Cambridge Assessment International Education

Cambridge IGCSE™

ADDITIONAL MATHEMATICS **0606/11**

Paper 1 **May/June 2023**

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 May/June 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

This document consists of **9** printed pages.

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.

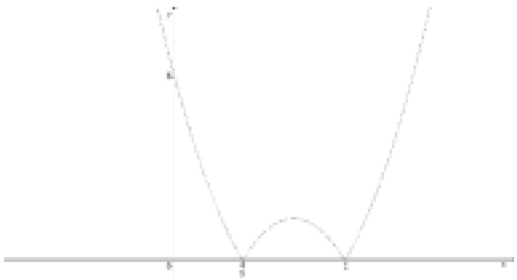
A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. For accuracy marks to be given, the associated Method mark must be earned or implied.

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(a)	$5\left(x-\frac{7}{5}\right)^2-\frac{9}{5}$	**3**	**B1** for $5(x \pm b)^2$ **B1** for $\left(x-\frac{7}{5}\right)^2$ **B1** for $-\frac{9}{5}$
	Alternative By comparing coefficients: $a(x^2+2bx+b^2)+c=5x^2-14x+8$. $2abx=-14x$ $ab^2+c=8$	**(3)**	**B1** for $a=5$ **B1** for $b=\frac{-14}{10}$ oe **B1** for $c=\frac{-18}{10}$ oe
1(b)	$\left(\frac{7}{5},\ -\frac{9}{5}\right)$	**2**	**FTB1** for each, follow through on *their* a and b from **(a)** **or** **SC1** if differentiation is used in *their* **(a)** or restarted in **(b)** $\frac{\mathrm{d}y}{\mathrm{d}x}=10x-14=0$ then $\left(\frac{7}{5},\ -\frac{9}{5}\right)$
1(c)		**3**	**B1** for the correct shape. Must have the parabola part of the curve with maximum in the first quadrant and cusps on the x-axis. Ignore labelling of their maximum point if incorrect coordinates **B1** for $\left(\frac{4}{5},\ 0\right)$ and (2, 0), must have a correct shape in the first quadrant. **B1** for (0, 8) must have a correct shape.
1(d)	$0<k<\frac{9}{5}$	**2**	**B1FT** follow through from 0 and *their* $-b$ in part **(a)**
2(a)	p′(x) = 3ax^2 + 14x + b p″(x) = 6ax + 14 leading to 3a + 14 = 32 a = 6	**2**	**M1** for attempt to differentiate twice and substitute $x=\frac{1}{2}$

Question	Answer	Marks	Guidance
2(b)	$\mathrm{p}\left(\frac{4}{3}\right)$: $80 + 4b + 3c = 0$ oe	M1	Must have 3 terms. For use of $x = \frac{4}{3}$, at least once **and** equating to 0 with an attempt at simplification leading to an equation in b and c only Allow one sign error.
	p(–1): $-b + c = 6$ oe	M1	Must have 3 terms. For use of $x = -1$ **and** equating to 7 with an attempt at simplification leading to an equation in b and c only
	$b = -14$, $c = -8$	2	**M1 dep** on both previous **M** marks and attempt to solve simultaneously to obtain both b and c **A1** for both
2(c)	$(3x - 4)(2x^2 + 5x + 2)$	2	**B1** for two terms correct in the quadratic factor. Allow if seen as a quotient in long division. For both marks, need to see both factors together. $\left(x - \frac{4}{3}\right)(6x^2 - 15x + 6)$ from synthetic method gets 0 marks unless recovered.
2(d)	$(3x - 4)(2x + 1)(x + 2)$	B1	Must be all integers
3(a)	Mid-point (6, –5)	B1	
	Gradient of $AB = -\frac{5}{2}$	B1	
	Perpendicular gradient $\frac{2}{5}$	M1	For *their* perp gradient
	$-9 + 5 = \frac{2}{5}(x - 6)$ oe $x = -4$	2	**Dep M1** for attempt at the equation of the perpendicular bisector with *their* mid-point and *their* perpendicular gradient and use of $y = -9$
3(b)	(16, –1)	2	**B1** for each, **FT** on 12 – *their a* for the x-coordinate.
4(a)	Area under graph = 800 $\frac{1}{2}(10 \times 10) + (10 \times 10) + \frac{1}{2}(10(10 + V)) + \frac{15V}{2} = 800$	M1	For attempt to find the area, allow one error and one omission.
	$V = 48$	A1	

