Cambridge Assessment International Education

Cambridge O Level

ADDITIONAL MATHEMATICS **4037/22**

Paper 2 **May/June 2020**

MARK SCHEME

Maximum Mark: 80

Published

Students did not sit exam papers in the June 2020 series due to the Covid-19 global pandemic.

This mark scheme is published to support teachers and students and should be read together with the question paper. It shows the requirements of the exam. The answer column of the mark scheme shows the proposed basis on which Examiners would award marks for this exam. Where appropriate, this column also provides the most likely acceptable alternative responses expected from students. Examiners usually review the mark scheme after they have seen student responses and update the mark scheme if appropriate. In the June series, Examiners were unable to consider the acceptability of alternative responses, as there were no student responses to consider.

Mark schemes should usually be read together with the Principal Examiner Report for Teachers. However, because students did not sit exam papers, there is no Principal Examiner Report for Teachers for the June 2020 series.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the June 2020 series for most Cambridge IGCSE™ and Cambridge International A & 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	Partial Marks
1	$\frac{\mathrm{d}y}{\mathrm{d}x} = \cos x - \mathrm{e}^{-x}$	B2	**B1** for $\cos x$ or $-\mathrm{e}^{-x}$
	$\delta y = \textit{their} \left.\frac{\mathrm{d}y}{\mathrm{d}x}\right\|_{x=\frac{\pi}{4}} \times h$	M1	
	$0.251h$	A1	
2	Squares: $(1-\sqrt{5})^2 = 1-\sqrt{5}-\sqrt{5}+5$	B1	or rationalises $\frac{10+2\sqrt{5}}{(1-\sqrt{5})^2} \times \frac{(1+\sqrt{5})^2}{(1+\sqrt{5})^2}$
	Rationalises, e.g. $\frac{10+2\sqrt{5}}{6-2\sqrt{5}} \times \frac{6+2\sqrt{5}}{6+2\sqrt{5}}$	B1	or squares $(1+\sqrt{5})^2 = 1+\sqrt{5}+\sqrt{5}+5$
	Multiplies out, e.g. $\frac{60+20\sqrt{5}+12\sqrt{5}+4(5)}{36-20}$	M1	Multiplies out $\left[\frac{10+2\sqrt{5}}{(1-\sqrt{5})^2} \times \frac{6+2\sqrt{5}}{(1+\sqrt{5})^2} = \right]$ $\frac{60+20\sqrt{5}+12\sqrt{5}+4(5)}{(1-5)^2}$
	$5+2\sqrt{5}$	A2	A1 for $k+2\sqrt{5}$ or $5+k\sqrt{5}$
3	$x-3 = k^2x^2+5kx+1$	M1	
	$k^2x^2+(5k-1)x+4=0$ soi	A1	
	$(5k-1)^2-4(k^2)(4)$	M1	
	$9k^2-10k+1*0$	M1	
	Critical values: $\frac{1}{9}$ and 1 soi	A1	
	$k<\frac{1}{9}$ or $k>1$	A1	

Question	Answer	Marks	Partial Marks
4	Factorised form: $(x+n)(x-n)(2x-1)$ oe	**B1**	
	Multiplies out correctly	**M1**	**FT** *their* factorised form provided of equivalent difficulty
	Correct expanded form in terms of *n*: $2x^3 - x^2 - 2n^2x + n^2$	**A1**	
	Uses (*their* n^2) = 4 in *their* expression	**M1**	
	$2x^3 - x^2 - 8x + 4$	**A1**	If **A0A0** then **SC1** for $(x+n)(x-n)(x-0.5)$ giving $n^2 = 8$ leading to $x^3 - \frac{1}{2}x^2 - 8x + 4$
			Alternative method: **B1** for factorised form: $(x+n)(x-n)(2x-1)$
			M1 for *their* $n^2 = 4$
			A1 for $n = 2$
			M1 for multiplying out $(x + \textit{their}\,2)(x - \textit{their}\,2)(2x-1)$
			A1 for $2x^3 - x^2 - 8x + 4$ If **A0A0** then **SC1** for $(x+n)(x-n)(x-0.5)$ giving $n^2 = 8$ leading to $x^3 - \frac{1}{2}x^2 - 8x + 4$
5(a)	Finds coordinates of mid-point (8, –2)	**B1**	
	$m_{AB} = \frac{3+7}{4-12}\left[= -\frac{5}{4}\right]$ oe soi	**B1**	
	$m_L = \frac{-1}{-5/4}$ oe	**M1**	
	$y + 2 = \frac{4}{5}(x-8)$ oe isw	**A1**	

