Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

ADDITIONAL MATHEMATICS **0606/13**

Paper 1 **May/June 2017**

MARK SCHEME

Maximum Mark: 80

Published

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.

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MARK SCHEME NOTES

The following notes are intended to aid interpretation of mark schemes in general, but individual mark schemes may include marks awarded for specific reasons outside the scope of these notes.

Types of mark

M Method marks, awarded for a valid method applied to the problem.

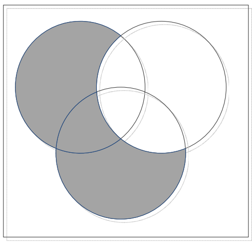
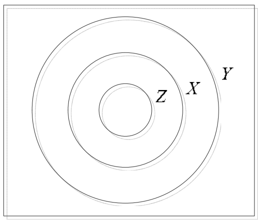
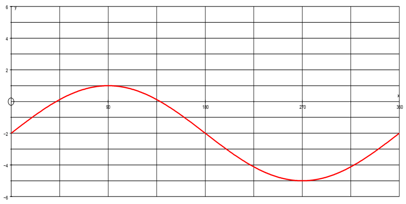
A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. For accuracy marks to be given, the associated Method mark must be earned or implied.

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 in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. The notation '**dep**' is used to indicate that a particular M or B mark is dependent on an earlier mark in the scheme.

Abbreviations

awrt	answers which round to
cao	correct answer only
dep	dependent
FT	follow through after error
isw	ignore subsequent working
nfww	not from wrong working
oe	or equivalent
rot	rounded or truncated
SC	Special Case
soi	seen or implied

Question	Answer	Marks	Partial Marks
1(a)		1	
1(b)		1	
2(i)	4	1	
2(ii)	40° or $\frac{2\pi}{9}$ or 0.698 rad	1	
3(i)		3	**B1** for a complete cycle starting and ending at –2 **B1** for max at $y = 1$ and min at $y = -5$ **B1** for a completely correct graph
3(ii)	5	1	**FT** *their* min value for y
4(i)	Area = $\frac{1}{2}\left(3+2\sqrt{5}\right)\left(4+6\sqrt{5}\right)$ $=\frac{1}{2}\left(12+26\sqrt{5}+60\right)$	M1	use of correct formula and attempt to expand out the brackets
	$=36+13\sqrt{5}$	A1	
4(ii)	$\frac{3+2\sqrt{5}}{2+3\sqrt{5}}$	B1	
	$=\frac{3+2\sqrt{5}}{2+3\sqrt{5}}\times\frac{2-3\sqrt{5}}{2-3\sqrt{5}}$	M1	
	$=\frac{6-5\sqrt{5}-30}{4-45}$ $=\frac{24+5\sqrt{5}}{41}$	A1	for answer

Question	Answer	Marks	Partial Marks
5	When $x = 4,\ y = 5$	**B1**	for y
	$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{1}{2} \times 4(4x+9)^{-\frac{1}{2}}$	**B1**	for $2(4x+9)^{-\frac{1}{2}}$, allow unsimplified
	When $x = 4,\ \frac{\mathrm{d}y}{\mathrm{d}x} = \frac{2}{5}$, so perp grad = $-\frac{5}{2}$	**M1**	obtaining numerical gradient for normal
	Equation of normal $y - 5 = -\frac{5}{2}(x-4)$ $(2y = 30 - 5x)$	**M1**	for equation of normal
	$A(6,\ 0),\ B(0,\ 15)$	**A2**	**A1** for each
	Midpoint $\left(3,\ \frac{15}{2}\right)$	**B1**	**FT** on *their x*/*y* intercepts
6(a)(i)	dealing with multiplication and addition	**M1**	implied by 2 correct elements
	A + 3**C** = $\begin{pmatrix} -12 & 7 \\ 11 & 7 \end{pmatrix}$	**A1**	
6(a)(ii)	correct attempt to multiply	**M1**	implied by 2 correct elements
	BA = $\begin{pmatrix} 17 & 9 \\ 14 & 18 \\ -3 & -1 \end{pmatrix}$	**A1**	
6(b)(i)	$\mathbf{X}^{-1} = \frac{1}{10}\begin{pmatrix} -2 & 3 \\ -4 & 1 \end{pmatrix}$	**B2**	**B1** for $\frac{1}{10}$, **B1** for $\begin{pmatrix} -2 & 3 \\ -4 & 1 \end{pmatrix}$
6(b)(ii)	$\begin{pmatrix} a & b \\ c & d \end{pmatrix} = \frac{1}{10}\begin{pmatrix} -2 & 3 \\ -4 & 1 \end{pmatrix}\begin{pmatrix} 5 & -10 \\ 15 & 20 \end{pmatrix}$	**M1**	pre-multiplication using matrix from (b)(i)
	$= \begin{pmatrix} 3.5 & 8 \\ -0.5 & 6 \end{pmatrix}$	**A2**	–1 for each incorrect element

