



Cambridge O Level

ADDITIONAL MATHEMATICS

4037/21

Paper 2

May/June 2022

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 2022 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 **8** 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
nfw	not from wrong working
oe	or equivalent
rot	rounded or truncated
SC	Special Case
soi	seen or implied

Question	Answer	Marks	Partial Marks
1(a)	$w - 1 = \log_5 12$ or $w - 1 = \frac{\log 12}{\log 5}$	M1	
	$w = 2.54$ cao	A1	
1(b)	Rewrites in quadratic form e.g.: $y = x^{\frac{1}{3}} \quad y^2 - 5y + 6 = 0$ or $\left(x^{\frac{1}{3}}\right)^2 - 5x^{\frac{1}{3}} + 6 = 0$	M1	
	and factorises or solves e.g. : $(y - 2)(y - 3) = 0$	M1	Factorising <i>their</i> 3 term quadratic
	$x = 8$ and $x = 27$	A1	
2(a)	$\lg \frac{x^2}{3(x+6)}$ oe, nfw	B2	B1 for any two log laws applied correctly e.g. $\lg \frac{x^2}{x+6} - \lg 3$
2(b)	$\lg \frac{x^2}{3(x+6)} = \lg 1$ or $10^0 = \frac{x^2}{3(x+6)}$	B1	FT <i>their</i> $\lg \frac{x^2}{3(x+6)}$ providing a single logarithm
	$x^2 - 3x - 18 = 0$	B1	dep on B2 in part (a)
	Factorises or solves their 3-term quadratic	M1	
	$x = 6$ indicated as only solution	A1	dep on B2 in part (a)
3	Valid method to find m $m = \frac{8-1}{9-16} [= -1]$	M1	
	Valid method to find c e.g. $1 = \text{their}(-1) \times 16 + c$	M1	FT their m
	$\sqrt[3]{y} = \text{their}(-1)x^2 + \text{their}17$	A1	Equation with correct variables and $\sqrt[3]{y} =$
	$y = (-x^2 + 17)^3$ oe, isw	A1	

Question	Answer	Marks	Partial Marks
4	$27m - 153 + 3n + 6 = 0$ or better	B1	
	$-m - 17 - n + 6 = -12$ or better	B1	
	Eliminates one unknown for a pair of linear equations in m and n and solves for one unknown	M1	
	$m = 6, n = -5$	A2	A1 for either
	-24 cao	A1	
5(a)(i)	$1 + 4nx + 8n(n - 1)x^2$	B2	B1 for any two correct terms or all 3 correct but listed not summed
5(a)(ii)	$8n(n - 1) - 16n$	M1	FT from (i) identifying correct terms and combining <i>their</i> coefficient of $x^2 - 4 \times$ <i>their</i> coefficient of x
	Solves or factorises <i>their</i> 3-term quadratic in n only	M1	Forms a 3-term quadratic $= 0$ and solves except allow ‘ $=$ a constant’ if they go on to complete to square
	$n = 29$ only	A1	
5(b)	${}^{10}C_2 \times \left(\frac{x}{2}\right)^8 \times \left(-\frac{8}{x^4}\right)^2$ soi	M1	Must be clearly identified not in expansion
	11.25 or $\frac{45}{4}$	A1	
6(a)(i)	$6 \times 6 \times 5 \times 4 \times 3$ oe	M1	
	2160	A1	
6(a)(ii)	Full correct calculation ($360 + 900$) ‘how many end with 0’+ ‘how many end with 2, 4, 6’ oe	M2	M1 for any correct product soi Eg $(6 \times 5 \times 4 \times 3 \times 1)$ or 360 $(5 \times 5 \times 4 \times 3 \times 1)$ or 300 $(5 \times 5 \times 4 \times 3 \times 3)$ or 900
	1260 cao	A1	
6(b)	${}^{15}C_7 - {}^9C_7$	M1	
	6399	A1	

Question	Answer	Marks	Partial Marks
6(c)(i)	$\frac{n!}{(n-3)!3!} + \frac{n!}{(n-2)!2!}$	B2	B1 for either expression correct
	$\frac{n(n-1)(n-2)}{6} + \frac{n(n-1)}{2}$	M2	M1 for either expression correct
	$\frac{n(n-1)(n-2+3)}{6}$ or $\frac{n^3-3n^2+2n}{6} + \frac{3n^2-3n}{6}$ leading to $\frac{1}{6}(n^3-n)$	A1	
6(c)(ii)	$n(n^2-25)=0$ oe	M1	
	$n=5$ as the only solution	A1	
7	$\frac{d}{dx}(\sin 3x) = 3 \cos 3x$ soi	B1	
	$u = (1 + \sin 3x)^4$ $\frac{du}{dx} = 4(1 + \sin 3x)^3 (3 \cos 3x)$ soi	M1	FT <i>their</i> $3 \cos 3x$
	$\frac{dy}{dx} = \frac{\sqrt{x} (4(1 + \sin 3x)^3 (3 \cos 3x)) - (1 + \sin 3x)^4 \times \frac{1}{2} x^{-\frac{1}{2}}}{(\sqrt{x})^2}$	M1	FT <i>their</i> $\frac{du}{dx}$ or <i>their</i> $\frac{dv}{dx}$ but not both
	Correct derivative	A1	
	Evaluates <i>their</i> derivative at $x = 1.9$ and multiplies by h	M1	
	$0.651h$	A1	
8(a)	$x = 6\sqrt{3} \sin 60$ $y = -6\sqrt{3} \cos 60$ oe and completion to $9\mathbf{i} - 3\sqrt{3}\mathbf{j}$	B2	B1 for either x or y correct Allow SC1 for verification that $9\mathbf{i} - 3\sqrt{3}\mathbf{j}$ has a bearing of 120° and that $9\mathbf{i} - 3\sqrt{3}\mathbf{j}$ has a magnitude of $6\sqrt{3}$
8(b)	$(5\mathbf{i} + 16\mathbf{j}) + 3(9\mathbf{i} - 3\sqrt{3}\mathbf{j})$ oe, isw	B1	
8(c)	$29\mathbf{i} + 16\mathbf{j} + t(-12\sqrt{3}\mathbf{j})$ oe, isw	B1	

