with their variance Any z (must be a z value) accept one side only Seen Must be an interval
	(ii)	$'2' \times (1 - 0.97) \times 0.97$ $= 0.0582$	M1 A1 [2]	
			Total 6	

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4	(i)	$\left(\frac{1508}{50}\right) = 30.16 \text{ (30.2)}$ $\frac{50}{49} \left(\frac{51\,825}{50} - (30.16^2) \right)$ $= 129 \text{ (3 sf) Or } 130$	B1 M1 A1 [3]	Allow any form (129.46367)
	(ii)	$(1.5 \times '30.16' + 10)$ $= 55.24$ $(1.5^2 \times '129....')$ $= 291 \text{ (3 sf)}$	B1ft M1 A1ft [3]	ft their 30.16 1.5 ² × their(129) with nothing added at any stage Allow 290
			Total 6	
5	(i)	Cables broken or not all cables can be accessed oe or Too many cables oe or too time consuming oe	B1 [1]	e.g. previous days' stocks may have gone
	(ii)	$H_0: \text{Pop mean brk str (or } \mu) = 5$ $H_1: \text{Pop mean brk str (or } \mu) < 5$ $(\pm) \frac{4.95 - 5}{\frac{0.15}{\sqrt{60}}}$ $(= \pm 2.582)$ comp ±2.326 There is evidence that mean breaking strength is less than it should be Or reject H ₀ (H ₀ correctly defined)	B1 M1 A1 B1 ft [4]	Not just “mean” Allow 60 instead of √60 Ft their –2.582 (No ft 2 tailed test) Correct comparison shown, no errors seen. Accept area comparison 0.0049 with 0.01 [CR method $(x - 5)/(0.15/\sqrt{60})$ = –2.326 M1 A1 leading to $x = 4.955$ compared to 4.95 and correct conclusion B1ft OR $((x - 4.95)/0.15/\sqrt{60})$ leading to 4.995 M1 A1 compared to 5 and correct conclusion B1ft]
	(iii)	Population not necessarily normal so yes	B1 B1dep [2]	SR B1 For “it” is not necc normal (no mention of population) AND Yes
			Total 7	

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6	(i)	$e^{-3.5} \times \frac{3.5^3}{3!}$ $= 0.216 \text{ (3 sf)}$	M1 A1 [2]	P(X = 3) any λ
	(ii)	N(42, 42) stated or implied $\frac{29.5 - 42}{\sqrt{42}} \quad (= -1.929)$ $P(z > '-1.929') = \Phi('1.929')$ $= 0.973 \text{ (3 sf)}$	B1 M1 M1 A1 [4]	Allow with wrong or no cc <u>OR</u> without $\sqrt{}$ For correct area consistent with their working
	(iii)	$(\lambda) = 2.4$ $1 - e^{-2.4} \left(1 + 2.4 + \frac{2.4^2}{2} + \frac{2.4^3}{3!} \right)$ $= 0.221 \text{ (3 sf)}$	B1 M1 M1 A1 4	for $1 - P(X \leq 3)$, any λ allow one end error Correct expression any λ NB For combination method B1 attempting 10 combinations with $\lambda=1$, $\lambda=1.4$ M1 6 expressions M1 10 expressions 0.221 A1
			Total 10	
7	(i)	$\frac{3}{4} \int_0^c (cx - x^2) dx = 1$ $\frac{3}{4} \left[\frac{cx^2}{2} - \frac{x^3}{3} \right]_0^c = 1$ $\frac{3}{4} \left(\frac{c^3}{2} - \frac{c^3}{3} \right) = 1 \text{ or } \frac{3}{4} \times \frac{c^3}{6} = 1 \text{ or } \frac{c^3}{8} = 1$ $(c = 2 \text{ AG})$	M1 A1 A1 [3]	Attempt integ f(x) and = 1. Ignore limits Correct integration and limits (condone c = 2) No errors seen
	(ii)	Inverted parabola Through (0, 0) and (2, 0) and zero elsewhere Median = 1	B1 B1 B1 [3]	Must not extend beyond [0,2]
	(iii)	$\frac{3}{4} \int_0^{1.5} (2x - x^2) dx$ $= \frac{3}{4} \left[x^2 - \frac{x^3}{3} \right]_0^{1.5}$ $\frac{3}{4} \left(1.5^2 - \frac{1.5^3}{3} \right)$ $= \frac{27}{32} \text{ or } 0.844 \text{ (3 sf)}$	M1 A1 B1 A1 [4]	Attempt integ f(x) ignore limits Correct integration ignore limits Use of correct limits [0,1.5] or 1-[1.5,2]

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(iv)	$\left(\frac{27}{32} - \frac{1}{2} \text{ or } 0.844 - 0.5 \right)$ $= \frac{11}{32} \text{ or } 0.344 \text{ (3 sf)}$	B1f [1]	ft their (iii) For use of symmetry Note If do not use “hence” and start again B1 for cwo
		Total 11	

Total for paper 50