
MATHEMATICS

9709/71

Paper 7

October/November 2016

MARK SCHEME

Maximum Mark: 50

Published

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	Cambridge International A Level – October/November 2016	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.

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- 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.

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AG Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)

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CWO Correct Working Only – often written by a ‘fortuitous’ answer

ISW Ignore Subsequent Working

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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)

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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 $\frac{1}{2}$ ” 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	$\left(\frac{508}{8}\right) = 63.5$ $(\Sigma x^2 = 32360.12)$ $\frac{8}{7} \left(\frac{32360.12}{8} - '63.5'^2 \right)$ $= 14.6$ (3 sf) or 2553/175	B1 M1 A1	[3]	oe From correct working
2 (i)	$H_0: P(6) = \frac{1}{6} \quad H_1: P(6) < \frac{1}{6}$	B1	[1]	Allow $H_0: p = \frac{1}{6} \quad H_1: p < \frac{1}{6}$
(ii)	$\left(\frac{5}{6}\right)^{15}$ $= 0.065 > 0.05$	M1 A1	[2]	Correct result and comparison needed for A1 SR if 2 tail test followed allow A1 for $0.065 > 0.025$
(iii)	$\left(\frac{5}{6}\right)^{16} = 0.054$ and $\left(\frac{5}{6}\right)^{17} = 0.045$ Smallest n is 17 OR $\left(\frac{5}{6}\right)^n < 0.05$ and attempt to solve $n \ln\left(\frac{5}{6}\right) < \ln 0.05$ smallest n is 17	M1 A1 M1 A1	[2]	both No errors seen
3 (i)	$(\lambda) = 3.6 \div 3 = 1.2$ $1 - e^{-1.2} \left(1 + 1.2 + \frac{1.2^2}{2} + \frac{1.2^3}{3!} \right)$ $= 0.0338$ (3 sf)	B1 M1 A1	[3]	1.2 seen Allow any λ As final answer
(ii)	$N(60 \times 3.6, 60 \times 3.6)$ $\frac{240.5 - '216'}{\sqrt{216}} \quad (= 1.667)$ $1 - \Phi('1.667')$ $= 0.0478$ (3 sf)	M1 M1 M1 A1	[4]	Stated or implied Allow with no or wrong cc (no sd/var mixes) Area consistent with their working SR use of Poisson 0.0497 scores 4/4
4 (i)	6080 (litres) 106 (litres)	B1 B1	[2]	
(ii)	$E(21Y - 2X) = 635$ $\text{Var}(21Y - 2X) =$ $21^2 \times 12^2 + 2^2 \times 53^2$ $(= 74740)$ $\frac{0 - 635}{\sqrt{74740}} \quad (= -2.323)$ $1 - \Phi(' -2.323') = \Phi('2.323')$ $= 0.99(0)$ (3 sf)	B1 B1 M1 M1 A1	[5]	correct expression or result or sd = 273 seen no sd/var mixes Area consistent with their working No errors seen
5 (a)	$63 \pm z \times \frac{9}{\sqrt{100}}$ $z = 1.645$ 61.5 to 64.5 (3 sf)	M1 B1 A1	B1 [3]	Expression of correct form, any z Seen Must be an interval

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(b) (i)	$z = \frac{1.96}{2} \quad (= 0.98)$ $\Phi("0.98") \quad (= 0.8365)$ $"0.8365" - (1 - "0.8365")$ $\quad (= 0.673)$ $\alpha = 67.3 \text{ (3 sf)}$	M1 M1 A1	[3]	Allow $\frac{\text{any } z}{2}$ Allow 67 from correct working
	(ii) $4 = (2x'z'x'\sigma')/\sqrt{n}$ $n = 200$	M1 A1	[2]	Attempt to solve equ of correct form SR B1 for $n = 100$
6 (i)	m_X, m_Y, m_Z, m_W or X, Y, Z, W	B2	[2]	B1 if two adjacent means interchanged, i.e. m_Y, m_X, m_Z, m_W or m_X, m_Z, m_Y, m_W or m_X, m_Y, m_W, m_Z B1 for correct order reversed.
(ii) (a)	$\int_0^3 \frac{4}{81} x^4 dx$ $= \left[\frac{4}{81} \frac{x^5}{5} \right]_0^3$ $= \frac{4}{81} \times \frac{3^5}{5}$ or $\frac{4}{81} \times \frac{243}{5}$ or $\frac{972}{405}$ oe $= \frac{12}{5}$ or 2.4 AG	M1 A1 A1	[3]	Attempt int $xf(x)$. Ignore limits Correct integration and limits (condone missing 4/81) Must see correct expression as well as $\frac{12}{5}$ or 2.4 No errors seen
(b)	$\int_{2.4}^3 \frac{4}{81} x^3 dx$ or $1 - \int_0^{2.4} \frac{4}{81} x^3 dx$ $= \left[\frac{4}{81} \frac{x^4}{4} \right]_{2.4}^3$ or $1 - \left[\frac{4}{81} \frac{x^4}{4} \right]_0^{2.4}$ $= 1 - \frac{4}{81} \times \frac{2.4^4}{4}$ oe $= \frac{369}{625}$ or 0.59(0) (3 sf)	M1 A1 A1	[3]	Attempt int $f(x)$ ignore limits Correct integration and limits (condone missing 4/81) As final answer
(c)	1	B1	[1]	

