

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Level

MARK SCHEME for the October/November 2014 series

9709 MATHEMATICS

9709/71

Paper 7, maximum raw mark 50

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	Cambridge International A Level – October/November 2014	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.
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B2/1/0 means that the candidate can earn anything from 0 to 2.

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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.
PA –1	This is deducted from A or B marks in the case of premature approximation. The PA –1 penalty is usually discussed at the meeting.

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1	$N(-35, 60^2 + 4 \times 28^2)$ $N(35, 60^2 + 4 \times 28^2)$ $\frac{0 - (-35)}{\sqrt{6736}} (= 0.426)$ $\frac{0 - 35}{\sqrt{6736}} (= -0.426)$	B1 B1 M1	for $\pm(175 - 2 \times 105)$ or ± 35 for $60^2 + 4 \times 28^2$ or 6736 For standardising with their mean and variance. Allow without $\sqrt{}$ For use of tables and finding area consistent with working
	$1 - \Phi("0.426")$ $= 0.335$ (3 sf)	M1 A1 5	
		Total: 5	
2 (i)	(Bin) with $n > 50$ and mean (or np) < 5 Po(1.5) $1 - e^{-1.5}$ $= 0.777$ (3 sf)	B1 B1 M1 A1 4	Accept n 'large', p 'small' Poisson with correct mean stated or implied Poisson $1 - P(X = 0)$; allow incorrect λ ; allow 1 end error SR If zero scored use of Bin leading to 0.778 / 0.779 scores B1
(ii)	3.5 $e^{-3.5} \left(\frac{3.5^4}{4!} + \frac{3.5^5}{5!} + \frac{3.5^6}{6!} \right)$ $= 0.398$ (3 sf)	B1 M1 A1 3	Correct mean stated or implied Poisson $P(X = 4, 5, 6)$; allow incorrect λ ; allow 1 end error
		Total: 7	
3 (a)	$\int_0^{0.5} (1.5t - 0.75t^2) dt$ o.e. $= [0.75t^2 - 0.25t^3]_0^{0.5}$ o.e. $= \frac{5}{32}$ or 0.156 (3 sf)	M1 A1 A1 3	Attempt int $f(t)$ Correct integration and limits
(b) (i)	$\frac{1}{2} \pi a^2 = 1$ or $\pi a^2 = 2$ oe $a = \sqrt{\frac{2}{\pi}}$ or 0.798 (3 sf)	M1 A1 2	Attempt to find the area and equate to 1
(ii)	0	B1 1	
(iii)	Symmetry stated, seen or implied 0.8	M1 A1 2	Could be a diagram As final answer
		Total: 8	
4 (i)	$\text{Var}(P_s) = \frac{\frac{33}{150} \times \frac{150 - 33}{150}}{150}$ (= 0.001144) $z = 2.576$ $\frac{33}{150} \pm z\sqrt{0.001144}$ $= 0.133$ to 0.307 (3 sf)	M1 B1 M1 A1 4	Seen. Accept 2.574 to 2.579 Expression of correct form. Any z Must be an interval

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(ii)	$\frac{19035}{150} (= 126.9 = 127(3\text{sf}))$	B1	
	$\frac{150}{149} \left(\frac{4054716}{150} - \left(\frac{19035}{150} \right)^2 \right)$ o.e. = 11001.17 or 11000(3 sf)	M1 A1	For use of a correct formula 3
(iii)	4-digit nos. each digit 0-9 Ignore nos > 9526 Ignore repeats	B1 B1 B1	Some valid way of generating 4 digit random nos from valid method from valid method SR If zero score, full explanation of method for drawing numbers out of a hat can score B1. NB Systematic sampling follows the scheme with first B1 for some way of generating a random starting point. 3
		Total: 10	
5 (i)	$\frac{4.8}{\sqrt{40}}$	B1	or $\frac{4.8^2}{40}$. Accept $4.8\sqrt{40}$ or $4.8^2 \times 40$ for totals method
	$\frac{50.3 - 49.5}{\frac{4.8}{\sqrt{40}}} (= 1.054)$	M1	For standardising with their SD Accept $\pm$
	$1 - \Phi(1.054)$	M1	Accept totals method. No mixed methods
	= 0.146 (3 sf)	A1	For use of tables and finding area consistent with their working 4
(ii) (a)	Looking for decrease	B1	1
(b)	H_0 : Pop mean time spent (or μ) = 49.5 H_1 : Pop mean time spent (or μ) < 49.5	B1	Not just “mean time spent”
	$\frac{1920}{40} - 49.5$	M1	For standardising. Allow $\div \frac{4.8}{40}$
	$\frac{4.8}{\sqrt{40}} (= -1.976)$	M1	Accept totals method; CV method. No mixed methods
	‘1.976’ > 1.555 (or ‘-1.976’ < -1.555) There is evidence that mean time has decreased.	M1 A1	For valid comparison (area comparison 0.024 < 0.06) CWO. No contradictions in conclusions 4
(c)	Population normally distr so No	B1	1 Both needed
		Total: 10	

