CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2012 series

9709 MATHEMATICS

9709/12 Paper 1, maximum raw mark 75

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.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2012 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

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	$\left(x^2 - \frac{a}{x}\right)^7$ Term in x^5 is ${}_7C_3 \times (x^2)^4 \times (-a/x)^3$ This term isolated Equated to $-280 \quad \rightarrow \quad a = 2$.	B1 M1 A1 [3]	Allow on own or in an expansion. Correct term in x^5 selected. Equated to -280
2	**(i)** $f(x) = \sqrt{\frac{x+3}{2}} + 1$, for $x \geq -3$ Make x the subject or interchanges x,y $\rightarrow \quad 2(x-1)^2 - 3$ $\rightarrow \quad 2x^2 - 4x - 1$ **(ii)** domain of f^{-1} is ≥ 1.	M1 M1 A1 [3] B1 [1]	Attempt at x as subject and removes +1 Squares both sides and deals with "+3" and "÷2". co co. condone >1
3	**(i)** $A = 2400 - 20(60 - 2x) - x(40 - x) - 30x$ $\rightarrow \quad A = x^2 - 30x + 1200$. (could be trapezium − triangle) **(ii)** $\frac{dA}{dx} = 2x - 30$ or $(x - 15)^2 + 975$ $= 0$ when $x = 15$ or Min at $x = 15$ $\rightarrow \quad A = 975$.	M1 A1 [2] B1 M1 A1 [3]	Needs attempts at all areas co answer given co - either method okay Sets differential to 0 + solution. co co.
4	$y = \frac{x}{k} + k \quad 4y = x^2$ **(i)** $\frac{x^2}{4} = \frac{x}{k} + k \rightarrow kx^2 - 4x - 4k^2 = 0$ Uses $b^2 - 4ac \quad \rightarrow \quad k = -1$ (calculus $\frac{1}{k} = \frac{2x}{4}$ B1 $\rightarrow x = \frac{2}{k}, \; y = \frac{1}{k^2}$ M1 $\rightarrow \quad k = -1$ A1) **(ii)** $y = -x - 1, \; 4y = x^2$ $\rightarrow \quad x^2 + 4x + 4 = 0$ $\rightarrow \quad P(-2, 1)$	M1 M1 A1 [3] M1 M1 A1 [3]	Eliminates x or y completely. Uses $b^2 - 4ac$ for a quadratic = 0 co nb a,b,c must not be $f(x)$ Elimination of x or y Soln of eqn. co.

5	$A\ (1, 3), B\ (5, 11)\ , X\ (4, 4)$ **(i)** Gradient of $AB = 2$ Gradient of $BC = -½$ → Eqn of BC is $y - 11 = -\frac{1}{2}(x - 5)$ **(ii)** gradient of AC (or AX) is ⅓ → eqn of AC is $y - 3 = \frac{1}{3}(x - 1)$ or $y - 4 = \frac{1}{3}(x - 4)$ Sim equations → $C\ (13,7)$	B1 M1 A1 [3] B1 M1 A1 [3]	co For use of $m_1m_2 = -1$ co – unsimplified is fine co Correct form of line equation + sim eqns co answer only -0/3- assumed $AB = BC$. Uses graph or table and gets exactly (13,7) allow the 3 marks for **(ii)**.
6	$2\cos x = 3\tan x$ **(i)** Replaces tan x by sin$x$ ÷ cos x → $2c^2 = 3s$ → $2s^2 + 3s - 2 = 0$ **(ii)** Soln of quadratic → $y = 15°$ $2y$ can also be $180 - 30$ → $y = 75°$.	M1 M1 A1 [3] M1 A1 DM1 A1√ [4]	Uses $t = s \div c$ Uses $s^2 + c^2 = 1$. Correct eqn . Method for quadratic = 0 and ÷2 co Works with $2y$ first before ÷ 2 for $90° - 1^{st}$ answer. (loses √ mark if extra soln in range)
7	$\overrightarrow{OA} = \begin{pmatrix}1\\0\\2\end{pmatrix}$ $\overrightarrow{OB} = \begin{pmatrix}k\\-k\\2k\end{pmatrix}$ **(i)** $\begin{pmatrix}1\\0\\2\end{pmatrix}.\begin{pmatrix}2\\-2\\4\end{pmatrix} = 10$ $= \sqrt{5} \times \sqrt{24}\cos\theta$ → $\theta = 24.1°$ **(ii)** $\overrightarrow{AB} = \begin{pmatrix}k-1\\-k\\2k-2\end{pmatrix}$ allow each cpt ± $(k-1)^2 + k^2 + (2k-2)^2$ → $6k^2 - 10k + 4 = 0$ → $k = 1$ or ⅔	M1 M1 M1 A1 [4] M1 M1 A1 A1 [4]	Use of $x_1x_2 + y_1y_2 + z_1z_2$ Product of 2 moduli All connected correctly. co Correct for either **AB** or **BA**. Sum of 3 squares (doesn't need =1) Correct quadratic co