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7	(i)	H_0 : Pop mean time (or μ) = 20.5 H_1 : Pop mean time (or μ) < 20.5 $\frac{20.3-20.5}{1.2\div\sqrt{100}}$ = -1.667 or 0.0478/0.952 if areas compared ‘1.667’ < 1.751 (or ‘-1.667’ > -1.751) No evidence that (pop) mean time has decreased	B1 M1 A1 M1 A1ft	Not just “mean” Allow without $\sqrt{}$ sign (accept $\pm 1.667/1.67$) Correct comparison of their z_{calc} with 1.751/1.75 oe valid comparison of areas (0.0478 > 0.04) No contradictions (ft their z)	[5]
	(ii)	$\frac{cv-20.5}{1.2\div\sqrt{100}} = -1.751$ cv = 20.29 or 20.3 $\frac{20.29-20.1}{1.2\div\sqrt{100}} (= 1.583 \text{ or } 1.582)$ $1 - \Phi(1.583)$ = 0.0567 – 0.0569 (3 sf)	M1* A1 DM1 M1 A1	Allow $\frac{20.3-20.1}{1.2\div\sqrt{100}} (= 1.667)$ $1 - \Phi(1.667)$ = 0.0478 (3 sf)	M1 M1 A1
	(iii)	Concluding (mean) time not decreased when in fact it has.	B1	Must be in context oe	[1]

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1	$e^{-3.5} \left(1 + 3.5 + \frac{3.5^2}{2!} \right)$ $= 0.321 \text{ (3 sf)}$	M2 A1	[3]	Allow M1 if extra term $e^{-3.5} \times \frac{3.5^3}{3!}$ or “1 - . “ or omit P(0)
2 (i)	59	B1	[1]	
(ii)	Any x such that $0.687 \leq x \leq 0.693$ (3 sf)	B1	[1]	or 0.69 or “ ... 0.686.. < 0.693 rec “
(iii)	Possible repeats	B1	[1]	
3	$N(178, \dots)$ $\text{Var} = 3.2^2 + 4.1^2 + 3.8^2$ or 41.49 $\frac{175 - 178}{\sqrt{41.49}} \div \sqrt{15} \quad (= -1.804')$ $\Phi(-1.804') = 1 - \Phi(1.804')$ $= 0.0356 \text{ (3 sf)}$	B1 B1 M1 M1 A1	[5]	stated or implied or sd = 6.44 stated or implied need $\sqrt{15}$ but allow var / sd mix for “41.49” allow cc for method marks independent M1 for area / prob consistent with working
4	$\frac{11.8 - 11}{1.6 \div \sqrt{n}} = 1.645$ $\frac{11.8 - 11}{1.6 \div \sqrt{n}} = 1.96$ $n = 10.8$ (allow 11) $n = 15.4$ (allow 15) Possible values are 11, 12, 13, 14, 15	M1 B1 B1 A1 A1	[5]	M1 for $\frac{11.8 - 11}{1.6 \div \sqrt{n}} = \text{any } z$ allow var / sd mix for 1.6 but need $\sqrt{n}$ B1 for each correct z for both not for just $11 \leq n \leq 15$ oe