Question	Answer	Marks	Partial Marks
8(d)	Forms $\overrightarrow{AB}$ or $\overrightarrow{BA}$ when $t = 1$ e.g. $\overrightarrow{BA} = (32\mathbf{i} + (16 - 9\sqrt{3})\mathbf{j}) - (29\mathbf{i} + (16 - 12\sqrt{3})\mathbf{j})$ oe	B1	FT <i>their</i> (b) and (c) with $t = 1$
	$\sqrt{3^2 + (3\sqrt{3})^2}$	M1	FT <i>their</i> $\overrightarrow{AB}$ or $\overrightarrow{BA}$
	6 (km)	A1	cao
9(a)	$h = \sqrt{x^2 - \left(\frac{x}{2}\right)^2}$ oe or $\cos 30 = \frac{h}{x}$ oe or $\frac{1}{2}xh = \frac{1}{2}x^2 \sin 60$	M1	Correct expression connecting x and h
	$x = \frac{2h}{\sqrt{3}}$ oe	A1	Must be $x =$
	$V = \frac{1}{2} \times \left(\text{their } \frac{2h}{\sqrt{3}}\right)^2 \times \sin 60^\circ \times 5$ or $\frac{1}{2} \times h \times \text{their } \frac{2h}{\sqrt{3}} \times 5$	M1	
	Correct completion to given answer $V = \frac{5\sqrt{3}h^2}{3}$	A1	
9(b)	Correct derivative of V e.g. $\frac{10\sqrt{3}}{3}h$	B1	
	$\frac{dh}{dt} = \frac{dV}{dt} \times \frac{dh}{dV}$ soi	B1	Not $\frac{\partial V}{\partial h}$
	$0.5 \div \left(\frac{10\sqrt{3}}{3} \times 0.1\right)$ oe	M1	
	0.866 (metres per minute) or 0.8660[25...] rot to 4 or more sf	A1	Allow $\frac{\sqrt{3}}{2}$ isw
10(a)	$\ln x - 1$	B2	B1 for $[1 \times] \ln x + x \times \frac{1}{x} [-2]$ oe

Question	Answer	Marks	Partial Marks
10(b)	$x + \frac{1}{x} + 2$	B1	
	$\frac{dy}{dx} = \frac{x^2}{2} + \ln x + 2x (+c)$	M2	M1 for $\frac{dy}{dx} = \dots + \ln x + \dots$ or for $\frac{dy}{dx} = \frac{x^2}{2} + \dots + 2x$
	Substitution to find c : $\frac{e^2}{2} + 2e = \frac{e^2}{2} + \ln e + 2e + c$ $[c = -1]$	M1	FT <i>their</i> attempt to integrate dependent on at least M1
	$y = \int \left(\frac{x^2}{2} + 2x + \ln x - 1 \right) dx$	A1	
	Integrates and uses (a) $y = \frac{x^3}{6} + \frac{2x^2}{2} + x \ln x - 2x + C$	M1	Dependent on M2M1 FT error in c only
	$\frac{e^3}{6} + e^2 = \frac{e^3}{6} + e^2 + e \ln e - 2e + C$	M1	Substitution to find C Dependent on previous M1
	$y = \frac{x^3}{6} + x^2 + x \ln x - 2x + e$	A1	
11	$B\left(\frac{\pi}{10}, 0\right) \text{ soi}$	B1	
	$\int_0^{\frac{\pi}{4}} e^{\frac{x}{2}} dx - \int_0^{\frac{\pi}{10}} \cos 5x dx$	M2	M1 Integrates $e^{\frac{x}{2}}$ to $ke^{\frac{x}{2}}$, $k \neq 0$ M1 Integrates $\cos 5x$ to $k \sin 5x$, $k > 0$ or $k = -\frac{1}{5}$
	$\left[2e^{\frac{x}{2}} \right]_0^{\frac{\pi}{4}} - \left[\frac{\sin 5x}{5} \right]_0^{\frac{\pi}{10}}$	A2	A1 for each part correct
	$\left[2e^{\frac{\pi}{8}} - 2e^0 \right] - \left[\frac{1}{5} \sin \frac{5\pi}{10} - \frac{1}{5} \sin 0 \right]$	M1	M1 for correct attempt at subtraction and for one correct use of limits dependent on at least M1 for integration and B1
	$2e^{\frac{\pi}{8}} - \frac{11}{5} \text{ isw}$	A1	