CAMBRIDGE
International Education

Cambridge IGCSE™

ADDITIONAL MATHEMATICS **0606/13**

Paper 1 **May/June 2024**

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 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

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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 descriptions 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.

Mathematics-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, non-integer 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 or sign 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 A or B 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.

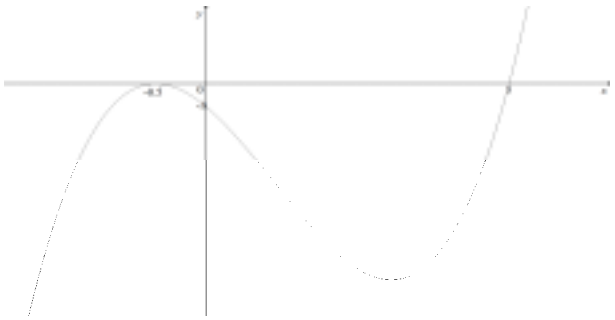
B Mark for a correct result or statement independent of Method marks.

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.

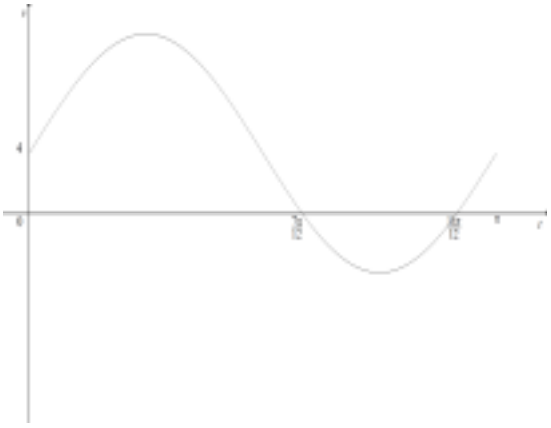
Abbreviations

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	$a = 4$	**B1**	
	$b = \frac{3}{8}$ or 0.375 oe	**B1**	
	$c = 2$	**B1**	
2	$6\left(2^{2x}\right) - 11\left(2^{x}\right) + 3 = 0$ soi	**B1**	
	$2^x = \frac{1}{3}, \quad 2^x = \frac{3}{2}$	**2**	**M1** for solution of *their* quadratic equation in 2^x or appropriate substitution to obtain $2^x = ...$
	$-1.58, \quad 0.58$	**A1**	For both

Question	Answer	Marks	Guidance
3(a)	$\frac{dy}{dx} = (2x+1)^2 + 4(2x+1)(x-3)$ or $\frac{dy}{dx} = 12x^2 - 16x - 11$	**M1**	For correct attempt to differentiate a product or expansion and then differentiate.
	$x = -\frac{1}{2}, \quad \frac{11}{6}$	**2**	**M1** for setting *their* quadratic $\frac{dy}{dx}$ to zero and attempting to solve to obtain two x values.
	$y = 0, \quad -\frac{686}{27}$ or -25.4	**A1**	For both Must be separate inequalities
3(b)		**3**	**B1** for correct shape with max on the negative x-axis and a min in the 4th quadrant **B1** for correct x intercepts $-\frac{1}{2}$ and 3. Must have a cubic curve **B1** for correct y intercept -3. Must have a cubic curve
3(c)	$k > 0$	**B1**	
	$k < -\frac{686}{27}$ or $k < -25.4$	**B1**	**FT** on *their* $-\frac{686}{27}$ or -25.4 from part (a)
4	$1 + 2e^{2x} + e^{4x}$	**B1**	For correct integrand
	$x + e^{2x} + \frac{e^{4x}}{4}$	**B2**	**B1** for 2 correct terms in integral
	$\left(2 + e^4 + \frac{e^8}{4}\right) - \left(1 + \frac{1}{4}\right)$	**M1**	For correct application of limits. Must be in the form $me^{4x} + ne^{2x} + x$
	$\frac{3}{4} + e^4 + \frac{e^8}{4}$	**A1**	

Question	Answer	Marks	Guidance
5(a)	$e^{2y} = mx^3 + c$ soi	**B1**	May be seen later
	Either $7.2 = 6.4m + c$ or $5 = 2m + c$ Or gradient = $m = \frac{1}{2}$	**M1**	For correct use of coordinates at least once or for finding the gradient and equating it to m
	$m = \frac{1}{2}$, $c = 4$	**A1**	For both
	$y = \frac{1}{2}\ln\left(\frac{x^3}{2} + 4\right)$ oe	**A1**	
5(b)	$\frac{x^3}{2} + 4 > 0$	**M1**	Allow *their* $\frac{x^3}{2} + 4 > 0$
	$x > -2$	**A1**	
6(a)	$\frac{(x+2)\frac{4x}{(2x^2+1)} - \ln(2x^2+1)}{(x+2)^2}$	**3**	**B1** for $\frac{4x}{(2x^2+1)}$ **M1** for correct attempt at a quotient or equivalent product **A1** for all other terms correct
6(b)	When $x = 1$, $\frac{dy}{dx} = \frac{4 - \ln 3}{9}$ or 0.322	**B1**	
	$\frac{4 - \ln 3}{9}h$ or $0.322h$	**B1**	**FT** on *their* $\frac{4 - \ln 3}{9}$ or 0.322
6(c)	$\frac{dx}{dt} = \frac{3}{\text{their } 0.322}$	**M1**	
	9.31 or 9.32	**A1**	
7(a)	Ending in 0: 15120 or ${}^9P_5$ or $9 \times 8 \times 7 \times 6 \times 5$ oe	**B1**	
	Ending in 5: 13440 or ${}^8P_1 \times {}^8P_4$ or $8 \times 8 \times 7 \times 6 \times 5$ oe	**B1**	
	Total: 28560	**B1**	

