UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9709 MATHEMATICS

9709/63 Paper 6, 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.

- Cambridge will not enter into discussions or correspondence in connection with these mark schemes.

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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)**	$(3.6\times 9+64)\ /\ 24$ $= 4.02$ years	M1 A1 **[2]**	Mult by 9, adding 64 then dividing by 24 Correct answer
	(ii)	$\frac{\Sigma x_A^{\ 2}}{9} - 3.6^2 = 1.925^2$	M1	Attempt to find $\Sigma x_A^{\ 2}$ using correct variance formula
		$\Sigma x_A^{\ 2} = 150$	A1	Correct $\Sigma x_A^{\ 2}$
		$\frac{150.0+352}{24} - 4.017^2 = 4.780$	M1	Using 352 + their 150 in correct variance formula
		sd = 2.19	A1 **[4]**	Correct answer
2	**(i)**	$4\times 3\times 7$ $= 84$	B1 **[1]**	Correct answer
	(ii)	$10! - 9! \times 2$ $= 2903040$ (2900000)	B1 B1 **[2]**	$10! - k \times 9!$ seen oe Correct answer
		OR $8! \times 9 \times 8$ $= 2903040$ (2900000)	B1 B1	$8! \times 9 \times l$ seen oe Correct answer
	(iii)	${}^9C_1 + {}^9C_2 + ... + {}^9C_9$	M1 M1	Using combinations Adding 9 combinations
		$= 511$	A1 **[3]**	Correct answer
		OR $2^9 - 1$	M1 M1	2^9 seen Subtracting 1
		$= 511$	A1	Correct answer
3	**(i)**	$\text{median}_A < 35$ or $20 \le \text{median}_A < 35$ or $\text{median}_A = 33.0/33.1/33.5/33.6$ or $\text{median}_B \ge 50$ or $50 \le \text{median}_B < 70$ or $\text{median}_B = 51.7/51.9/52.2/52.4$ $\text{median}_B > \text{median}_A$	B1 B1 **[2]**	Correct numerical statement re median_A or median_B Correct numerical statement re other median and a conclusion
		OR A has 66 cand 50 < mark < 100, so $\text{med}_A < 50$ or *B* has 156 cand 50 < mark < 100, so $\text{med}_B > 50$ $\text{median}_B > \text{median}_A$	B1 B1	As before As before
	(ii)	$159 - 68 = 91$	B1 **[1]**	Correct final answer
	(iii)	$\text{mean} = \begin{pmatrix} 4.5\times 25 + 14.5\times 43 + 27\times 91 \\ + ... + 84.5\times 40 \end{pmatrix} / 300$	M1 M1 M1	Using an attempt at mid-points, not end points or class widths Using an attempt at frequencies, not cum freqs Sum of 6 prods, correct freqs, divided by 300
		$= 11270 / 300 = 37.6$	A1 **[4]**	Correct answer

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4 (i) (a)	P(final score is 12) = P(6, 6) = 1/36	B1 **[1]**	Correct answer
(b)	P[(1,5) + (1,4) + (2,3) + (3,2) + (4,1)]	M1	Considering P(1, 5)
		M1	Considering P[(1,4) + (2,3) + (3,2) + (4,1)]
	= 5/36	A1 **[3]**	Correct answer
(ii)	P(A) = 1/6 P(B) = P[(1,5) + (2,4) + (3,3) + (4, 2) + (5,1)] = 5/36	B1	Any two of P(A), P(B) and P(C) correct
	P(C) = 1 – P(O, O) = 3/4	B1	Third probability correct
	P(A and B) = P(1 and 5) = 1/36 ≠ P(A) × P(B) P(A and C) = P[(2,5) + (4,5) + (6,5)] = 3/36 ≠ P(A) × P(C) P(B and C) = P[(2,4) + (4,2)] = 2/36 ≠ P(B) × P(C)	M1	Numerical attempt to compare P(X and Y) with P(X) × P(Y), must be three positive probs
	None are independent.	A1√	One correct comparison and conclusion, ft their probabilities
		A1 **[5]**	Correct conclusion(s) following legitimate working
5 (i)	$z = \pm 1.751$	B1	Correct z
	$\pm \dfrac{20-\mu}{\mu/4} = 1.751$	M1	Standardising no cc, no sqrt, must be a z-value
	$\mu = 13.9$	A1 **[3]**	Correct answer
(ii)	$P(X < 10) = P\left(z < \pm \dfrac{10-13.91}{13.91/4}\right)$	M1	Standardising attempt with 10, their μ and their μ/4, no cc, no sqrt
	= P(z < −1.124) = 1− 0.8694 = 0.131	M1	"$\Phi_1 + \Phi_2 - 1$", ft their mean
	P(10 < X < 20) = 0.96 – 0.131 = 0.829 or 0.830	A1 **[3]**	Correct answer
(iii)	$\mu = 250 \times 0.96 = 240$ $\sigma^2 = 250 \times 0.96 \times 0.04 = 9.6$	B1	240 and 9.6 or sq rt 9.6 seen unsimplified
	$P(\geq 235) = 1 - \Phi\left(\pm \dfrac{234.5-240}{\sqrt{9.6}}\right)$	M1	Standardising, with or without cc, must have sq rt in denom
		M1	Continuity correction 234.5 or 235.5 only
	= Φ (1.775)	M1	Correct region > 0.5, ft their mean
	= 0.962	A1 **[5]**	Correct answer

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6 **(i)**	$(0.75)^n < 0.06$	M1*	Equation or inequality with 0.75^n and 0.06 or 0.94 seen
	$n > 9.78$	M1dep*	Attempt at solving by trial and error (can be implied) or using logarithms correctly
	$n = 10$	A1 **[3]**	Correct answer
(ii)	$E(X) = 14 \times 0.75$ or 10.5 Try $P(10) = {}^{14}C_{10}(0.75)^{10}(0.25)^4 = 0.220$	M1	Evaluating binomial probability for an integer value directly above or below their mean
	$P(11) = {}^{14}C_{11}(0.75)^{11}(0.25)^3 = 0.240$	M1	Evaluating the other binomial probability
	(mode is) 11	A1 **[3]**	Correct answer
	OR	M1	Evaluating binomial $P(n)$ and $P(n + 1)$
		M1	Evaluating binomial P(10), P(11) and P(12)
		A1	Correct answer
(iii)	$P(> 11)$ $= {}^{14}C_{12}(0.75)^{12}(0.25)^2 + {}^{14}C_{13}(0.75)^{13}(0.25)^1 + (0.75)^{14}$	M1	A binomial term of the form ${}^{14}C_n p^n(1-p)^{14-n}$ seen, $n \neq 0$ or 14
		M1	Summing binomial P(12, 13, 14) or P(11, 12, 13, 14,)
	$= 0.281$	A1	Correct answer 0.280 – 0.282
	$P(3) = {}^5C_3\ (0.2811)^3(0.7189)^2$	M1	A binomial term of the form ${}^5C_3 p^3(1-p)^2$ seen, any p
	$= 0.115$	A1 **[5]**	Correct answer

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