UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

International General Certificate of Secondary Education

MARK SCHEME for the May/June 2012 question paper

for the guidance of teachers

0606 ADDITIONAL MATHEMATICS

0606/13 Paper 1, maximum raw mark 80

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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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 Accuracy 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 following abbreviations may be used in a mark scheme or used on the scripts:

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)

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)

Penalties

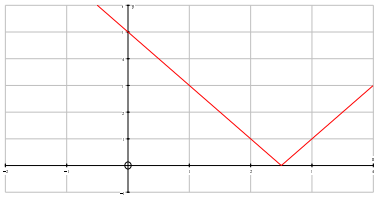
MR –1 A penalty of MR –1 is deducted from A or B marks when the data of a question or part question are genuinely misread and the object and difficulty of the question remain unaltered. In this case all A and B marks then become "follow through √ " marks. MR is not applied when the candidate misreads his own figures – this is regarded as an error in accuracy.

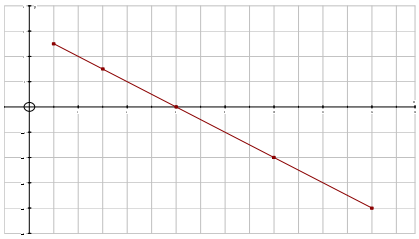
OW –1,2 This is deducted from A or B marks when essential working is omitted.

PA –1 This is deducted from A or B marks in the case of premature approximation.

S –1 Occasionally used for persistent slackness – usually discussed at a meeting.

EX –1 Applied to A or B marks when extra solutions are offered to a particular equation. Again, this is usually discussed at the meeting.

1	**(i)** 	**B1** **B1**	**B1** for shape **B1** for both intercepts
	(ii) $2x - 5 = \pm 3$, leading to $x = 1, 4$	**B1, B1** **[4]**	
2	$f(-2) : 4a - 2b = 46$ $f\left(\frac{1}{2}\right) : a + 2b = -21$ $a = 5, b = -13$	**M1** **M1** **M1** **A1 A1** **[5]**	**M1** for substitution of $x = -2$ and equating to zero **M1** for substitution of $x = 0.5$ and equating to – 35 **M1** for solution of equations
3	$x^2 + x(k - 2) + (5 - k) = 0$ Using '$b^2 > 4ac$', $(k - 2^2) > 4(5 - k)$ $k^2 > 16$ $k > 4, k < -4$	**M1** **DM1** **A1** **A1** **A1, A1** **[6]**	**M1** for equating line and curve **DM1** for use of $b^2 > 4ac$ $b = k - 2$ and $c = 5 - k$ Accept $< = \geq \leq$ etc. **A1** for each
4	**(a) (i)** 15120 **(ii)** 210 **(b) (i)** 15504 **(ii)** ${}^{12}C_{10} \times {}^{8}C_5$ $= 3696$ **(iii)** 56	**B1** **B1** **B1** **B1, B1** **B1** **B1** **[7]**	
5	**(i)** (0, 4) $\frac{dy}{dx} = 3x^2 + 4x - 3$ When $x = 0$, $\frac{dy}{dx} = -3$ $y - 4 = -3x$ **(ii)** $4 - 3x = x^3 + 2x^2 - 3x + 4$ leading to, $0 = x^3 + 2x^2$, $(-2, 10)$	**B1** **M1** **M1** **A1** **M1** **M1** **A1** **[7]**	 **M1** for differentiation **M1** for attempt at line equation **M1** for equating line and curve **M1** for solution of cubic **A1** need x and y

6	**(i)** $15+2\dfrac{\sin^2\theta}{\cos^2\theta}=\dfrac{7}{\cos^2\theta}$	**M1**	**M1** for dividing by $\cos^2\theta$
	$15 + 2\tan^2\theta = 7\sec^2\theta$	**M1**	**M1** for $\dfrac{1}{\cos^2\theta}=\sec^2\theta$
	$15 + 2\tan^2\theta = 7(1 + \tan^2\theta)$	**M1**	**M1** for $\sec^2\theta = 1 + \tan^2\theta$
	leading to $\tan^2\theta=\dfrac{8}{5}$	**A1**	**A1** for rearrangement to get required result
	or $15\cos^2\theta + 2\sin^2\theta = 7(\cos^2\theta + \sin^2\theta)$	**[M1]**	**M1** for use of identity
	$8\cos^2\theta = 5\sin^2\theta$	**[M1]**	**M1** for simplification
	leading to $\tan^2\theta=\dfrac{8}{5}$	**[M1]** **[A1]**	**M1** for use of $\tan\theta=\dfrac{\sin\theta}{\cos\theta}$
	(ii) $\tan\theta=\pm\sqrt{\dfrac{8}{5}}$	**M1**	**M1** for attempt to solve
	leading to θ = 0.902, 2.24	**A1, A1**	
	(also, $\sin\theta=\pm\sqrt{\dfrac{8}{13}}$, $\cos\theta=\pm\sqrt{\dfrac{5}{13}}$)	**[M1]**	**M1** for attempt to solve
		[7]	
7	**(i)** $\dfrac{y}{x}=A+Bx$	**B1**	
	x: 1, 3, 6, 10, 14 y/x: 2.5, 1.5, 0, –2, –4	**M1**	**M1** for attempt to calculate points and plot
		**A2, 1, 0**	–1 each error
	(ii) Grad = B = –0.5	**M1, A1**	**M1** for grad = B
	Intercept = A = 3	**M1, A1**	**M1** for intercept = A
		[8]	
8	**(a)** $2\lg x - \lg(5x + 60) = \lg 10$	**B1**	**B1** for lg 10
		B1	**B1** for dealing with 'power'
	$\dfrac{x^2}{5x+60}=10$	**M1**	**M1** for dealing with division
	leading to $x^2 - 50x - 600 = 0$	**DM1**	**DM1** for attempt to solve quadratic
	$x = 60$	**A1**	
	(b) $\log_5 y=\dfrac{4\log_5 5}{\log_5 y}$	**M1**	**M1** for change of base
	$(\log_5 y)^2 = 4$	**M1**	**M1** for valid attempt to solve
	$\log_5 y = \pm 2$		
	$y = 25,\ \dfrac{1}{25}$	**A1,A1**	
		[9]	

