Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

ADDITIONAL MATHEMATICS **0606/12**

Paper 12 **March 2018**

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 International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the March 2018 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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.

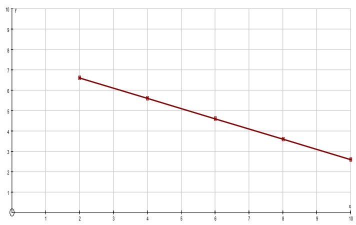
Abbreviations

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	Guidance
1	attempt at $\mathrm{p}(2)$ or $\mathrm{p}(-3)$	**M1**	
	$2\mathrm{p}(2) = \mathrm{p}(-3)$	**M1**	attempt at correct relationship
	$22 = a - b$	**A1**	may be implied, allow unsimplified
	$\mathrm{p}(-1) = 0$ $a + b = -2$	**B1**	B1 for $a + b = -2$, allow unsimplified
	$a = 10 \quad b = -12$	**A1**	A1 for both
2(i)	$k\cos 3x$	**M1**	
	$\frac{\mathrm{d}y}{\mathrm{d}x} = 15\cos 3x$	**A1**	A1 all correct
2(ii)	When $x = \frac{\pi}{3}$, $y = 4$	**B1**	for $y = 4$
	attempt to find the equation of the tangent	**M1**	
	$\frac{\mathrm{d}y}{\mathrm{d}x} = -15$ $y - 4 = -15\left(x - \frac{\pi}{3}\right)$ Equation of tangent $\left(\begin{array}{l} y = -15x + 5\pi + 4 \text{ or} \\ y = -15x + 19.7 \end{array}\right)$	**A1**	**A1FT** for correct equation, using *their* $\frac{\mathrm{d}y}{\mathrm{d}x}$, allow unsimplified
3(a)	$\frac{18 + 12\sqrt{5} - 6\sqrt{5} - 20}{4 - \sqrt{5}}$	**M1**	attempt to deal with the numerator
	$\frac{6\sqrt{5} - 2}{4 - \sqrt{5}} \times \frac{4 + \sqrt{5}}{4 + \sqrt{5}}$ $\frac{22\sqrt{5} + 22}{11}$	**M1**	attempt to rationalise
	$2\sqrt{5} + 2$	**A1**	must be convinced a calculator has not been used
3(b)	$AC^2 = \left(6 - 2\sqrt{3}\right)^2 + \left(6 + 2\sqrt{3}\right)^2$ $-2\left(6 - 2\sqrt{3}\right)\left(6 + 2\sqrt{3}\right)\left(-\frac{1}{2}\right)$	**M1**	application of the cosine rule
	simplification of surds	**M1**	**M1Dep**
	$AC = 2\sqrt{30}$	**A1**	

Question	Answer	Marks	Guidance
4(i)	–2	**B1**	
	$-\frac{1}{2} \leqslant x \leqslant \frac{1}{2}$	**B1**	
4(ii)	attempt to differentiate a quotient	**M1**	
	for $\frac{8x}{4x^2-1}$	**B1**	
	$\frac{dy}{dx} = \frac{(x+2)\frac{8x}{(4x^2-1)} - \ln(4x^2-1)}{(x+2)^2}$	**A1**	everything else correct
4(iii)	When $x = 2$ $\frac{dy}{dx} = \frac{4}{15} - \frac{\ln 15}{16}$ or 0.0974	**M1**	attempt to evaluate $\frac{dy}{dx}$ when $x = 2$ and attempt to use method of small changes
	$\partial y = 0.0974h$	**A1**	cao
5(i)	$n = 10$	**B1**	
	$10 \times 2^9 \times a = -1280$	**M1**	attempt to equate second terms
	$a = -\frac{1}{4}$	**A1**	
	${}^{10}C_2 \times 2^8 \times \left(-\frac{1}{4}\right)^2 = 720$	**M1**	attempt to equate third terms
	$b = 720$	**A1**	
5(ii)	$\left[\left(1024 - 1280x + 720x^2\right)\right]\left(\frac{1}{x^2} - 2 + x^2\right)$	**B1**	expansion of $\left(x - \frac{1}{x}\right)^2$
	Independent term $= 720 - 2048$	**M1**	attempt to find independent term, must be considering 2 terms
	$= -1328$	**A1**	Must be identified

Question	Answer	Marks	Guidance
6(i)	$\mathbf{c}-\mathbf{a}$	B1	
6(ii)	attempt to use the ratio	M1	
	$\overrightarrow{OM}=\mathbf{a}+\frac{2}{3}(\mathbf{c}-\mathbf{a})$ or $\mathbf{c}-\frac{1}{3}(\mathbf{c}-\mathbf{a})$ $\left(=\frac{2}{3}\mathbf{c}+\frac{1}{3}\mathbf{a}\right)$	A1	allow unsimplified
6(iii)	$\overrightarrow{OM}=\frac{3}{5}\mathbf{b}$	B1	
6(iv)	$\frac{3}{5}\mathbf{b}=\frac{2}{3}\mathbf{c}+\frac{1}{3}\mathbf{a}$	M1	attempt to equate *their* (ii) and (iii)
	$5\mathbf{a}+10\mathbf{c}=9\mathbf{b}$	A1	Must be convinced from simplification
6(v)	$\overrightarrow{AB}=\mathbf{b}-\mathbf{a}$ $=\frac{5}{9}\mathbf{a}+\frac{10}{9}\mathbf{c}-\mathbf{a}$	M1	use of (iv) with $\mathbf{b}-\mathbf{a}$ or $\mathbf{a}-\mathbf{b}$
	$=-\frac{4}{9}\mathbf{a}+\frac{10}{9}\mathbf{c}$	A1	
7(a)	$2a^2-4a=6-3a$ $2a^2-a-6=0$	M1	attempt to use determinant correctly, obtain a 3 term quadratic equation and attempt to solve correctly
	$a=2$	A1	
	$a=-\frac{3}{2}$	A1	
7(b)(i)	$\frac{1}{5}\begin{pmatrix}4 & -1\\ -3 & 2\end{pmatrix}$	B2	B1 for $\frac{1}{5}$ B1 for $\begin{pmatrix}4 & -1\\ -3 & 2\end{pmatrix}$
7(b)(ii)	$\mathbf{A}^{-1}\mathbf{AC}=\mathbf{A}^{-1}\mathbf{B}$	M1	for pre-multiplying
	$\mathbf{C}=\frac{1}{5}\begin{pmatrix}4 & -1\\ -3 & 2\end{pmatrix}\begin{pmatrix}2 & 0\\ -3 & 5\end{pmatrix}$	M1	**M1Dep** for attempt at matrix multiplication, at least 2 terms correct, allow with *their* inverse
	$=\frac{1}{5}\begin{pmatrix}11 & -5\\ -12 & 10\end{pmatrix}$ oe	A1	

