Cambridge Assessment International Education

Cambridge IGCSE™

ADDITIONAL MATHEMATICS **0606/12**

Paper 1 **March 2021**

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 2021 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.

Maths-Specific Marking Principles	
1	Unless a particular method has been specified in the question, full marks may be awarded for any correct method. However, if a calculation is required then no marks will be awarded for a scale drawing.
2	Unless specified in the question, answers may be given as fractions, decimals or in standard form. Ignore superfluous zeros, provided that the degree of accuracy is not affected.
3	Allow alternative conventions for notation if used consistently throughout the paper, e.g. commas being used as decimal points.
4	Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored (isw).
5	Where a candidate has misread a number in the question and used that value consistently throughout, provided that number does not alter the difficulty or the method required, award all marks earned and deduct just 1 mark for the misread.
6	Recovery within working is allowed, e.g. a notation error in the working where the following line of working makes the candidate's intent clear.

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.

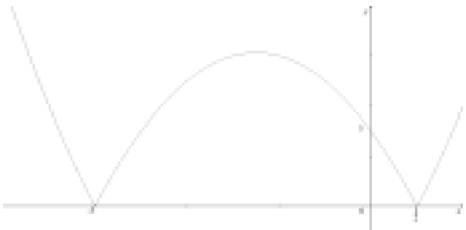
B Mark for a correct result or statement independent of Method marks.

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	$(3\ln 5x-1)(\ln 5x+1)=0$ $\ln 5x=\frac{1}{3},\ \ln 5x=-1$	**M1**	For recognition of a quadratic in $\ln 5x$ and attempt to solve to obtain $\ln 5x=k$
	$x=\frac{1}{5}e^{\frac{1}{3}},\ \frac{\sqrt[3]{e}}{5},\ e^{\frac{1}{3}-\ln 5}$ oe $x=\frac{1}{5e},\ \frac{e^{-1}}{5},\ e^{-1-\ln 5}$ oe	**3**	**Dep M1** for dealing with *their* $\ln 5x=k$ correctly once **A1** for $x=\frac{1}{5}e^{\frac{1}{3}}$ oe isw **A1** for $x=\frac{1}{5e}$ oe isw
2	$a=3$	**B1**	
	$b=\frac{1}{2}$	**B1**	
	$c=4$	**B1**	
3(a)	Gradient of line perp to AB $=-\frac{3}{4}$	**B1**	
	Mid-point of AB $(-1, 10)$ soi	**B1**	
	$y-10=-\frac{3}{4}(x+1)$ soi	**M1**	For attempt at straight line using *their* perp gradient and *their* mid-point
	$a-10=-\frac{3}{4}(7+1)$ $a=4$	**A1**	Allow $y=4$
3(b)	$(-9, 16)$	**2**	**B1** for $x=-9$ **B1 FT** on *their* a, **dep** on **M1** from **(a)** for $y=16$ or $20-$ *their* a **B1** for $-9,16$
4(a)	$2\left(x+\frac{5}{4}\right)^2-\frac{49}{8}$	**3**	**B1** for $b=\left(x+\frac{5}{4}\right)^2$ or $(x+1.25)^2$ **B1** for $c=-\frac{49}{8}$ or -6.125

Question	Answer	Marks	Guidance
4(b)	$\left(-\frac{5}{4}, -\frac{49}{8}\right)$ oe	2	**B1** for $-\frac{5}{4}$ as part of a set of coordinates or $x = -\frac{5}{4}$, **FT** on $-$ *their b* **B1** for $-\frac{49}{8}$ as part of a set of coordinates or $y = -\frac{49}{8}$ **FT** on *their c* Need to be using *their* answer to **(a)** and not using differentiation as 'Hence'. **B1** for $-\frac{5}{4}, -\frac{49}{8}$
4(c)		3	**B1** for correct shape, with maximum in the second quadrant and cusps on the x-axes and reasonable curvature for $x < -3$ and $x > 0.5$. **B1** for $(-3, 0)$ and $(0.5, 0)$ either seen on the graph or stated, must have attempted a correct shape **B1** for $(0, 3)$ either seen on the graph or stated, must have attempted a correct shape
4(d)	$\frac{49}{8}$ oe	B1	**FT** on *their* $\lvert c \rvert$ from **(a)** Allow $\frac{49}{8}$ from other methods
5(a)	$\begin{pmatrix} -4 \\ 3 \end{pmatrix} t$ or $\begin{pmatrix} 0 \\ 0 \end{pmatrix} + \begin{pmatrix} -4 \\ 3 \end{pmatrix} t$ oe	B1	
5(b)	$\begin{pmatrix} 12 \\ 6 \end{pmatrix} + \begin{pmatrix} -5 \\ 8 \end{pmatrix} t$ or $\begin{pmatrix} 12-5t \\ 6+8t \end{pmatrix}$	B1	