Question	Answer	Marks	Partial Marks
7(a)	LHS $= \dfrac{\dfrac{\sin^2\theta}{\cos^2\theta}+\sin^2\theta}{\cos\theta+\dfrac{1}{\cos\theta}}$	M1	for obtaining all in terms of $\sin\theta$ and $\cos\theta$
	$= \dfrac{\dfrac{\sin^2\theta+\sin^2\theta\cos^2\theta}{\cos^2\theta}}{\dfrac{\cos^2\theta+1}{\cos\theta}}$	M1	for simplification using addition of fractions
	$= \dfrac{\sin^2\theta\left(1+\cos^2\theta\right)}{\cos\theta\left(\cos^2\theta+1\right)}$ $= \dfrac{\sin^2\theta}{\cos\theta}$	M1	for factorisation and subsequent cancelling of common term
	$\tan\theta\sin\theta$ = RHS	A1	correct final simplification
	Alternative $\dfrac{\sec^2\theta-1-\cos^2\theta+1}{\cos\theta+\sec\theta}$	M1	use of correct identities
	$= \dfrac{(\sec\theta-\cos\theta)(\sec\theta+\cos\theta)}{(\sec\theta-\cos\theta)}$ $= \sec\theta-\cos\theta$	M1	attempt to factorise and simplify
	$= \dfrac{1-\cos^2\theta}{\cos\theta}$	M1	simplification to obtain terms in $\sin\theta$ and $\cos\theta$ only
	$= \dfrac{\sin^2\theta}{\cos\theta}$ $= \tan\theta\sin\theta$	A1	for final simplification
7(b)	$\sin\phi = \dfrac{x}{3},\ \cos\phi = \dfrac{3}{y}$	M1	for obtaining $\sin\phi$ and $\cos\phi$ in terms of x and y and attempt to use correct identity
	Using $\sin^2\phi+\cos^2\phi=1$ leads to $\dfrac{x^2}{9}+\dfrac{9}{y^2}=1$ and hence $x^2y^2+81=9y^2$	M1	attempt at simplification
	81	A1	

Question	Answer	Marks	Partial Marks
	Alternative method using substitution $\left(9\times\frac{9}{\cos^2\phi}\right)-\left(\frac{9}{\cos^2\phi}\times 9\sin^2\phi\right)$	M1	attempt to substitute in for x and y
	$=\left(\frac{81}{\cos^2\phi}\right)-\left(\frac{81\sin^2\phi}{\cos^2\phi}\right)$	M1	simplification of fractions
	$=\frac{81\left(1-\sin^2\phi\right)}{\cos^2\phi}$ or $81\left(\sec^2\phi-\tan^2\phi\right)$ leading to 81	A1	use of correct identity to obtain 81
8(i)	$\mathrm{p}\left(-\frac{1}{2}\right)=-\frac{2}{8}+\frac{a}{4}-2+b$	M1	for attempt at $\mathrm{p}\left(-\frac{1}{2}\right)$
	leading to $a+4b=9$ oe	A1	
	$\mathrm{p}(1)=2+a+4+b$ leading to $a+b=-18$ oe	B1	
	solution of simultaneous equations	M1	
	$a=-27,\ b=9$	A1	for both
8(ii)	attempt at factorisation using either long division or observation	M1	
	$(2x+1)\left(x^2-14x+9\right)$	A1	
8(iii)	attempt to solve q(x) = 0	M1	
	$x=7\pm2\sqrt{10},\ -\frac{1}{2}$	A1	for all 3 solutions
9(i)	$\left[3\mathrm{e}^{5x}+\mathrm{e}^{-5x}\right]_{-k}^{k}=6$	B2	**B1** for each term integrated correctly
	$\left(3\mathrm{e}^{5k}+\mathrm{e}^{-5k}\right)-\left(3\mathrm{e}^{-5k}+\mathrm{e}^{5k}\right)=6$	M1	for use of limits with $a\mathrm{e}^{5x}+b\mathrm{e}^{-5x}$
	$2\mathrm{e}^{5k}-2\mathrm{e}^{-5k}=6$	A1	correct unsimplified
	$\mathrm{e}^{5k}-\mathrm{e}^{-5k}=3$	A1	correct simplification to obtain given answer