Question	Answer	Marks	Guidance
7(c)	$\begin{pmatrix} -\frac{3}{4} & 0 \\ 0 & -\frac{3}{4} \end{pmatrix}$	**B1**	
8(i)	for attempt to integrate to obtain $k_1 e^{2t} + k_2 t^2$	**M1**	
	$x = 6e^{2t} - 24t^2 \quad (+c)$	**A1**	all correct, condone omission of $+ c$
	When $t = 0$, $x = 0$ $\therefore c = -6$	**M1**	**M1Dep** for attempt to find c
	$x = 6e^{2t} - 24t^2 - 6$	**A1**	
8(ii)	$\frac{d^2x}{dt^2} = 24e^{2t} - 48$	**M1**	attempt to differentiate to obtain $k_1 e^{2t} + k_2$
	When acceleration = 0, $e^{2t} = 2$ oe	**M1**	equating to zero and attempt to solve
	$t = \frac{1}{2}\ln 2$ or $t = \ln\sqrt{2}$ or 0.347	**A1**	
8(iii)	substitution of *their* (ii) into given equation for v	**M1**	
	$v = 24 - 24\ln 2$ or $24 - 48\ln\sqrt{2}$ or 7.36	**A1**	
9(i)	$\ln y = \ln A + bx$	**B1**	
9(ii)	$\ln y$  x	**M1**	attempt to plot $\ln y$ against x Allow $\lg y$ against x Allow $\lg y$ against $\lg e^x$
	straight line with all points joined	**A1**	

Question	Answer	Marks	Guidance
9(iii)	Gradient = b	M1	**M1Dep** on (ii) for attempt to find gradient and equate to b or $b\lg e$ if $\lg y$ plotted against x
	$b = -0.5$, allow -0.45 to -0.55	A1	value within the given range
	Intercept = $\ln A$ ($= 7.6$)	M1	**M1Dep** on (ii) for attempt to use intercept or coordinates of a point on the curve with *their* gradient to obtain A
	$A = 2000$ allow $1900 - 2100$	A1	
9(iv)	use of graph or appropriate substitution	M1	
	When $y = 500$, $x = 2.77$ allow $2.2 - 3.0$	A1	
9(v)	use of graph or appropriate substitution	M1	
	When $x = 5$, $\ln y = 5.1$ $y = 164$ allow $155 - 175$	A1	

Question	Answer	Marks	Guidance
10(i)	$y = -3x^3 - 11x^2 - 8x + 4$	**M1**	attempt to differentiate
	$\frac{dy}{dx} = -9x^2 - 22x - 8$	**A1**	all correct
	When $\frac{dy}{dx} = 0$, $9x^2 + 22x + 8 = 0$	**M1**	**M1Dep** for equating to zero and correct attempt to solve
	$x = -2$	**A1**	SC Allow B1 for $x = -2$ if A1 not obtained from differentiation
	$x = -\frac{4}{9}$	**A1**	
	10(i) Alternate scheme		
	$\frac{dy}{dx} = (x+2)^2(-3) + (1-3x)2(x+2)$	**M1**	attempt to differentiate
	all correct	**A1**	
	When $\frac{dy}{dx} = 0$, $(x+2)(-4-9x) = 0$ oe	**M1**	**M1Dep** for equating to zero and correct attempt to solve
	$x = -2$	**A1**	SC Allow B1 for $x = -2$ if A1 not obtained from differentiation
	$x = -\frac{4}{9}$	**A1**	
10(ii)	$D\left(\frac{1}{3}, 0\right)$	**B1**	Allow mismatch of letters
	$C\ (0, 4)$	**B1**	Allow mismatch of letters
10(iii)	Area $= \int_0^{\frac{1}{3}} -3x^3 - 11x^2 - 8x + 4\ dx$	**M1**	correct attempt to integrate a cubic equation
	$= \left[-\frac{3}{4}x^4 - \frac{11}{3}x^3 - 4x^2 + 4x\right]_0^{\frac{1}{3}}$	**A2**	A1 for 3 terms correct A1 for all correct
	$-\frac{3}{4}\left(\frac{1}{81}\right) - \frac{11}{3}\left(\frac{1}{27}\right) - \frac{4}{9} + \frac{4}{3}$	**M1**	**M1Dep** for application of limits
	$= \frac{241}{324}$ or 0.744	**A1**	