Question	Answer	Marks	Guidance
5(c)	$\overrightarrow{PQ}=\begin{pmatrix}12\\6\end{pmatrix}+\begin{pmatrix}-5\\8\end{pmatrix}t-\begin{pmatrix}-4\\3\end{pmatrix}t$	**M1**	For $their(b)-their(a)$, or $their(a)-their(b)$ Allow unsimplified. Both vectors must be in terms of t
	$\begin{pmatrix}12-t\\6+5t\end{pmatrix}$ soi	**B1**	
	$\left\|\left(\overrightarrow{PQ}\right)^2\right\|=(12-t)^2+(6+5t)^2$ $\left\|\left(\overrightarrow{PQ}\right)^2\right\|=26t^2+36t+180$	**A1**	Allow **FT** for use of modulus with $\begin{pmatrix}t-12\\-6-5t\end{pmatrix}$ and simplification to obtain the given result.
5(d)	Attempt to solve or consider the discriminant of $26t^2+36t+180=0$	**M1**	Must be using the equation from part (c) as 'Hence'.
	Conclusion from either $36^2-4(26)(180)<0$ or $t>0$	**A1**	Must have stated somewhere that $\left\|\left(\overrightarrow{PQ}\right)^2\right\|=0$ oe has been considered not just $\left\|\left(\overrightarrow{PQ}\right)^2\right\|$.
6(a)(i)	$a=10,\ \ 6=\dfrac{a}{1-r}$ $10=6-6r$	**M1**	For use of first term and sum to infinity to obtain an equation in r only
	$r=-\dfrac{2}{3}$	**A1**	
6(a)(ii)	$S_7=10\dfrac{\left(1-(their\ r)^7\right)}{1-\ their\ r}$	**M1**	For sum formula with $\|their\ r\|<1$.
	$S_7=6.35$	**A1**	
6(b)(i)	$\log_x 3$	**B1**	
6(b)(ii)	$S_n=\dfrac{n}{2}\left(2\log_x 3+(n-1)\log_x 3\right)$	**M1**	For use of sum formula with *their* (i)
	$\dfrac{n}{2}(n+1)\log_x 3,\ \dfrac{n}{2}\log_x 3^{n+1},\ \dfrac{n+1}{2}\log_x 3^n$	**A1**	Allow other similar equivalents
6(b)(iii)	$\dfrac{n}{2}(n+1)=3081$	**M1**	For a correct attempt to solve *their* (ii) $=3081\log_x 3$ to obtain an answer for n. Must be a 3 term quadratic in n only.
	$n=78$	**A1**	

Question	Answer	Marks	Guidance
6(b)(iv)	$1027=\frac{78}{2}(79)\log_x 3$ or $3081\log_x 3$	M1	For using *their* 78 in a sum equation or using 3081 to obtain x
	$x=27$	A1	
7(a)	$AE^2=\left(\sqrt{17}-1\right)^2+\left(\sqrt{17}+1\right)^2$ $=18+2\sqrt{17}+18-2\sqrt{17}$	M1	For attempt to find AE. Must see at least 3 terms in an expansion that is not the difference of two squares to be convinced a calculator is not being used.
	$AE=6$	A1	
	Perimeter = $4\sqrt{17}+8+\textit{their } AE$ $=4\sqrt{17}+14$	B1	**FT** on *their AE*
7(b)	Area = $\frac{1}{2}\left(3\sqrt{17}+7\right)\left(\sqrt{17}+1\right)$ oe $=\frac{1}{2}\left(51+3\sqrt{17}+7\sqrt{17}+7\right)$ oe	M1	For attempt at a trapezium or triangle and rectangle. Must see at least 3 terms in an expansion that is not the difference of two squares to be convinced a calculator is not being used. Allow one arithmetic slip.
	Area $=29+5\sqrt{17}$	A1	
7(c)	$\tan AED=\frac{\sqrt{17}+1}{\sqrt{17}-1}\times\frac{\sqrt{17}+1}{\sqrt{17}+1}$	M1	For attempt at rationalisation.
	$\frac{9+\sqrt{17}}{8}$	A1	Must come from $\frac{18+2\sqrt{17}}{16}$ to be convinced a calculator is not being used.
7(d)	$\sec^2 AED=\tan^2 AED+1$ $=\frac{\left(9+\sqrt{17}\right)^2}{64}+1$ $\frac{81+17+18\sqrt{17}+64}{64}$ oe if $\frac{\left(9+\sqrt{17}\right)^2}{64}$ and 1 are considered separately.	M1	For use of *their* **(c)** in the correct identity and attempt to simplify to obtain a single fraction. Must see at least 3 terms in an expansion that is not the difference of two squares to be convinced a calculator is not being used. Allow one arithmetic slip
	$\frac{81+9\sqrt{17}}{32}$ oe	A1	cao

