UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2010 question paper for the guidance of teachers

9709 MATHEMATICS

9709/72 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 must be read in conjunction with the question papers and the report on the examination.

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International Examinations

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	$0.605 \pm z \times \sqrt{\frac{0.605\times(1-0.605)}{1000}}$ $z = 1.645$ seen [0.580, 0.630]	M1 B1 A1 [3]	 Allow [0.58, 0.63]. Allow any brackets
2	**(i)** $e^{-\frac{10}{3}} \times \frac{(\frac{10}{3})^4}{4!}$ = 0.184 or 0.183	M1 A1 [2]	Allow incorrect λ
	(ii) $\lambda = 5$ $e^{-5}(1 + 5 + \frac{5^2}{2})$ = 0.125 (3 sfs)	B1 M1 A1 [3]	 Allow incorrect λ. Allow one end error OR Combination method scores B1, identifying all 6 possible combinations M1, multiply each combination and add (must use at least 5 combinations) A1
3	**(i)** B(40 000, 0.0001)	B1 [1]	
	(ii) Po(4) $n = 40\,000 > 50$, $np = 4 < 5$	B1*B1*dep B1 [3]	B1 for Po. B1 for 4 Accept 40000 large and 0.0001 small
	(iii) $1 - (P(X \leq 3)$ or $e^{-4}(1 + 4 + \frac{4^2}{2} + \frac{4^3}{3!}))$ $1 - e^{-4}(1 + 4 + \frac{4^2}{2} + \frac{4^3}{3!})$ = 0.567 or 0.566	M1 M1 A1 [3]	Allow one end error (any λ) Expression of correct form (any λ), no end errors. (OR Use of normal scores M1, standardising M1, standardising with correct cc A1ft, **(ii)** 0.599. Award A mark only if normal given in **(ii)**) (OR Binomial M1 expression of correct form allow end error, M1 correct form no end error, A1ft 0.567 or 0.566. Award A mark only if Bin given in **(ii)**) NB Part **(iii)** must be Poisson or ft from **(ii)** for A mark to be awarded. SR If no answer given in **(ii)** allow BOD for A marks.

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4	**(i)**	$0.5(0.5 + 0.75)\times 0.5$ or $\int_1^{1.5} \frac{x}{2}\,dx$	M1	Attempt find correct area eg 1 squ + $^1/_4$ squ
		$= {}^5/_{16}$ or 0.3125 or 0.313	A1 [2]	or integral with correct limits any f(x)
	(ii)	$^1/_2 m \times {}^m/_2$ or $\int_0^m \frac{x}{2}\,dx$	M1	Attempt area from 0 to m (or m to 2) their f(x)
		$= {}^1/_2$	M1	Expression for area = $^1/_2$. Ignore limits
		$m = \sqrt{2}$ or 1.41	A1 [3]	
	(iii)	$\int_0^2 \frac{x^2}{2}\,dx$	M1	Attempt $\int xf(x)dx$. Ignore limits
		$= {}^4/_3$ oe	A1 [2]	
5	**(i)**	E(F) = 28 + 1/2 × 52 = 54 Var(F) = 5.6^2 + 1/4 × 12.4^2 = 69.8	B1 M1 A1 [3]	 √69.8 or 8.35: M1A0
	(ii)	H_0: Grinford mean = 54; H_1; Grinford mean < 54	B1ft	Allow "μ", otherwise undefined mean: B0 ft their 54
		$\frac{49 - 54}{\sqrt{\frac{69.8}{10}}}$	M1	Standardising must have √10
		= –1.89(3) or –1,89(2) allow + Comp with –1.645 (or 1.893 with 1.645)	A1 M1	 Comp P(z < –1.893) with 0.05 Allow comparison with 1.96 for consistent 2-tail test
		Evidence that Grinford mean lower	A1ft [5]	Allow "Accept Grinford mean lower" No contradictions OR Alt methods (x – 54)/(√(69.8/10)) = 1.645 giving x = 49.65 compare with 49 scores M1A1M1A1ft. oe. No mixed methods.

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6	**(i)**	H_o: P(6) = $^1/_6$ H_1: P(6) > $^1/_6$	B1		Allow "p"
		$1 - (({}^5/_6)^{10} + 10({}^1/_6)({}^5/_6)^9 + {}^{10}C_2({}^1/_6)^2({}^5/_6)^8)$	M1		Allow 1 term omitted or extra or incorrect
		= 0.225 (3 sfs)	A1		
		0.225 > 0.1	M1		Allow correct comparison with 0.9, and recovery of previous then M1A1 possible.
		No evidence that die biased	A1ft	[5]	Allow Accept die not biased. In context. SR Calc just P(3)max score B1M0A0M1A0
	(ii)	P(4 or more sixes)	M1		Idea of 1 – Σ of terms oe compared with 0.1
		$= 1 - (({}^5/_6)^{10} + 10({}^1/_6)({}^5/_6)^9 + {}^{10}C_2({}^1/_6)^2({}^5/_6)^8 + {}^{10}C_3({}^1/_6)^3({}^5/_6)^7)$	M1		1 – Σ of appropriate no.terms oe compared with 0.1
		= 0.0697 or 0.0698	A1	[3]	
	(iii)	Concluding die is fair when die is biased	B1	[1]	Must be in context
7 (a)	**(i)**	Pop too large Not all pop accessible	B1	[1]	Time consuming Or similar
	(ii)	Testing involves destruction	B1	[1]	Or similar
(b)	**(i)**	$^{9850}/_{500} = (19.7)$	B1		
		$^{500}/_{499}(^{194125}/_{500} - (^{9850}/_{500})^2)$	M1		Allow with √. Method must be seen or clearly implied.
		= 0.160(32) (3 sfs) or 80/499	A1	[3]	
	(ii)	$\frac{19.73-19.7}{\sqrt{\frac{"0.160"}{60}}}$	M1		For standardising
		= 0.580 or 0.581	A1ft		ft their mean and var in **(b)(i)**
		1 – Φ("0.580")	M1		Correct tail
		(= 1 – 0.7191)			
		= 0.281	A1	[4]	
	(iii)	"Yes" must be seen or implied to gain mks			
		X not nec'y normal	B1		
		Sample large	B1	[2]	or $\overline{X}$ is approx N (SR Both reasons correct, but wrong or no conclusion scores SR B1)

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