Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **May/June 2017**

MARK SCHEME

Maximum Mark: 80

Published

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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

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Question	Answer	Marks	Guidance
1(a)	$\log_7 2.5 = 2x + 5$ or $\log_7\left(\frac{2.5}{7^5}\right) = 2x$ or $(2x+5)\log 7 = \log 2.5$	**M1**	correct first anti-logging step
	$[x =]\frac{\log_7 2.5 - 5}{2}$ or $\frac{1}{2}\log_7\left(\frac{2.5}{7^5}\right) = x$ or $x = \frac{1}{2}\left(\frac{\log 2.5}{\log 7} - 5\right)$	**M1**	isolates x
	$-2.26(4...)$	**A1**	
1(b)	$5^2 p^{-3} q^{\frac{5}{4}}$ oe	**B3**	**B1** for each term If B0 then allow **M1** for numerator of $125q^{\frac{3}{2}}$ or denominator of $5p^3q^{\frac{1}{4}}$
2(i)	B and C with valid reason	**B2**	**B1** for one graph and valid reason or both graphs and no reason
2(ii)	B only with valid reason	**B2**	**B1** for graph B or valid reason
3	$[m =]\frac{13-5}{1-0.2}$ or 10 soi	**M1**	or $13 = m + c$ and $5 = 0.2m + c$ and subtracting/substituting to solve for m or c, condone one error
	$Y - 13 = their\ 10(X-1)$ or $Y - 5 = their\ 10(X - 0.2)$ or $13 = their\ 10 + c$ or $5 = their\ 10 \times 0.2 + c$	**M1**	or using *their m* or *their c* to find *their c* or *their m*, without further error
	$\sqrt[3]{y} = (their\ m)\frac{1}{x} + (their\ c)$ or $\sqrt[3]{y} = (their\ m)\left(\frac{1}{x} - 1\right) + 13$ or $\sqrt[3]{y} = (their\ m)\left(\frac{1}{x} - 0.2\right) + 5$	**M1**	*their m* and *c* must be validly obtained
	$y = \left(\frac{10}{x} + 3\right)^3$ or $y = \left(10\left(\frac{1}{x} - 1\right) + 13\right)^3$ or $y = \left(10\left(\frac{1}{x} - 0.2\right) + 5\right)^3$ cao, isw	**A1**	

Question	Answer	Marks	Guidance
4(a)(i)	$\begin{pmatrix}-4\\3\end{pmatrix}$	**B1**	
4(a)(ii)	$\sqrt{11^2+(-15)^2}$ or better	**M1**	
	$\frac{1}{\sqrt{346}}\begin{pmatrix}11\\-15\end{pmatrix}$	**A1**	
4(b)	$\overrightarrow{OR}=\overrightarrow{OP}+\frac{3}{4}\overrightarrow{PQ}$ soi	**M1**	or $\overrightarrow{OR}=\overrightarrow{OQ}-\frac{1}{4}\overrightarrow{PQ}$ soi
	$\left[\overrightarrow{OR}=\right]\mathbf{p}+\frac{3}{4}(\mathbf{q}-\mathbf{p})$	**M1**	or $\left[\overrightarrow{OR}=\right]\mathbf{q}-\frac{1}{4}(\mathbf{q}-\mathbf{p})$
	$\left[\overrightarrow{OR}=\right]\frac{1}{4}\mathbf{p}+\frac{3}{4}\mathbf{q}$ oe	**A1**	
5(a)	$(9\times8\times7\times6\times1)+(8\times8\times7\times6\times1)$ soi	**M2**	**M1** for one correct product of the sum
	5712	**A1**	
5(b)	${}^9C_4\times{}^5C_4+{}^9C_3\times{}^5C_5$ oe	**M2**	**M1** for one correct product of the sum
	[630 + 84 =] 714	**A1**	
6	$64=2^n$	**M1**	
	$n=6$	**A1**	
	$their\,6(2)^{their(6-1)}\times(-a)=-16b$ oe	**M1**	
	$their\,\frac{6\times(6-1)}{2}(2)^{their(6-2)}\times(-a)^2=100b$ oe	**M1**	
	attempts to solve	**DM1**	dep on both M1 marks being awarded; must have correctly or correct FT eliminated one unknown
	$a=5$	**A1**	
	$b=60$	**A1**	