Question	Answer	Marks	Guidance
8(a)(i)	$\sin x\dfrac{\sin x}{\cos x}+\cos x$	**B1**	
	$\dfrac{\sin^2 x+\cos^2 x}{\cos x}$ oe	**B1**	
	$\dfrac{1}{\cos x}=\sec x$	**B1**	Poor notation is B0
8(a)(ii)	$\sec\dfrac{\theta}{2}=4$ $\cos\dfrac{\theta}{2}=\dfrac{1}{4}$	**M1**	For use of (i) and dealing with sec to obtain $\cos\dfrac{\theta}{2}=\dfrac{1}{4}$
	$\dfrac{\theta}{2}=1.3181,\ \ 4.9651$ $\theta=2.64$ or 0.839π $\theta=9.93$ or 3.16π	**3**	**Dep M1** for a correct attempt to solve to obtain at least one solution for θ **A1** for one correct solution **A1** for a second correct solution and no extra solutions
8(b)	$\tan\left(y+38^\circ\right)=\dfrac{1}{\sqrt{3}}$ $y=172^\circ$ $y=352^\circ$	**3**	**M1** for dealing with cot and a correct attempt to obtain at least one correct solution, allow for -8° **A1** for one correct solution **A1** for a second correct solution and no extra solutions
9(a)	$(2x-1)\left(x^2-x-1\right)$	**M1**	For attempt at factorisation by observation or by algebraic long division
	$(2x-1)\left(x^2-x-1\right)$	**A1**	cao
9(b)	At A $x=\dfrac{1}{2}$	**B1**	
	$x^2-x-1=0$	**M1**	For a valid attempt to solve *their* quadratic equation, allow for decimal solutions
	$x=\dfrac{1\pm\sqrt{5}}{2}$ soi	**A1**	
	At B $x=\dfrac{1+\sqrt{5}}{2}$	**A1**	

Question	Answer	Marks	Guidance
9(c)	$\int \frac{1}{x}\,\mathrm{d}x = \ln x$	**B1**	
	$[\ln x]_{\frac{1}{2}}^{\frac{1+\sqrt{5}}{2}} = \ln\left(1+\sqrt{5}\right)$	**B1**	Allow $\ln\left(\frac{1+\sqrt{5}}{2}\right) - \ln\frac{1}{2}$
	$\left(\int -2x^2+3x+1\right)\mathrm{d}x = -\frac{2}{3}x^3+\frac{3x^2}{2}+x$	**M1**	**M1** for attempt at $-\frac{2}{3}x^3+\frac{3x^2}{2}+x$, must have 2 correct terms.
	$\left[-\frac{2}{3}x^3+\frac{3x^2}{2}+x\right]_0^{\frac{1}{2}}$ $=\left(-\frac{2}{3}\times\frac{1}{8}\right)+\left(\frac{3}{2}\times\frac{1}{4}\right)+\frac{1}{2}$ oe	**M1**	**Dep** for correct application of the limits 0 and $\frac{1}{2}$ and attempt to evaluate – may be implied by 0.792 or $\frac{19}{24}$.
	$\frac{19}{24}$	**A1**	
	$\ln\left(1+\sqrt{5}\right)+\frac{19}{24}$	**A1**	isw
10(a)	$\frac{(x-1)(6x)\left(2x^2+10\right)^{\frac{1}{2}}-\left(2x^2+10\right)^{\frac{3}{2}}}{(x-1)^2}$	**3**	**B1** for $\frac{3}{2}\times 4x\times\left(2x^2+10\right)^{\frac{1}{2}}$ oe **M1** for correct attempt at differentiation of a quotient **A1** for all the other terms correct
	$\left(\frac{\left(2x^2+10\right)^{\frac{1}{2}}}{(x-1)^2}\right)\left(4x^2-6x-10\right)$	**2**	**A2** for all 3 terms correct in the quadratic **A1** for 2 terms correct and 1 incorrect term in the quadratic **A0** for 1 term correct or no terms correct in the quadratic

Question	Answer	Marks	Guidance
10(b)	$4x^2 - 6x - 10 = 0$ $(2x-5)(x+1) = 0$	**M1**	For attempt to solve *their* quadratic = 0 and obtain at least one solution or state that *their* quadratic equation has no real roots.
	$x = \frac{5}{2}$	**A1**	
	Rejecting $x = -1$ correctly	**A1**	May be implied by the statement $x > 1$.
	Discounting $(2x^2 + 10)^{\frac{1}{2}} = 0$	**B1**	