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Cambridge International Advanced Level

MARK SCHEME for the October/November 2015 series

9709 MATHEMATICS

9709/73 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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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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.

- For a numerical answer, allow the A or B mark if a value is obtained which is correct to 3 s.f., or which would be correct to 3 s.f. if rounded (1 d.p. in the case of an angle). As stated above, an A or B mark is not given if a correct numerical answer arises fortuitously from incorrect working. For Mechanics questions, allow A or B marks for correct answers which arise from taking g equal to 9.8 or 9.81 instead of 10.

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The following abbreviations may be used in a mark scheme or used on the scripts:

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 (i)	N(352, …) Variance = 2.9	**B1** **B1**	[2]	no recovery in (ii) for each B mark accept sd = $\sqrt{2.9}$ = 1.70(29) stated
(ii)	$\frac{354-352}{\sqrt{2.9}}$ (= 1.174) 1 – Φ('1.174') = 0.120 (3 sf)	**M1** **M1** **A1**	[3]	with their mean and var Or $\frac{354.05-352}{\sqrt{2.9}}$ or correct restart (= 1.204) (accept sd/var mix)1 – Φ('1.204') = 0.114 (3 sf) Incorrect cc can score M1M1A0
Total			**[5]**	
2	($\Phi^{-1}(0.99)$ =) 2.326 seen N(λ, λ) seen or implied $\frac{55.5-\lambda}{\sqrt{\lambda}}$ = + "2.326" λ + "2.326" $\sqrt{\lambda}$ – 55.5 = 0 $\sqrt{\lambda} = \frac{-\text{"2.326"} \pm \sqrt{\text{"2.326"}^2 + 4\times 55.5}}{2}$ (= 6.377.. or – 8.703..)) λ = 40.7 (3 sf)	**B1** **M1** **M1** **M1** **A1**	[5]	must be Φ^{-1}, not Φ allow with wrong or no cc & Φ(0.99) (= 0.8389) must = " z " or attempt at z (0.99 / 0.01 M0) for correct method of solving their quad in √λ and squaring to find λ cao, one ans only Without cc, λ = 40.2: lose final A1
Total			**[5]**	
3 (i)	0.4 or 2/5 or 26/65	**B1**	[1]	no recovery in (ii) for the B mark
(ii)	" 0.4 " + $z \times \sqrt{\frac{0.4\times 0.6}{65}}$ = 0.516 oe $z = \left(0.116 \times \sqrt{\frac{65}{0.4\times 0.6}}\right)$ = 1.909 (Φ('1.909') = 0.97(18)) 2 ('0.97' – 1) α = 94	**M1** **A1** **M1** **A1**	[4]	or " 0.4 " – $z \times \sqrt{\frac{0.4\times 0.6}{65}}$ = 0.284 or $z \times \sqrt{\frac{0.4\times 0.6}{65}}$ = 0.116 oe for fully correct method to find α from their z allow 94.36 or 94.4 or 94.374
Total			**[5]**	

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4 **(i)**	$k\int_{-2}^{2}(4-x^2)\mathrm{d}x = 1$	**M1**		attempt Integral f(x) = 1, ignore limits
	$k[4x - \frac{x^3}{3}]_{-2}^{2} = 1$	**A1**		correct integration & limits
	$\left(k\left(8-\frac{8}{3}-\left(-8-\left(-\frac{8}{3}\right)\right)=1\right)\right)$			
	$k \times \frac{32}{3} = 1$ oe Not e.g. $k \times 10.7 = k$			
	$k = \frac{3}{32}$ **AG**	**A1**	[3]	exact answer correctly found
(ii)	Inverted parabola, vertex on y axis	**B1**		parabola must finish on x axis at ± 2, labelled (ignore markings on y axis)
	E(X) = 0	**B1**	[2]	
(iii)	$\frac{3}{32}\int_{-2}^{1}(4-x^2)\mathrm{d}x$	**M1**		or $1 - \frac{3}{32}\int_{1}^{2}(4-x^2)\mathrm{d}x$ ignore limits
	$\frac{3}{32}[4x - \frac{x^3}{3}]_{-2}^{1}$	**A1**		or $1 - \frac{3}{32}[4x - \frac{x^3}{3}]_{1}^{2}$
	$\frac{3}{32}(4 - \frac{1}{3} - (-8 - (-\frac{8}{3}))$			correct integration and correct limits
				$= 1 - \frac{3}{32}(8 - \frac{8}{3} - (4 - \frac{1}{3})$
	$= \frac{27}{32}$ or 0.844 (3 sf)	**A1**	[3]	
Total			**[8]**	