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6 (i)	$\lambda = 4.65$ $e^{-4.65} \times \frac{4.65^4}{4!}$ $= 0.186 \text{ (3 sf)}$	B1 M1 A1 3	Poisson $P(X = 4)$ with any λ
(ii)	$\lambda = 3.875$ $= e^{-3.875} \left(1 + 3.875 + \frac{3.875^2}{2!} \right) = 0.257 \text{ (3 sf)}$	B1 M1 A1 3	$P(X = 0, 1, 2)$ Attempted, any λ As final answer
(iii)	$\lambda = 1.5$ $1 - e^{-1.5} \left(1 + 1.5 + \frac{1.5^2}{2!} \right)$ $= 0.191 \text{ (3 sf)}$	B1 M1 A1 3	$1 - P(X = 0, 1, 2)$ Attempted, any λ As final answer
(iv)	He will reject H_0 .	B1 1	
		Total: 10	

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1	(i)	“Different” being investigated	B1	[1]	Oe (“changed”, “not equal to”)
	(ii)	H ₀ : Pop mean (or μ) in region same as elsewhere			Must be “pop mean”, not just “mean” Can be awarded in (i)
		H ₁ : Pop mean (or μ) in region diff from elsewhere	B1		oe
		1.91 < 2.054 (or 2.055) or –1.91 > –2.054	M1		or $P(z > 1.91) = 0.0281 > 0.02$ or $0.0562 > 0.04$ or $0.972 < 0.98$ Accept 2.05 if nothing better seen.
		No evidence that mean is different	A1	[3]	inequality sign incorrect M1A0 no contradictions “accept H ₀ ” provided H ₀ reasonably well defined
Total				[4]	
2	(i)	$\frac{1}{2}c^2 = 1$ $c = \sqrt{2}$ or 1.41 (3 sf)	M1 A1	[2]	Area of triangle = 1 or integral of kx with limits 0 and c and equated to 1
	(ii)	$f(x) = x$ or $y = x$	B1		Seen or implied, e.g. by next line. Can be awarded anywhere in the question. Implied by $(a + 1)$ in area of trapezium.
		$\int_a^1 x dx = 0.1$	M1		Ignore limits. Must be integral of kx and equated to 0.1. Or trapezium area.
		$\left[\frac{x^2}{2}\right]_a^1 = 0.1$	A1 $\checkmark$		Correct limits, ft incorrect kx .
		$1 - a^2 = 0.2$ $a = 0.894$ (3 sf)	A1	[4]	$\sqrt{\left(\frac{4}{5}\right)}$ oe
	(iii)	$\int_0^{\sqrt{2}} x^2 dx$ $\left[\frac{x^3}{3}\right]_0^{\sqrt{2}}$ $= \frac{2}{3}\sqrt{2}$ or 0.943 or $\sqrt{\left(\frac{8}{3}\right)}$	M1 A1 $\checkmark$	[2]	Ignore limits; ft their $f(x)$ but not $\int x dx$ ft their c , dep $0 < \text{ans} < \text{their } c$. Not ft their $f(x)$
Total				[8]	

