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

9709/73 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 must be read in conjunction with the question papers and the report on the examination.

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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.

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.

1	Normal 31 for mean $\sqrt{31}$ or 5.57 for sd	B1 B1 B1 [3]	 For mean Must be sd
2	**(i)** Only the more committed or less busy etc Only readers of that particular issue	B1 B1 [2]	Any sensible category of readers who will not respond implied
	(ii) Three randomly generated 4-digit numbers given 4975 3952 (0)386	B1 B1dep [2]	Starting with 4975 Accept 4975 0239 5203 and 4975 5203 6088 SC alternative consistent methods producing a set of 3 randomly generated 4 digit numbers can score B1 for the first number and B1dep for all three numbers, all < = 7302
3	**(i)** $29.6 \pm z \times {}^{1.0}/_{\sqrt{65}}$ $29.6 \pm 2.576 \times {}^{1.0}/_{\sqrt{65}}$ (29.6 ± 0.3195) (29.3, 29.9) (3 sfs)	M1 B1 A1 [3]	Allow any value of z For 2.576 seen Allow any brackets or none, but cwo.
	(ii) CI does not include 30 Claim not supported or not justified or probably not true	B1ft B1ft [2]	30 seen or implied
	(iii) CI is a variable oe	B1 [1]	Allow "Sample mean diff" (not population mean).
4	$E(V) = 46 + 53 + 2 \times 25 = 149$ $Var(V) = 19^2 + 23^2 + 4 \times 10^2$ $= 1290$ $\frac{93 - 149}{\sqrt{'1290'}}$ $= -1.559$ $1 - \Phi('-1.559') = \Phi('1.559')$ $= 0.9405$	B1 M1 A1 M1 A1ft M1 A1 [7]	 or $\sqrt{(19^2 + 23^2 + 4 \times 10^2)}$ or $\sqrt{1290}$ or 35.9 With their mean and their variance. ft their mean and variance providing 3 random variables used, allow +/-. Area consistent with their mean Accept 0.940 or 0.941 or 0.94

5	**(i)** $\int_2^4 \frac{x^2}{6}\,dx \quad (= \left[\frac{x^3}{18}\right]_2^4)$		M1	Attempt integ $xf(x)$, ignore limits
	$= \frac{4^3}{18} - \frac{2^3}{18}$		M1	Subst correct limits in $\frac{x^3}{n}$
	$= \frac{28}{9}$		A1 [3]	oe
	(ii) $\int_2^m \frac{x}{6}\,dx \; (= \left[\frac{x^2}{12}\right]_2^m)$	or $\int_m^4 \frac{x}{6}\,dx$	M1	Attempt integ $f(x)$ and = 0.5 (ignore limits).
	$\frac{m^2}{12} - \frac{2^2}{12} = 0.5$	$\frac{4^2}{12} - \frac{m^2}{12} = 0.5$	M1	Attempt integ $f(x)$, limits 2 to unknown or unknown to 4. Or by areas.
	$m = \sqrt{10}$ oe	$m = \sqrt{10}$ oe	A1 [3]	$\sqrt{10}$ or 3.16 (3 sfs)
	(iii) $\int_3^4 \frac{x}{6}\,dx \quad (= \left[\frac{x^2}{12}\right]_3^4 = {}^7/_{12})$		M1*	Attempt integ $f(x)$, one limit must be 3.
	$(\text{“}{}^7/_{12}\text{”})^2$		M1*dep	Square their “$^7/_{12}$”
	$= {}^{49}/_{144}$ or 0.340 (3 sfs)		A1 [3]	

6	**(i)**	$\bar{x} = 43.5/100 = 0.435$	B1	
		$s = \sqrt{\frac{100}{99}} \times \sqrt{\frac{31.56}{100} - 0.435^2}$ (=0.3573) or Var (= 0.128) or $1/99(31.56-(43.5)^2/100)$	M1	$s = \sqrt{\frac{31.56}{100} - 0.435^2}$ M0 (= 0.3555), or Var (= 0.126)
		H_0: Pop mean (for B) = 0.336 H_1: Pop mean (for B) ≠ 0.336	B1	Undefined mean: B0, but allow just "μ"
		$\frac{0.435 - 0.336}{\frac{"0.3573"}{\sqrt{100}}}$	M1	$\frac{0.435 - 0.336}{\frac{"0.3555"}{\sqrt{100}}}$ M1 Or x_{crit} = 0.336 +/-"2.576"√(0.12765/100)
		= 2.77 (3 sfs)	A1	Or x_{crit} = (0.244) or 0.428 A1 z = 2.785 (3 sfs) A0
		Z_{crit} = 2.576 (or 2.326 consistent with 1-tail test)	B1	Or use of area – correct 0.005 (2-tail) or 0.01 (1-tail)
		Valid comparison with *z*-value	M1	Valid comp P(z > 2.77) with 0.005 or 0.01 Or comp 0.435 with "0.428"
		Evidence that B amounts diff from A	A1ft [8]	No errors seen. Conclusion consistent with their H_0/H_1.No contradictions.
	(ii)	Must state or imply "No" to score these marks		
		n large	B1	
		$\bar{X}$ approx normally distr or CLT applies	B1 [2]	B0 for "No" with invalid (or no) reason SR both reasons correct but wrong conclusion scores SR B1.

7	**(i)** H_0: mean no. sales = 2.4 H_1: mean no. sales > 2.4	B1	Or "= 0.8 per week" Accept λ, not μ.
	$P(X \geq 5)$ $= 1 - e^{-2.4}(1 + 2.4 + \frac{2.4^2}{2!} + \frac{2.4^3}{3!} + \frac{2.4^4}{4!})$	M1*	Attempted with or without "1–". Allow one end error.
	$(= 1 - 0.9041)$	A1	Allow incorrect λ in otherwise correct expression.
	$= 0.0959$	A1	
	Comp with 0.05	M1*	Indep M. (Allow recovery of above 3 marks at this point if comparison with 0.95 done.)
	No evidence to believe mean sales incr	A1ft dep [6]	Conclusion, no contradictions. SC: $e^{-2.4} \times \frac{2.4^5}{5!} = 0.0602 > 0.05$: max B1M0A0A0M1A0
	(ii) Need 1st x such that $P(X \geq x) < 0.05$	M1*	Attempt sum of at least 3 relevant Poisson terms, with comparison with 0.05 (can be implied). Can be implied, e.g. by $P(X \leq 5) = 0.9643$ identified.
	$P(X \geq 6) = 1 - e^{-2.4}(1 + 2.4 + \ldots + \frac{2.4^5}{5!})$	M1*dep	
	$(= 1 - 0.9643)$ $= 0.0357$	A1 [3]	
	(iii) Mean sales still 0.8 per week, but ≥ 6 sales in 3 weeks, so reject 0.8.	B1 [1]	Conclude mean sales have increased when not true
	(iv) Value of true (new, changed) mean oe	B1 [1]	