Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

ADDITIONAL MATHEMATICS **0606/12**

Paper 12 **March 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.

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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.

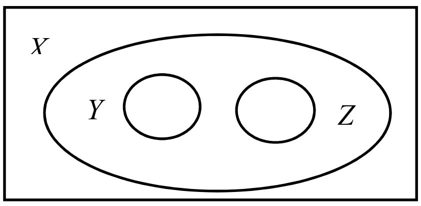
A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. For accuracy marks to be given, the associated Method mark must be earned or implied.

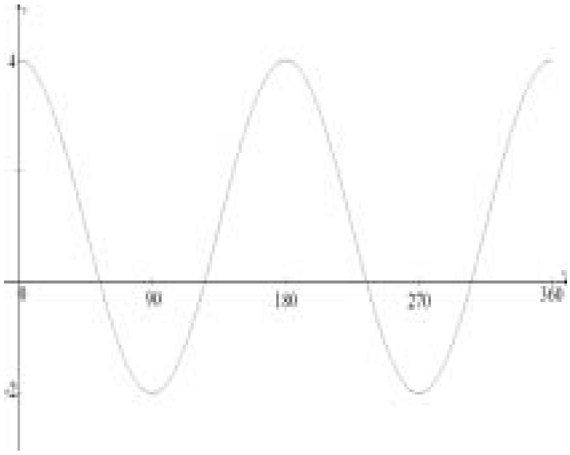
B Mark for a correct result or statement independent of Method marks.

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
www without wrong working

Question	Answer	Marks	Part Marks
1 (a) (i)	0	B1	
(ii)	10	B1	
(b)		B1	either $X \cap Y = Y$ or $X \cap Z = Z$
		B1	$Y \cap Z = \varnothing$
		B1	completely correct Venn diagram.

Question	Answer	Marks	Part Marks
2 (i)		B1 B1 B1	2 complete cycles having a maximum at $y=4$ and a minimum at $y=-2$ completely correct curve
(ii)	$(90°, -2)$	B1	
3	$a^5+5a^4\left(\frac{x}{4}\right)+10a^3\left(\frac{x}{4}\right)^2$ $a^5=32$, so $a=2$ $b=5\times\frac{1}{4}\times(\mathit{their}\ a)^4$, leading to $b=20$ $c=10\times\frac{1}{16}\times(\mathit{their}\ a)^3$ leading to $c=5$	 B1 M1 A1 M1 A1	 correct attempt to obtain b
4 (a) (i)	$\frac{1}{10}\begin{pmatrix}4 & 3\\-2 & 1\end{pmatrix}$	B1 B1	for $\frac{1}{\text{determinant}}$ for matrix
(ii)	$\mathbf{M}=\frac{1}{10}\begin{pmatrix}4 & 3\\-2 & 1\end{pmatrix}\begin{pmatrix}-1 & -5\\4 & 2\end{pmatrix}$	M1	pre-multiplication by the matrix from part (i)
	$\mathbf{M}=\frac{1}{5}\begin{pmatrix}4 & -7\\3 & 6\end{pmatrix}$ oe	A2,1,0	–1 each element error
(b)	$-3a+2=4(6a-4)$ $a=\frac{2}{3}$	M1 A1	correct use of a determinant

Question	Answer	Marks	Part Marks
5 (i)	LHS $= \dfrac{1}{\sin\theta} - \sin\theta$		
	$= \dfrac{1-\sin^2\theta}{\sin\theta}$	**M1**	dealing with $\text{cosec}\,\theta$ and attempt at dealing with fractions
	$= \dfrac{\cos^2\theta}{\sin\theta}$	**M1**	correct use of identity
	$= \cot\theta\cos\theta$	**A1**	completely correct proof
(ii)	$\cot\theta\cos\theta = \dfrac{1}{3}\cos\theta$		
	$3\cot\theta\cos\theta - \cos\theta = 0$		
	$\cos\theta(3\cot\theta - 1) = 0$	**M1**	use of part (i), manipulation and factorisation
	$\cos\theta = 0 \quad \cot\theta = \dfrac{1}{3}$, so $\tan\theta = 3$	**M1**	dealing with $\cot\theta$ and attempt to solve
	$\theta = \dfrac{\pi}{2}, \dfrac{3\pi}{2}$, $\theta = 1.25,\ 4.39$	**A1,A1**	**A1** for each pair of solutions (allow 1.57 and 4.71)
6 (a) (i)	40320	**B1**	
(ii)	720	**B1**	
(iii)	5040	**B1**	
(b) (i)	35	**B1**	
(ii)	1	**B1**	
(iii)	Twins in team of 4 $^5C_2 = 10$	**B1**	
	Twins in team of 3 $= 5$	**B1**	
	Total = 15 www	**B1**	