8	**(a)** **(i)** $ar = 24,\ ar^3 = 13\frac{1}{2}$ Eliminates a (or r) $\rightarrow$ $r = \frac{3}{4}$ $\rightarrow$ $a = 32$	B1 M1 A1 [3]	Both needed Method of Solution. co
	(ii) sum to infinity $= 32 \div \frac{1}{4} = 128$	M1A1√ [2]	Correct formula used. √ on value of r
	(b) $a = 3,\ d = 2$	B1	Correct value for d
	$\frac{n}{2}(6 + (n-1)2)$ $(= 360)$	M1	Correct S_n used. no need for 360 here.
	$\rightarrow$ $2n^2 + 4n - 720 = 0$	A1	Correct quadratic
	$\rightarrow$ $n = 18$	A1 [4]	co
9	$y = \frac{9}{2x+3}$ $A\ (3, 1)$ $B\ (0, 3)$		
	(i) $\frac{dy}{dx} = \frac{-9}{(2x+3)^2} \times 2$	B1 B1	Correct without the ×2. For × 2, independent of first part.
	$\rightarrow m = -\frac{2}{9}$	M1	Correct form of tan - numerical dy/dx
	$\rightarrow$ $y - 1 = -\frac{2}{9}(x-3)$	A1√ [4]	For his m following use of dy/dx. (normal →max 2/4, no calculus 0/4)
	(ii) Meets the y-axis when $x = 0$, $y = 1\frac{2}{3}$ This is nearer to B than to O.	B1 [1]	Sets x to 0 in his tangent. The $1\frac{2}{3}$ and part **(i)** must be correct.
	(iii) Integral of $\frac{81}{(2x+3)^2} = \frac{-81}{2x+3} \div 2$	B1 B1	Correct without the ÷ 2. For ÷ 2,
	Uses limits 0 to 3 $\rightarrow$ $\frac{-9}{2} - \frac{-81}{6} = 9\pi$	M1 A1 [4]	Use of limits with integral of y^2 only no π – max ¾. Use of area - 0/4,

10	$\frac{dy}{dx} = x + \frac{4}{x^2}$ and P (4, 8)		
	(i) $y = \frac{x^2}{2} - \frac{4}{x} \quad + (c)$	B1 B1	co.co (ignore $+c$ at this stage)
	Uses (4, 8) $\rightarrow$ $c = 1$	M1 A1 [4]	Uses the point after integration for c
	(ii) $\frac{d^2y}{dx^2} = 1 - \frac{8}{x^3}$	B1	Co
	$= 0$ when $x = 2$	B1	Sets to 0 + solution or verifies and states a conclusion (stationary or min)
	$\rightarrow$ gradient of 3	B1	Allow for $x = 2$ into dy/dx.
	$d/dx(1 - \frac{8}{x^3}) = \frac{24}{x^4}$ $\rightarrow$ +ve $\rightarrow$ Min.	B1 [4]	Any valid method - 3rd differential +ve 2nd diff goes −0+, or 1st goes >3,3,>3
11	**(i)** $OQ = x + OC = 20$	B1	Used somewhere – needs "20".
	$\sin 0.6 = \frac{x}{OC} \rightarrow OC = \frac{x}{\sin 0.6}$	M1	Use of trig in 90º triangle
	$x + \frac{x}{\sin 0.6} = 20 \rightarrow x = 7.218$	M1 A1 [4]	Soln of linear equation. (answer given, ensure there is a correct method)
	(ii) Area = ½. $20^2 \times 1.2 - \pi \times 7.218^2$ = 76.3	M1 A1 [2]	Use of $\frac{1}{2}r^2\theta$ - needs r=20 and $\theta = 1.2$ co
	(iii) Angle $PCR = \pi - 1.2$	B1	co
	Arc $PR = 7.218 \times (\pi - 1.2) = (14.01)$	M1	Use of $s = r\theta$ with $r = 7.218$ -any θ -even $2\pi/3$
	$OP = OR = \frac{x}{\tan 0.6}$	M1	Correct use of trig or Pythagoras
	$\rightarrow$ Perimeter of 35.1 cm	A1 [4]	co