Question	Answer	Marks	Partial Marks
9(ii)	$y^2 - 3y - 1 = 0$	**M1**	for correct attempt to obtain a quadratic equation in terms of y or e^{5x}
	$y = \frac{3 \pm \sqrt{9+4}}{2}$, $y = e^{5k} = 3.303$ only	**DM1**	for attempt to solve quadratic equation and solve for k
	$k = 0.239$	**A1**	**A0** if more than one solution is given
10(i)	for attempt to differentiate a product	**M1**	
	$\frac{5}{5x+1}$	**B2**	**B1** for $\frac{1}{5x+1}$
	$\frac{dy}{dx} = (10x+2) \times \frac{5}{5x+1} + 10\ln(5x+1)$	**A1**	all else correct
10(ii)	$(10x+2) \times \frac{5}{5x+1} = 10$	**B1**	simplification to obtain 10, allow if seen in (i)
	$10\int \ln(5x+1)\,dx$ $= (10x+2)\ln(5x+1) - 10x$	**M1**	use of result from part (i)
	$\int \ln(5x+1)\,dx$ $= \frac{(5x+1)}{5}\ln(5x+1) - x$	**A1**	
10(iii)	$\left[(x+0.2)\ln(5x+1) - x\right]_0^{\frac{1}{5}}$	**M1**	use of limits in result from (ii)
	$= -\frac{1}{5} + \frac{2}{5}\ln 2 = \frac{-1+\ln 4}{5}$ cao	**A1**	
11(i)	attempt to differentiate	**M1**	
	$\frac{dy}{dx} = 6 - \frac{3}{2}x^{\frac{1}{2}}$	**A1**	
	When $\frac{dy}{dx} = 0$	**M1**	equating to zero and attempt to solve
	$x = 16,\ y = 32$	**A1**	both correct

Question	Answer	Marks	Partial Marks
11(ii)	$\frac{d^2y}{dx^2} = -\frac{3}{4}x^{-\frac{1}{2}}$	**B1**	correct differentiation
	This is negative so a maximum point	**DB1**	correct conclusion
11(iii)	When $x = 4$, $\frac{dy}{dx} = 3$	**B1**	
	$\partial y \approx \frac{dy}{dx} \times h$	**M1**	use of small increases
	$\approx 3h$	**A1**	**FT** *their* (iii)
12(i)	attempt to differentiate	**M1**	
	$6\cos 2t + 6$	**A1**	
12(ii)	$\cos 2t = -1$	**M1**	attempt to equate (i) to zero and solve
	$t = \frac{\pi}{2}$	**A1**	
12(iii)	attempt to integrate	**M1**	
	$x = -\frac{3}{2}\cos 2t + 3t^2 + 2t \quad (+c)$	**A2**	–1 for each error
	When $t = 0,\ x = 0$, so $c = \frac{3}{2}$	**M1**	attempt to find c
	$x = \frac{3}{2} - \frac{3}{2}\cos 2t + 3t^2 + 2t$	**A1**	