Question	Answer	Marks	Part Marks
7 (a)	$\frac{102}{17}\begin{pmatrix}8\\-15\end{pmatrix}$	M1	attempt to obtain magnitude of $\begin{pmatrix}8\\-15\end{pmatrix}$ and use it
	$\begin{pmatrix}48\\-90\end{pmatrix}$	A1	
(b)	$\begin{pmatrix}2p-2q+4\\10p+2q+3\end{pmatrix}=\begin{pmatrix}p^2\\27\end{pmatrix}$	M1	dealing with the scalar and with addition
	$2p-2q+4=p^2$ $10p+2q+3=27$	M1 A1	equating like vectors and simplifying both equations correct
	leading to $p^2-12p+20=0$	M1	elimination of q and subsequent solution of quadratic
	$p=2,\ q=2$ $p=10,\ q=-38$	A1 A1	
8 (i)	$\frac{dy}{dx}=-2\cos 2x\ (+c)$	M1 A1	integration to obtain the form $a\cos 2x$ correct, condone omission of c
	$5=-2\cos\pi+c$	M1	attempt to find c
	$\frac{dy}{dx}=3-2\cos 2x$	A1	May be implied by a correct c
(ii)	$y=3x-\sin 2x\ (+c)$	M1 A1	integration to obtain the form $a\sin 2x$ correct, condone omission of c
	$-\frac{1}{2}=\frac{\pi}{4}-\frac{1}{2}+c$	M1	attempt to find c
	$y=3x-\sin 2x-\frac{\pi}{4}$ oe	A1	
(iii)	When $x=\frac{\pi}{12}$, $\frac{dy}{dx}=3-\sqrt{3}$		
	Normal equation: $y+\frac{1}{2}=\frac{1}{\sqrt{3}-3}\left(x-\frac{\pi}{12}\right)$	M1	attempt to obtain perpendicular gradient and normal equation
		A1FT	**FT** on *their* $\frac{dy}{dx}$ from (i). Allow unsimplified
	$y=-0.789x-0.294$ cao	A1	

Question	Answer	Marks	Part Marks
9 (i)	$\frac{1}{2}\times 10^2 \times \theta = 20\pi$	M1	use of sector area to obtain θ
	$\theta = \frac{2\pi}{5}$	A1	
(ii)	Arc length $AB = 4\pi$	B1FT	**FT** *their* θ
	$BC^2 = 10^2 + 10^2 - (2\times 10\times 10\times \cos 2\theta)$ or $\frac{BC}{\sin\frac{4\pi}{5}} = \frac{10}{\sin\frac{\pi}{10}}$	M1	valid attempt to obtain BC
	$BC = 19.02$	A1	
	Perimeter = 50.6	A1	
(iii)	Area = Either $\left(\frac{1}{2}\times 19.02^2 \sin\frac{\pi}{5}\right)$	M1	area of triangle ACB
	$+\left(20\pi - \left(\frac{1}{2}\times 10^2 \sin\frac{2\pi}{5}\right)\right)$	M1	area of relevant segment
	= 121.6 allow awrt 122	A1	
	Or $20\pi + 2\left(\frac{1}{2}\times 10\times 10 \sin\frac{4\pi}{5}\right)$	M1,M1	**M1** for area of triangle AOB or AOC **M1** for a complete method
	= 121.6 allow awrt 122	A1	

Question	Answer	Marks	Part Marks
10	$(2x-5)^{\frac{3}{2}} = 3\sqrt{3}$	M1	attempt to find x-coordinate of B
	$x = 4$	A1	x-coordinate of B
	At A $x = 2.5$	B1	x-coordinate of A
	Either		
	Area $= \frac{1}{2}\times\frac{3}{2}\times 3\sqrt{3} - \int_{2.5}^{4}(2x-5)^{\frac{3}{2}}\,dx$	M1	plan and attempt to find the area of the triangle. Allow unsimplified
	$= \frac{9\sqrt{3}}{4} - \left[\frac{1}{5}(2x-5)^{2.5}\right]_{2.5}^{4}$	M1	attempt at integration, must be in the form $(2x-5)^{2.5}$
		A1	correct integration
	$= \frac{9\sqrt{3}}{4} - \left(\frac{1}{5}(3)^{2.5} - 0\right)$	DM1	attempt to use limits correctly
	$= \frac{9\sqrt{3}}{20}$	A1	
	Or		
	line AB: $y = 2\sqrt{3}x - 5\sqrt{3}$	M1	equation of AB and attempt to integrate
	Area $= \int_{2.5}^{4} 2\sqrt{3}x - 5\sqrt{3} - (2x-5)^{\frac{3}{2}}\,dx$	M1	attempt at integration, must contain the form $(2x-5)^{2.5}$
	$= \left[\sqrt{3}x^2 - 5\sqrt{3}x - \frac{(2x-5)^{\frac{5}{2}}}{5}\right]_{2.5}^{4}$	A1	correct integration
	$= \frac{9\sqrt{3}}{4} - \frac{9\sqrt{3}}{5}$	DM1	attempt to use correct limits correctly
	$= \frac{9\sqrt{3}}{20}$	A1	
11 (i)	$\ln y = \ln A + bx$	B1	may be implied by later work
		M1	use of either point correctly in above equation or equivalent
	$0.7 = \ln A + b$ $3.7 = \ln A + 2.5b$	A1	one correct equation
	leading to $b = 2$	A1	
	and $\ln A = -1.3$, so $A = 0.273$ or $e^{-1.3}$	M1,A1	M1 for dealing with ln correctly to obtain A.
(ii)	$\ln y = -1.3 + 2x$ $\ln y = 2.7$	M1	valid attempt to find y. Must include correct substitution and dealing with ln correctly.
	$y = 14.9$	A1	