9	$120(p^7q^3)$ and $(45)(p^8q^2)$	**B3,2,1,0**	–1 per element (of 4) incorrect
	$120p^7q^3 = 270p^8q^2$	**M1**	**M1** for equating and multiplying by 6
	$252p^5q^5 = 252$	**B1**	**B1** for $252p^5q^5$
	$pq = 1$ and $4q = 9p$	**B1**	**B1** for $pq = 1$ **OR** $4p = 9q$
	leading to $p = \frac{2}{3}$, $q = \frac{3}{2}$	**A1, A1** **[8]**	**A1** for each
10	**(i)** $\frac{dy}{dx} = 2e^{2x} - 2e^{-2x}$	**B1,B1**	One per term
	(ii) $3 = 2e^{2x} - 2e^{-2x}$	**M1**	**M1** for attempt to obtain in 'quadratic' form
	$2e^{4x} - 3e^{2x} - 2 = 0$	**DM1**	**DM1** for attempt to solve
	$(2e^{2x} + 1)(e^{2x} - 2) = 0$	**M1**	**M1** for attempt to solve for y
	$e^{2x} = 2$, $y = \frac{5}{2}$	**A1**	
	(iii) $\frac{dx}{dt} = -0.5$,		
	$\frac{dy}{dt} = (2e^2 - 2e^{-2}) \times (-0.5)$	**M1, M1**	**M1** for substitution of $x = 1$ **M1** for correct application of chain rule
	$= -7.25$	**A1** **[9]**	
11	**EITHER**		
	(i) $\frac{dy}{dx} = 18x - 3x^2$	**M1**	**M1** for differentiation
	When $\frac{dy}{dx} = 0$, $0 = 3x(6 - x)$	**M1**	**M1** for equating to zero and attempt to solve
	Turning points when $x = 0, 6$	**M1**	**M1** for finding y
	When $x = 6$, $y = 108$	**A1**	
	(ii) Area $\left[3x^3 - \frac{x^4}{4}\right]_0^9$	**M1, A1**	**M1** for attempt to integrate
	$= 546.75$	**DM1,A1**	**DM1** for correct application of limits
	$B(0, -18)$		
	Area of triangle $= 81$	**B1**	**B1** for area of triangle
	Total Area $= 628$	**A1**	
	Or: Area $= \int_0^9 9x^2 - x^3 - 2x + 18 \ dx$	**[M1]** **[A3,2,1,0]**	
	$\left[3x^3 - \frac{x^4}{4} - x^2 + 18x\right]_0^9 = 628$	**[DM1,A1]** **[10]**	

11 OR		
(i) $\frac{dy}{dx} = 6\cos 3x$	**B1**	**B1** for differentiation
When $x = \frac{\pi}{9}$, $\frac{dy}{dx} = 3$, $y = \sqrt{3}$	**B1**	For y
Equation of normal		
$y - \sqrt{3} = -\frac{1}{3}\left(x - \frac{\pi}{9}\right)$	**M1** **M1**	Use of $m_1m_2 = -1$ **M1** for equation of normal and attempt to solve when $x = 0$
When $x = 0$, $y = 1.85$	**A1**	
(ii) $\frac{1}{2}\left(\sqrt{3} + 1.85\right)\frac{\pi}{9} - \int_0^{\frac{\pi}{9}} 2\sin 3x\,dx$	**B1**	**B1** for trapezium – allow unsimplified
0.6251 $-\left[-\frac{2}{3}\cos 3x\right]_0^{\frac{\pi}{9}}$	**M1** **A1**	**M1** for attempt to integrate **A1** correct integration
$0.6251 - \left(\frac{1}{3}\right) = 0.292$	**M1, A1**	**M1** for correct application of limits
Alt method:		
Area $= \int_0^{\frac{\pi}{9}} \sqrt{3} - \frac{1}{3}\left(x - \frac{\pi}{9}\right) - 2\sin 3x\,dx$	**[M1]** **[A2,1,0]**	
$\left[\sqrt{3}x - \frac{x^2}{6} + \frac{\pi x}{27} + \frac{2}{3}\cos 3x\right]_0^{\frac{\pi}{9}} = 0.292$	**[DM1]** **[A1]** **[10]**	