UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2007 question paper

9709 MATHEMATICS

9709/01 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.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- CIE 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.

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)

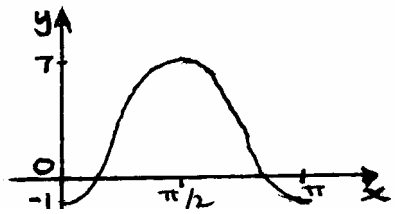
SR Special Ruling (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)

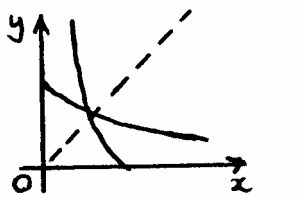
Penalties

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	Eliminates x or y completely $y^2-2y+2c$ or $4x^2+x(4c-4)+c^2=0$ Use of $b^2-4ac=0$ → $c=½$ [or gradients equal $2=1/\sqrt{x}$ M1A1 → value for x,y *and* c. M1A1]	M1 M1 A1 A1 [4]	Aims to make x or y subject + subst Correct quadratic – not nec =0 Used correctly on "quadratic=0" co
2	$V=\pi\int 9\sqrt{x}dx$ $=\pi\,\frac{9x^{\frac{3}{2}}}{\frac{3}{2}}$ [ ] at 4 − [ ] at 1 → 42π	M1 A1 DM1 A1 [4]	For integral of y^2 (ignore π here) All correct (ignoring π here) Correct use of correct limits. co.
3	Use of $t=s/c$ → $(c^2-s^2)\div(c^2+s^2)$ Use of $c^2+s^2=1$ → (c^2-s^2) → $1-2\sin^2x$	M1 A1 M1 A1 [4]	tan completely removed May omit the denominator (=1) Whenever used appropriately ag Beware fortuitous answers
4	$\times(x^4)$ → $4x^4-x^2-18=0$ $(4x^2-9)(x^2+2)=0$ $x=1.5$ or $x=-1.5$	M1 DM1 A1 A1√ [4]	Recognition of quad in x^2 or $1\div(x^2)$ Solution of quadratic. Positive root. For recognition of (−ve) The A1√ assumes no other real answers.
5 **(i)**	$\tan\frac{1}{6}\pi=AX\div 12$ or other valid method $\tan\frac{1}{6}\pi=\sqrt{3}\div 3$ → $AX=4\sqrt{3}$	M1 A1 [2]	Use of trig with tangent in correct Δ Co (12 ÷ √3 ok)
(ii)	area $AOC=½r^2\theta$ $(=24\pi)$ Area of $\Delta AOX=½\times AX\times 12$ → shaded area $=48\sqrt{3}-24\pi$	M1 M1 A1 [3]	Correct formula + attempt with radians Use of ½*bh* in correct Δ (once ok) co (144 ÷ √3 ok)
6 **(i)**	m of $AB=1.5$ (or 1½) m of $BC=-1\div$ (m of AB) $=-⅔$ → Eqn $y-8=-\frac{2}{3}(x+2)$ or $3y+2x=20$	B1 M1 M1 A1√ [4]	co anywhere Use of $m_1m_2=-1$ Correct form used – or $y=mx+c$. co (√ needs both M marks)
(ii)	Put $y=0$ → $C(10, 0)$ Vector move → $D(14, 6)$ (or sim eqns $3y+2x=46$ and $2y=3x-30$)	B1√ M1A1 [3]	√ in his linear equation. completely correct method. co