Question	Answer	Marks	Guidance
4(b)	$(-)\dfrac{their\ V}{15}$	**M1**	Allow omission of negative sign.
	$-\dfrac{16}{5}$ ms^{-2} oe	**A1**	**FT** on *their V* but must be negative.
5(a)	$(5\sqrt{3}-6)^2+(5\sqrt{3}+6)^2-2(5\sqrt{3}-6)$ $(5\sqrt{3}+6)\cos 120°$ soi	**M1**	For the correct use of the cosine rule Condone missing brackets if intention is clear
	$75+36-60\sqrt{3}+75+36+60\sqrt{3}+75-36$	**M1**	**M1 Dep** must see sufficient detail to be sure that a calculator is not being used. This is the minimum acceptable $75+36-60\sqrt{3}+75+36+60\sqrt{3}+39$
	261	**A1**	Maybe implied by $\sqrt{261}$
	$3\sqrt{29}$	**A1**	
5(b)	$\dfrac{2+5\sqrt{5}}{4}=\dfrac{1}{2}(3+2\sqrt{5})\times QR\times\sin 30°$ soi	**M1**	For the correct use of the area of the triangle. Condone missing brackets if intention is clear
	$\dfrac{2+5\sqrt{5}}{3+2\sqrt{5}}\times\dfrac{3-2\sqrt{5}}{3-2\sqrt{5}}$ or $\dfrac{2+5\sqrt{5}}{3+2\sqrt{5}}\times\dfrac{-3+2\sqrt{5}}{-3+2\sqrt{5}}$	**M1**	**M1 dep** for a correct attempt to rationalise *their QR* .must be the same two terms in the numerator and denominator to rationalise
	$\dfrac{6+15\sqrt{5}-4\sqrt{5}-50}{9-20}$ $\dfrac{11\sqrt{5}-44}{-11}$	**M1**	**M1 dep**, must see sufficient detail to be sure that a calculator is not being used. This is the minimum acceptable $\dfrac{6+15\sqrt{5}-4\sqrt{5}-50}{-11}$
	$4-\sqrt{5}$	**A1**	

Question	Answer	Marks	Guidance
6(a)	$\dfrac{\dfrac{\cos\theta}{\sin\theta}+\dfrac{\sin\theta}{\cos\theta}}{\dfrac{1}{\cos\theta}}$ soi	**2**	**B1** for tan θ and cot θ in terms of sin and cos. **B1** for $\sec\theta=\dfrac{1}{\cos\theta}$
	$\dfrac{\cos^2\theta+\sin^2\theta}{\sin\theta\cos\theta}\times\cos\theta$ soi oe	**M1**	For dealing with the fractions in the numerator.
	$\dfrac{1}{\sin\theta}\times$ cosec θ cso	**A1**	For correct use of $\cos^2\theta+\sin^2\theta=1$ to obtain the given answer.
	$\dfrac{\dfrac{1}{\tan\theta}+\tan\theta}{\dfrac{1}{\cos\theta}}=\dfrac{1+\tan^2\theta}{\tan\theta}\times\cos\theta$ soi oe	**(2)**	**B1** for sec $\theta=\dfrac{1}{\cos\theta}$ **M1** for dealing with the fractions in the numerator.
	$\dfrac{\sec^2\theta}{\tan\theta}\times\cos\theta$	**(B1)**	For correct use of $\tan^2\theta+1=\sec^2\theta$
	$\dfrac{1}{\sin\theta}\times$ cosec θ cso	**(A1)**	For correct use of tan θ and $\sec^2\theta$ to obtain the given answer.
6(b)	$\left(\dfrac{1}{\sin\dfrac{\phi}{3}}\right)^2=2$ or $\sin\dfrac{\phi}{3}=\pm\dfrac{1}{\sqrt{2}}$ soi or $\tan\dfrac{\phi}{3}=\pm1$ soi	**B2**	**B1** for ± missing
	–405°, –135°, 135°, 405°	**4**	**M1** for one correct positive or negative solution of *their* $\sin\dfrac{\phi}{3}=k$ **A1** for another correct solution **M1Dep** for one negative or positive solution **A1** for another correct solution and no extras in the range.
7(a)(i)	6435	**B1**	Must be evaluated not just ${}^{15}C_8$
7(a)(ii)	With family of 4: 330	**B1**	Must be evaluated not just ${}^{11}C_4$ or implied by a correct answer
	Without family of 4: 165	**B1**	Must be evaluated not just ${}^{11}C_8$ or implied by a correct answer
	Total: 495	**B1**	