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3	(i)	$\text{Est}(\mu) = \frac{7220}{80} \text{ or } 90.25$ $\text{Est}(\sigma^2) = \frac{80}{79} \left(\frac{656060}{80} - \left(\frac{7220}{80} \right)^2 \right)$ $= 56.3924 \text{ or } \frac{4455}{79}$ $z = 2.17$ $\frac{7220}{80} \pm z \times \sqrt{\frac{56.3924}{80}}$ $= 88.4 \text{ to } 92.1 \text{ (3 sf)}$	B1 M1 A1 B1 M1 A1	Accept 90.3 $\frac{1}{79} \left(656060 - \frac{7220^2}{80} \right)$ Accept 56.4 Expression of correct form [6] Must be an interval (N.B. biased var gives 88.4 to 92.1 scores possible B1M0A0B1M1A1)
	(ii)	Pop normal No	B1 B1dep	[2] X normal or full definition of pop normal SR B1 for “no” <u>and</u> relevant reference to normal
	Total			[8]
4	(i)	$4 \times 125 + 6 \times 130 (= 1280)$ $4 \times 30^2 + 6 \times 32^2 (= 9744)$ $(\pm) \frac{1500 - 1280}{\sqrt{9744}} (= 2.229)$ $\Phi(2.229)$ $= 0.987 \text{ (3 sf)}$	B1 B1 M1 M1 A1	Give at early stage. Could be implied by 220. (If B0B0 then 1.28 and 0.009744 can score B1B1). Standardising. Accept sd/var mix. Must be from combination attempt. Use of tables and correct area consistent with their working two [5]
	(ii)	$125 - 0.9(130) (= 8) \text{ (or } -8)$ $30^2 + 0.9^2(32^2) (= 1729.44)$ $(\pm) \frac{0 - '8'}{\sqrt{1729.44}} (= -0.192)$ $\Phi(0.192)$ $= 0.576 \text{ (3 sf)}$	B1 B1 M1 M1 A1	Give at early stage. (If B0B0 scored then accept 0.008 and 0.0017944 for B1B1) Accept sd/var mix. Must come from a linear combination. Use of tables and correct area consistent with their working (unclear M0) [5]
	Total			[10]

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5	(i) H_0 : population proportion = 0.1 oe H_1 : population proportion > 0.1 oe $P(X \geq 4) = 1 - P(X \leq 3) =$ $1 - \left(0.9^{18} + 18 \times 0.9^{17} \times 0.1 + \right.$ $\left. {}^{18}C_2 \times 0.9^{16} \times 0.1^2 + {}^{18}C_3 \times 0.9^{15} \times 0.1^3 \right)$ $= 0.0982$ (3 sf) Comp 0.08 No evidence that more reach 1m	B1 M1 A1 M1 A1 ✓ ^h		Allow “ $p = 0.1$ ” and “ $p > 0.1$ ” Allow 1 – (one term omitted or extra or wrong) (note CR method 0.0982 and $CR \geq 5$ for A1) Valid comparison ($0.9018 < 0.92$ also recovered previous A1). Or 4 is not in CR Dep M1M1 no contradictions “Accept H_0 ” provided H_0 defined
	(ii) Not rejected H_0 Type II	B1 ✓ ^h B1dep ✓ ^h	[2]	Ft their (i) If (i) “reject H_0 ” then ft gives Type I error
	(iii) $P(X \geq 5)$ (= 0.0282) $0.0282 < 0.08$ $P(\text{Type I error}) = 0.0282$ (3 sf)	M1 B1 ✓ ^h A1	[3]	Attempt $P(X \geq 5)$ e.g. ‘0.0982’ – ${}^{18}C_4 \times 0.9^{14} \times 0.1^4$ oe. Valid comp of their ≥ 5 (if CR method used, could be awarded in (i))
	Total		[10]	
6	(i) $e^{-3.84} \times \frac{3.84^4}{4!}$ $= 0.195$ (3 sf)	M1 A1	[2]	Poisson $P(X = 4)$, any λ
	(ii) 1.44 $1 - e^{-1.44} \left(1 + 1.44 + \frac{1.44^2}{2} \right)$ $= 0.176$	B1 M1 A1	[3]	Seen Any λ , allow one end error, need “1 – ...”
	(iii) $X \sim N(41, 41)$ $\frac{40.5 - 41}{\sqrt{41}} (= -0.078) \quad \frac{59.5 - 41}{\sqrt{41}} (= 2.889)$ $\Phi(2.889) - \Phi(-0.078)$ $= \Phi(2.889) - (1 - \Phi(0.078))$ $= 0.9981 - (1 - 0.5311)$ $= 0.529$ (3sf)	M1M1 M1 A1	[5]	Seen or implied M1M0 if no cc or incorrect cc OR no $\sqrt{\quad}$ in both Use of tables and correct area consistent with their working. cwo
	Total		[10]	