Question	Answer	Marks	Guidance
7(i)	$k(1+4x)^9$	**M1**	
	$4\times10(1+4x)^9$ or better	**A1**	
	$(1+4x)^{10}(their-\sin x)+$ $\cos x\left(their\left(4\times10\times(1+4x)^9\right)\right)$	**M1**	clearly applies product rule
	$(1+4x)^{10}(-\sin x)+\cos x\left(4\times10\times(1+4x)^9\right)$	**A1**	all correct
7(ii)	$\frac{\mathrm{d}}{\mathrm{d}x}\left(\mathrm{e}^{4x-5}\right)=4\mathrm{e}^{4x-5}$ soi	**B1**	
	$\frac{\mathrm{d}}{\mathrm{d}x}(\tan x)=\sec^2 x$ soi	**B1**	
	clearly applies correct form of quotient rule $\frac{\tan x\left(their\ 4\mathrm{e}^{4x-5}\right)-\mathrm{e}^{4x-5}\left(their\sec^2 x\right)}{(\tan x)^2}$	**M1**	or correct form of product rule to $\mathrm{e}^{4x-5}(\tan x)^{-1}$ $4\mathrm{e}^{4x-5}(\tan x)^{-1}+\mathrm{e}^{4x-5}(\tan x)^{-2}\times\sec^2 x$
	$\frac{\tan x\left(4\mathrm{e}^{4x-5}\right)-\mathrm{e}^{4x-5}\left(\sec^2 x\right)}{(\tan x)^2}$ isw	**A1**	all correct
8(i)	$\frac{\pi}{3}$	**B1**	
	6 [cm]	**B1**	
8(ii)	[major arc =]$\left(2\pi-their\frac{\pi}{3}\right)their\ r$	**M1**	
	$10\pi + 6$ cao	**A1**	
8(iii)	$\frac{1}{2}(their6)^2\left(2\pi-their\frac{\pi}{3}\right)$	**M1**	$\frac{1}{2}(their6)^2\left(their\frac{\pi}{3}\right)$
	$\frac{1}{2}(their6)^2\sin\left(their\frac{\pi}{3}\right)$	**M1**	$\frac{1}{2}(their6)^2\sin\left(their\frac{\pi}{3}\right)$
	Sector + triangle	**M1**	$\pi\times their6^2$ – (Sector – triangle)
	$30\pi + 9\sqrt{3}$	**A1**	

Question	Answer	Marks	Guidance
9(i)	$\frac{y}{9}=\sqrt{x-1}$ with attempt to swop x and y at some point or $\frac{x}{9}=\sqrt{y-1}$	**M1**	attempt to swop; may be in later work that contains an error
	$\left[\mathrm{f}^{-1}(x)=\right]\left(\frac{x}{9}\right)^2+1$ oe	**A1**	condone y = ... etc; must be a function of x
	$x>0$	**B1**	
9(ii)	f(51)	**M1**	or $\mathrm{fg}(x)=9\sqrt{x^2+1}$
	$9\sqrt{50}$ oe	**A1**	
9(iii)	$\left[\mathrm{gf}(x)=\right]\left(9\sqrt{x-1}\right)^2+2$	**M1**	
	$\left[\mathrm{gf}(x)=\right]81(x-1)+2$ or better	**A1**	
	$their\left(81x-79\right)=5x^2+83x-95\rightarrow$ $their\left(5x^2+2x-16\,[=0]\right)$	**M1**	provided $their(81x-79)$ of the form $ax+b$ for non-zero a and b
	1.6 oe only	**A1**	must disregard other solution
10(a)	$\sin x=0.5$, $\sin x=-0.5$	**M1**	
	$\frac{\pi}{6},\ -\frac{\pi}{6},\ \frac{5\pi}{6},\ -\frac{5\pi}{6}$ oe	**A2**	**A1** for any correct pair of angles if M0 then **SC1** for a correct pair of angles
10(b)	$2y+15=\tan^{-1}\left(\frac{1}{3}\right)$ soi	**M1**	
	18.43(49...) and 198.43(49...)	**M1**	
	1.7, 91.7	**A2**	**A1** for each

Question	Answer	Marks	Guidance
10(c)	Uses $\cot^2 z = \operatorname{cosec}^2 z - 1$ oe	**M1**	for using correct identity or identities to obtain an equation in terms of a single trigonometric ratio
	$2\operatorname{cosec}^2 z + 7\operatorname{cosec} z - 4 = 0 \Rightarrow$ $(2\operatorname{cosec} z - 1)(\operatorname{cosec} z + 4)$	**DM1**	for dealing with quadratic
	$[\sin z = 2\ ]\ \sin z = -\frac{1}{4}$	**M1**	
	194.5, 345.5	**A2**	**A1** for each
11(i)	$5 + \sqrt{10x} = \frac{5x+20}{4} \rightarrow \cancel{20} + 4\sqrt{10x} = 5x + \cancel{20}$	**M1**	or better; equates and solves as far as clearing the fraction
	$\left[\frac{x}{\sqrt{x}} = \right] \sqrt{x} = \frac{4\sqrt{10}}{5}$ oe	**M1**	Simplifies as far as $\sqrt{x} = \cdots$
	$x = 6.4$ cao	**A1**	squares and simplifies to 6.4
	$[y =] 13$	**B1**	
11(ii)	(area of trapezium =) *their* 57.6	**B1**	**FT** $x = \textit{their}\ 6.4, \quad y = \textit{their}\ 13$ using any valid method
	$\int_0^{6.4} \left(5 + \sqrt{10x}\right) \mathrm{d}x$	**M1**	
	$\int (10x)^{\frac{1}{2}}\ \mathrm{d}x = k\,(10x)^{\frac{3}{2}}$ or	**M1**	or $\int \sqrt{10}x^{\frac{1}{2}}\ \mathrm{d}x = k\,\sqrt{10}\,(x)^{\frac{3}{2}}$
	$\left[5x + \frac{2(10x)^{\frac{3}{2}}}{3\times 10}\right]$	**A1**	or $\left[5x + \frac{2(10)^{\frac{1}{2}}(x)^{\frac{3}{2}}}{3}\right]$
	$\textit{their}\left[5(6.4) + \frac{2(10\times 6.4)^{\frac{3}{2}}}{3\times 10}\right] - \textit{their}57.6$ oe	**M1**	limits used correctly or correct **FT** and subtraction of trapezium; $\textit{their}\frac{992}{15} - \textit{their}57.6$
	$\frac{128}{15}$ or 8.53 oe	**A1**	allow 8.5333333.... rot to 4 or more sf