Question	Answer	Marks	Guidance
7(b)	$\frac{(n+9)\times n!}{(n-10)!}=\frac{(n^2+243)(n-1)!}{(n-1-9)!}$ $n(n+9)=n^2+243$ oe	**2**	**B1** for either ${}^nP_{10}=\frac{n!}{(n-10)!}$ *or* ${}^nP_{10}=\frac{(n-1)!}{(n-1-9)!}$ **B1 dep** for $n(n+9)=n^2+243$
	$n=27$	**B1**	
8(a)	$\frac{(2x+1)\times\frac{1}{3}\times 3(3x-4)^{-\frac{2}{3}}-2(3x-4)^{\frac{1}{3}}}{(2x+1)^2}$ oe or by using the product rule $\frac{1}{3}\times 3\times(3x-4)^{-\frac{2}{3}}\times(2x+1)^{-1}+-2\times$ $(2x+1)^{-2}(3x-4)^{\frac{1}{3}}$	**3**	**B1** for $\frac{1}{3}\times 3\times(3x-4)^{-\frac{2}{3}}$ oe **M1** for an attempt to differentiate a quotient. **A1** for all terms other than $\frac{1}{3}\times 3\times(3x-4)^{-\frac{2}{3}}$ correct. Allow unsimplified.
	$\frac{(3x-4)^{-\frac{2}{3}}}{(2x+1)^2}$ $((2x+1)-2(3x-4))$	**M1**	**M1 dep** for attempt to factorise, must be in the form $\frac{(3x-4)^{-\frac{2}{3}}}{(2x+1)^2}$ $[(ax+1)-b(3x-4)]$
	$\frac{9-4x}{(2x+1)^2(3x-4)^{\frac{2}{3}}}$	**A1**	
8(b)	(2.25, 0.255)	**2**	**B1 FT** for *their* x-coordinate only. Do not allow **FT** if they score **M0** in part **(a)**
9(a)	$n=57$ cso	**3**	**B1** for $\frac{n}{2}(2\ln q+3(n-1)\ln q)$ oe soi Allow if in indices form i.e.: $\frac{n}{2}(\ln q^2+(n-1)\ln q^3)$ **B1** for $3n^2-n-9690=0$ oe soi
9(b)	Common ratio $=p^{-2x}$	**B1**	Allow unsimplified
	nth term $=p^{3x}(p^{-2x})^{n-1}$ soi	**B1**	Allow unsimplified
	$p^{(5-2n)x}$	**B1**	

Question	Answer	Marks	Guidance
9(c)	Common ratio = $\frac{4}{3}\cos^2 3\theta$	**B1**	Allow unsimplified. Must be convinced it is the common ratio not just writing the first term e.g. r = or seeing $\dfrac{\frac{16}{9}\cos^4 3\theta}{\frac{4}{3}\cos^2 3\theta}$
	$\frac{4}{3}\cos^2 3\theta(*) -1$ or $\frac{4}{3}\cos^2 3\theta(*)\ 1$ or oe soi $\frac{4}{3}\cos^2 3\theta(*)\ 0$	**B1**	
	$\cos 3\theta(*)\frac{\sqrt{3}}{2}$ or $\cos 3\theta(*) -\frac{\sqrt{3}}{2}$ or soi $\cos 3\theta(*)\ 0$	**B1**	
	$3\theta(*)\frac{5\pi}{6}$ **and** $3\theta(*)\frac{\pi}{6}$ soi	**B1**	Seeing $\frac{5\pi}{18}$ or $\frac{\pi}{18}$ implied the first 3 marks
	$\frac{\pi}{18} < \theta \leqslant \frac{5\pi}{18}$	**B1**	
10(a)	$\frac{dy}{dx} = 2\times 3(3x+1)\ln(3x+1) + \frac{3(3x+1)^2}{3x+1}$ Simplified to: $\frac{dy}{dx} = 3(3x+1)(1+2\ln(3x+1))$	3	**B1** for $\frac{3}{3x+1}$ **M1** for attempt to differentiate a product **A1** for all terms other than $\frac{3}{3x+1}$ correct. Allow unsimplified.
10(b)	$k(3x+1)^2\ln(3x+1)$ soi	**B1**	
	$\int(3x+1)dx = \frac{3x^2}{2} + x\ (+c)$	**B1**	May be a multiple May be seen as $\frac{1}{3}\times\frac{1}{2}\times(3x+1)^2$
	$\frac{1}{6}(3x+1)^2\ln(3x+1) - \frac{3x^2}{4} - \frac{x}{2} + c$	**B2**	**B1** for two correct algebraic terms For **B2** must have (+ c)