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5	(i)	$H_0: P(\text{free gift}) = 0.3 \text{ or } p = 0.3$ $H_1: P(\text{free gift}) < 0.3 \text{ or } p < 0.3$	B1	[1]	
	(ii)	$P(X \leq 2) =$ $0.7^{20} + 20 \times 0.7^{19} \times 0.3 + {}^{20}C_2 \times 0.7^{18} \times 0.3^2$ $= 0.03548 \text{ or } 0.0355$ $P(X \leq 3) =$ $'0.03548' + {}^{20}C_3 \times 0.7^{17} \times 0.3^3 (= 0.107)$ One comparison with 0.05 seen $P(\text{Type I error}) = 0.0355 \text{ (3 sf)}$	M1* A1 M1* M1* DA1 $\checkmark$	[5] 	P(X ≤ 2) attempted P(X ≤ 3) attempted or implied by fully correct methods for P(X ≤ 2) and P(X ≤ 3) dep on all 3 Ms
	(iii)	$P(X \leq 3) = '0.107'$ $'0.107' > 0.05$ or cv = 2 and compare 3 > 2 No evidence to reject claim oe	M1 A1 $\checkmark$	[2] 	Compare their P(X ≤ 3) with 0.05 No evidence that 30% is not correct oe ft their 0.107
6	(i)	$\text{est}(\mu) = 3.4$ $\text{est}(\sigma^2) = \frac{100}{99} \left(\frac{1356}{100} - '3.4'^2 \right)$ $= 2.02(0202)$ $z = 1.96$ $3.4 \pm z \times \sqrt{\frac{2.020202}{100}}$ $= 3.12 \text{ to } 3.68 \text{ (3 sf)}$	B1 M1 A1 B1 M1 A1	[6] 	1 / 99 (1356 – 340 ² /100) or 200/99 correct working only allow from unbiased or biased variance
	(ii)	Mean should be 3 CI does not include 3 Machine probably not working properly	B1* DB1 $\checkmark$	[2] 	stated or implied $\checkmark$ their CI or evidence that....
7	(i)	$1 - e^{-1} (1 + 1) \quad (= 0.26424)$ $1 - e^{-1.5} (1 + 1.5 + \frac{1.5^2}{2!}) \quad (= 0.19115)$ $'0.26424' \times '0.19115'$ $= 0.0505 \text{ (3 sf)}$	B1 B1 M1 A1	[4] 	B1 for either λ correct. B1 for either correct expression with correct λ product of their values for ≤ 2 and ≤ 3 from Poisson, need correct form “1 - .. “, but allow incorrect λ values and end errors accept 0.0504

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(ii)	$\lambda = 30$ $N(30, 30)$ $\frac{35.5-30}{\sqrt{30}} \quad (= 1.004)$ $\Phi ('1.004')$ $= 0.842 \text{ (3 sf)}$	B1 B1 $\sqrt{\lambda}$ M1 M1 A1	[5]	seen or implied, need $N(\lambda, \lambda)$ allow with wrong or no cc or no $\sqrt{}$ consistent with their working
8 (i)	$\sigma_X, \sigma_Z, \sigma_Y, \sigma_W$ or X, Z, Y, W	B2	[2]	B1 if two adjacent sds interchanged, ie $\sigma_Z, \sigma_X, \sigma_Y, \sigma_W$ or $\sigma_X, \sigma_Y, \sigma_Z, \sigma_W$ or $\sigma_X, \sigma_Z, \sigma_W, \sigma_Y$ B1 for correct order reversed
(ii) (a)	Mean = 0 stated or found or “– 0” seen $\frac{1}{18} \int_{-3}^3 x^4 dx - 0$ $= \frac{1}{18} \left[\frac{x^5}{5} \right]_{-3}^3$ $= \frac{1}{18} \left[\frac{3^5}{5} + \frac{3^5}{5} \right] \text{ oe}$ $= 5.4$ sd = $\sqrt{5.4}$ or $\sqrt{\frac{1}{18} \left[\frac{3^5}{5} + \frac{3^5}{5} \right]}$ or 2.324 sd = 2.32 (3 sf) AG	B1 M1 A1	[3]	Attempt integral $\int f(x)$. Ignore limits Allow without “– 0” Must see $\sqrt{\text{correct expression}}$ or 5.4 or 2.324 or better
(b)	$\frac{1}{18} \int_{2.324}^3 x^2 dx$ $\frac{1}{18} \left[\frac{x^3}{3} \right]_{2.324}^3 = \frac{1}{18} \left[\frac{3^3}{3} - \frac{2.324^3}{3} \right]$ $= 0.268 \text{ (3 sf)}$	M1 A1 A1	[3]	Attempt to integrate $f(x)$, ignore limits Sub correct limits into correct integral Allow 0.269
(c)	0	B1	[1]	