7	**(i)**	$ar=3$ and $\dfrac{a}{1-r}=12$ Solution of sim eqns → $a=6$	B1 B1 M1 A1 [4]	co for each one. Needs to eliminate a or r correctly. co (M mark needs a quadratic)
	(ii)	$a=6,\ d=-3$ $S_{20}=10(12-57)$ → -450	B1√ M1 A1 [3]	For $d=$ 3 − his "6". Sum formula must be correct and used. co.
8	**(i)**	$f(x)=a+b\cos 2x$, → $a+b=-1$ and $a-b=7$ Solution → $a=3$ and $b=-4$	B1 B1 B1 [3]	co co co
	(ii)	$3-4\cos 2x=0$ → $\cos 2x=¾$ → $x=0.36$ and 2.78	M1 A1 A1√ [3]	$\cos 2x$ subject and finds $\cos^{-1}$ before ÷2 co. √ for $\pi-1^{st}$ answer and no other answers in the range.(Degrees max ⅓)
	(iii)	 	B1 B1 [2]	Ignore anything outside 0 to π. Must be 1 oscillation only. Everything ok including curves, not blatant lines and from −1 to 7.
9	**(i)**	$\overrightarrow{AB}=\begin{pmatrix}-1\\1\\-2\end{pmatrix}$ and $\overrightarrow{AC}=\begin{pmatrix}-2\\2\\-4\end{pmatrix}$ $\overrightarrow{OC}=\overrightarrow{OA}+\overrightarrow{AC}=\begin{pmatrix}2\\3\\-6\end{pmatrix}$ Unit vector = $\frac{1}{7}\begin{pmatrix}2\\3\\-6\end{pmatrix}$	M1 A1 M1 A1√ [4]	For ±(**b**−**a**) (not **b**+**a**) Co Division by the modulus √for his $\overrightarrow{OC}$
	(ii)	$m\begin{pmatrix}4\\1\\-2\end{pmatrix}+n\begin{pmatrix}3\\2\\-4\end{pmatrix}=\begin{pmatrix}1\\4\\k\end{pmatrix}$ → $4m+3n=1$ and $m+2n=4$ → $m=-2$ and $n=3$ → $k=-8$	M1 A1 M1A1 [4]	Forming 2 simultaneous equations co Equation for k in terms of m and n. co

10	**(i)**	$\frac{dy}{dx} = 2 - \frac{16}{x^3}$ $\frac{d^2y}{dx^2} = \frac{48}{x^4}$	B1 B1 B1√ [3]	For $-16/x^3$. For "2" and for "0". For d/dx of his $-16/x^3$ providing −ve power differentiated.
	(ii)	$\frac{dy}{dx} = 0 \quad \rightarrow \quad x = 2, y = 6.$ $\frac{d^2y}{dx^2}$ is +ve Minimum.	M1 A1 A1√ [3]	Sets dy/dx to 0 + attempt at x. Needs both coordinates. Looks at sign. Correct conclusion for his x and his 2nd differential.
	(iii)	$x = -2 \quad m = 4$ Perp gradient = −¼ $y + 2 = -\frac{1}{4}(x + 2)$ Sets y to 0 → $x = -10$	M1 DM1 A1 [3]	Uses $m_1m_2 = -1$ with dy/dx. Correct form of equation (not for tan) Co nb answer given.
	(iv)	Area = $\left[x^2 - \frac{8}{x}\right]$ Evaluated from 1 to 2 → 7	B1 B1 B1 [3]	For each term Co. (−7 ⇒ 7 gets B0)
11	**(i)**	f′(x) = $-6(2x+3)^{-2}$ × 2 Always −ve → Decreasing	B1 B1 B1√ [3]	co.(−ve power ok) B1 for ×2 Answer given. Correct explanation.
	(ii)	$y = \frac{6}{2x+3}$ $\rightarrow \text{f}^{-1}(x) = \frac{1}{2}\left(\frac{6}{x} - 3\right)$ Domain of f^{-1}: $0 < x \leq 2$	M1 M1 A1 B1 [4]	Reasonable attempt in making x the subject (ok to interchange x, y first) Order of operations must be correct ie ÷ y, −3 then ÷ 2. Correct expression as f$^{-1}(x)$. Gets 2/3 for correct expression with y. Could be independent of answer for f^{-1}. Condone < or ≤
	(iii)		B1 B1 [2]	Correct graph for f^{-1}(curve, stops on axis) Makes clear on graph, or in words or by the line $y=x$ marked, the symmetry.
	(iv)	fg(x) = $\frac{6}{x+3}$ = 1.5 → $x = 1$ [or , using f^{-1}, → g(x) = ½, ⇒ $x = 1$.] [M1 M1 A1]	M1 M1 A1 [3]	g first, then f. Reverse (3÷(2x+3) M0 Not DM – so can get this if attempt ok co

DM1 for quadratic. Quadratic must be set to 0.
Factors. Attempt at two brackets. Each bracket set to 0 and solved.
Formula. Correct formula. Correct use, but allow for numerical slips in b² and −4ac.