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5 **(a)**	$\lambda = 4.5$ $e^{-4.5}$ (= 0.011109) $\left(\frac{99}{100}\right)^{450}$ (= 0.010860) $\left(\frac{'0.011109' - '0.010860'}{'0.010860} \times 100\right)$ = 2.29% (3 sf)	**B1** **M1** **M1** **A1**	[4]	alone allow any λ
(b)	H_0: $P(6) = \frac{1}{6}$ or $p = \frac{1}{6}$ H_1: $P(6) < \frac{1}{6}$ or $p < \frac{1}{6}$	**B1**		Both needed
	$\left(\frac{5}{6}\right)^{25} + 25\left(\frac{5}{6}\right)^{24} \times \frac{1}{6} + {}^{25}C_2\left(\frac{5}{6}\right)^{23} \times \left(\frac{1}{6}\right)^2$	**M1**		allow one error (extra term / missing term / incorrect term) CR method: attempt at least P(0) and P(0 and 1) (0.010... and 0.06... < 0.1)
	= 0.189 (3 sf)	**A1**		CR is 0,1 and must see 0.189 for A1
	comp 0.1	**M1**		valid comp '0.189' with 0.1 oe valid comparison of 2 with CR
	No reason to believe die biased	**A1**	[5]	correct conclusion, √ their 0.189 no contradictions
Total			**[9]**	
6 **(i)**	Ho: $\mu = 2.60$ H_1: $\mu > 2.60$	**B1**		allow pop mean, not just 'mean'
	$\pm \frac{2.64 - 2.6}{0.2 \div \sqrt{75}}$	**M1**		
	= ± 1.732	**A1**		accept ± 1.73 (3 sf)
	'1.732' > 1.645 Reject Ho. There is evidence that μ has increased	**B1** √	[4]	valid comparison with 1.645 (or 0.0416 < 0.05) and correct conclusion √ their 1.732 no contradictions (or CV method x_{crit} = 2.638 M1A1 comp 2.64 > 2.638 and concln B1 √)
				SR two tail test, using 1.96 (or using 0.025) can score B0M1A1B1ft max 3/4

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(ii)	$\frac{x-2.6}{0.2\div\sqrt{75}} = 1.645$ $(x = 2.638)$	**M1**		
	$\pm\frac{'2.638'-2.68}{0.2\div\sqrt{75}}$	**M1**		for standardising with their " 2.638 " using 2.68
	$= \pm 1.819$	**A1**		accept 1.82 (3 sf)
	$\Phi('-1.819') = 1 - \Phi('1.819')$	**M1**		indep M mark, calculate correct area / prob consistent with their working
	$= 0.0345$ or 0.0344	**A1**	[5]	
Total			**[9]**	
7 (i)	est $\mu = 2.087$	**B1**		allow 2.09
	est $\sigma^2 = \frac{100}{99}\left(\frac{435.57}{100} - 2.087^2\right)$	**M1**		1 / 99 (435.57 – 208.7^2 / 100)
	$= 0.000132(3232)$ or $131/990000$	**A1**	[3]	without $\frac{100}{99}$: 0.000131 M0A0
(ii)	$E(Y - X) = 2.12 - 2.087$ (= 0.033)	**B1**		or 2.12 – 2.087 – 0.01 for Y – X – 0.01 < 0 allow 2.09 for 2.087
	$\text{Var}(Y - X) = 0.000144 + '0.00013232'$	**M1**		or $\sqrt{(0.012^2 + '0.00013232')}$ M1
	$= 0.000276(32)$	**A1**		= 0.016623 A1
	$\frac{0.01-'0.033'}{\sqrt{'0.00027632'}}$ $(= -1.384)$	**M1**		their $E(Y - X)$ & $\text{Var}(Y - X)$ var must be a combination of the two vars
	$\Phi('-1.384') = 1 - \Phi('1.384')$	**M1**		correct area / prob consistent with their working
	$= 0.0832$	**A1**	[6]	SR use of biased var (0.000131) in (i) and (ii) scores in (ii) B1M1 A1 for 0.000275 and M1M1 A1 for 0.0827 (6 / 6 available)
Total			**[9]**	
	Total for paper		**[50]**	

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