Question	Answer	Marks	Guidance
7(b)	$\frac{(n+1)!}{(n-12)!13!} = \frac{16n!}{(n-12)!12!}$ soi	**B1**	
	$n+1 = 13\times16$ oe	**B1**	**Dep** on previous **B** mark for either $n+1$ or 13×16
	$n = 207$	**B1**	**Dep** on previous 2 **B** marks
8	When $x=2$, $y=12$	**B1**	
	$\frac{dy}{dx} = \frac{15}{2}(5x+6)^{-\frac{1}{2}}$	**2**	**M1** for $k(5x+6)^{-\frac{1}{2}}$, $k \neq \frac{15}{2}$
	When $x=2$, $\frac{dy}{dx} = \frac{15}{8}$,	**A1**	
	perp gradient = $-\frac{8}{15}$	**M1**	**Dep** on previous **M** mark. Allow for use of *their* gradient to obtain perp gradient
	Normal equation: $y-12 = -\frac{8}{15}(x-2)$	**M1**	Allow for using *their* perp gradient and *their y*
	When $x=-2$ $k = \frac{212}{15}$ or $14\frac{2}{15}$	**A1**	
9(a)	$v = 4+8\sin 2t$	**2**	**M1** for $v = 4+k\sin 2t$, $k \neq 8$
9(b)		**5**	**B1** for a complete correct cycle between $t=0$ and $t=\pi$ **B1** for $v=4$, must have a sine curve **M1** for correct attempt to find one *t*-intercept using their *v*, must be in the form $4+k\sin 2t$ and $0<t<\pi$ Allow **M1** for 105^o or 165^o seen **A1** for $t = \frac{7\pi}{12}$ **A1** for $t = \frac{11\pi}{12}$
9(c)	$a = 16\cos 2t$	**B1**	**FT** on *their v* which must be in the form $4+k\sin 2t$
9(d)	$t = \frac{\pi}{4}$, $\frac{3\pi}{4}$	**2**	**B1** for each Must be from $\cos 2t = 0$

Question	Answer	Marks	Guidance
10(a)(i)	$a+d=14$ soi	**B1**	
	$a(a+d)(a+2d)=-6720$	**B1**	
	$a\times14\times(a+2d)=-6720$, leading to $a(a+2d)=-480$	**B1**	**Dep** on both previous **B** marks **AG**, needs sufficient detail
10(a)(ii)	$(14-d)(14+d)=-480$ or $a(28-a)=-480$	**M1**	For attempt to obtain a quadratic equation in one variable
	$d^2=676$ or $a^2-28a-480=0$	**A1**	
	$a=40,\ d=-26$	**A2**	**A1** for each
10(b)	$ar^2=\dfrac{e^{4x}}{4}$	**B1**	
	$ar^9=\dfrac{e^{11x}}{512}$	**B1**	
	$r^7=\dfrac{e^{7x}}{128}$ oe	**M1**	For a correct attempt to solve *their* 2 equations. Must be the same structure to obtain $r^7=...$
	$r=\dfrac{e^x}{2}$	**A1**	
	$a=e^{2x}$	**A1**	

Question	Answer	Marks	Guidance
11	$12\log_{81} y = 3\log_3 y$ oe or $4\log_9 x = 2\log_3 x$ oe	**B1**	For either
	$8\log_3 x + 3\log_3 y = 5$ oe	**B1**	
	$2\log_3 x + 3\log_3 y = 2$ oe	**B1**	
	$y = 3^{\frac{1}{3}}, x = \sqrt{3}$	**3**	**M1** for attempt to solve *their* equations. Must have at least 2 **B** marks and obtain 2 solutions **A1** for each
	Alternative		
	$12\log_{81} y = \dfrac{\log_3 y^{12}}{4}$ oe or $4\log_9 x = \dfrac{\log_3 x^4}{2}$ oe	**B1**	
	$x^{32}y^{12} = 3^{20}$ or $x^8y^3 = 3^5$ oe	**B1**	
	$x^4y^6 = 3^4$ or $x^2y^3 = 3^2$ oe	**B1**	
	$y = 3^{\frac{1}{3}}, x = \sqrt{3}$	**3**	**M1** for attempt to solve *their* equations, which must both be in the correct form. Must have at least 2 **B** marks and obtain 2 solutions **A1** for each
12	$\cos\left(3\theta - \dfrac{\pi}{2}\right) = \dfrac{1}{2}$ oe soi	**B1**	
	$\theta = -\dfrac{7\pi}{18}, \dfrac{\pi}{18}, \dfrac{5\pi}{18}$	**4**	**M1 dep** on previous **B** mark, for one of the following $3\theta - \dfrac{\pi}{2} = -\dfrac{5\pi}{3}, -\dfrac{\pi}{3}, \dfrac{\pi}{3}, \dfrac{5\pi}{3}$ **A1** for one correct solution **A1** for a second correct solution **A1** for a third correct solution and no extra solutions in the range.