Question	Answer	Marks	Partial Marks
5(b)	$y-12=-\frac{5}{4}(x-5)$	**B1**	
	Attempts to solve *their* equations	**M1**	
	(13, 2)	**A2**	**A1** for $x = 13$ or $y = 2$
6(a)	$\frac{dy}{dx}=\sec^2 2x$	**B1**	
	$their\left.\frac{dy}{dx}\right\rvert_{x=\frac{\pi}{8}}=their2$	**B1**	**FT** *their* $\frac{dy}{dx}$
	$x=\frac{\pi}{8},\quad y=4$	**B1**	
	$y-their4=(their2)\left(x-\frac{\pi}{8}\right)$ oe	**M1**	
	$2x-y=\frac{\pi}{4}-4$	**A1**	
6(b)	$\sqrt{\left(\frac{\pi}{8}-2\right)^2+\left(4-\frac{\pi}{4}\right)^2}$ oe	**M1**	
	3.59 or 3.59[03…] rot to four or more figs	**A1**	
7(a)	$2\ln(5x+2)$	**B2**	**B1** for $k\ln(5x+2)$
	$2(\ln(22)-\ln(2))$ oe soi	**M1**	
	$2\ln 11$ or $\ln 121$ or $\ln 11^2$	**A1**	
7(b)	$\int e^{8x+4}dx$	**M1**	
	$\left[\frac{1}{8}e^{8x+4}\right]_0^{\ln 2}$	**M1**	
	$\frac{1}{8}\left(e^{\ln 2^8}\times e^4-e^4\right)$ oe	**M2**	**M1** for $\frac{1}{8}\left(e^{\ln 2^8+4}-e^4\right)$
	$\frac{255}{8}e^4$ or exact equivalent	**A1**	

Question	Answer	Marks	Partial Marks
8(a)	$3(\text{cosec}^2 x - 1) - 14\,\text{cosec}\,x - 2 [= 0]$	M1	
	$3\text{cosec}^2 x - 14\text{cosec}\,x - 5 = 0$	A1	
	$(\text{cosec}x - 5)(3\text{cosec}x + 1)$	M1	
	$\sin x = \frac{1}{5}$ nfww	A1	
	11.5 and 168.5 nfww	A1	
8(b)	Correct use of $\sin^2 y + \cos^2 y = 1$	B1	
	Factorises using the difference of 2 squares	B1	
	Uses $\frac{1}{\cot y} = \tan y$ or $\cot y = \frac{\cos y}{\sin y}$ correctly	B1	
	Full and correct completion to given answer: $\tan y - 2\cos y \sin y$	B1	
9(a)	$\frac{3^{10x}}{3^{3x-6}} [= 243]$ oe or $\log 9^{5x} - \log 27^{x-2} = \log 243$ oe	B1	
	$3^{7x+6} = 3^5$ soi oe or $5x(\log 9) - (x-2)\log 27 = \log 243$	M1	
	$x = -\frac{1}{7}$	A1	

Question	Answer	Marks	Partial Marks
9(b)	$\frac{1}{2}\log_a b - \frac{1}{2} = \frac{1}{\log_a b}$ or $\frac{\frac{1}{2}}{\log_b a} - \frac{1}{2} = \log_b a$	**B2**	**B1** for bringing down the power of $\frac{1}{2}$ e.g. $\frac{1}{2}\log_a b$ or for a change of base e.g. $\frac{1}{\log_a b}$
	Clears the fraction and rearranges $\frac{1}{2}(\log_a b)^2 - \frac{1}{2}\log_a b = 1$ oe $(\log_a b)^2 - \log_a b - 2 = 0$ oe or let $x = \log_a b$ $\quad x^2 - x - 2 = 0$ oe or $\frac{1}{2} - \frac{1}{2}\log_b a = (\log_b a)^2$ $0 = 2(\log_b a)^2 + \log_b a - 1$ oe or let $y = \log_b a$ $\quad 2y^2 + y - 1 = 0$	**M1**	
	$(\log_a b - 2)(\log_a b + 1)$ oe or $(2\log_b a - 1)(\log_b a + 1)$	**M1**	
	[$\log_a b = 2$, $\quad \log_a b = -1$ or $\log_b a = \frac{1}{2}$, $\quad \log_b a = -1$ leading to] $b = a^2$, $b =$ oe	**A1**	
10(a)(i)	$4 \times (-0.5)^{19}$	**M1**	
	$-\frac{1}{131072}$ or -7.63×10^{-6} or $-7.62939... \times 10^{-6}$ rot to four or more figs	**A1**	
10(a)(ii)	Valid explanation e.g. the common ratio is between –1 and 1	**B1**	
	$\frac{4}{1-(-0.5)} = \frac{8}{3}$	**B1**	

Question	Answer	Marks	Partial Marks
10(b)(i)	$a+9d=15(a+d)$	B1	
	$\frac{6}{2}\{2a+5d\}=87$	B1	
	Solves *their* equations for *d* e.g. $2\left(-\frac{3}{7}d\right)+5d=29$	M1	
	$d=7$	A1	
10(b)(ii)	$a=-3$ soi	B1	
	$6990=their(-3)+(n-1)(their\,7)$	M1	
	$n=1000$	A1	
11(a)	[perimeter =] $\frac{4}{3}\pi r$ soi	B2	**B1** for angle $ACB=\frac{2}{3}\pi$
	$\left(their\,\frac{4}{3}\pi r\right)=4\pi$ oe	M1	
	$r=3$	A1	
11(b)	$\frac{1}{2}\times their\,3^2\times their\,\frac{2\pi}{3}$ oe	M1	
	$\frac{1}{2}\times their\,3^2\times\sin their\,\frac{2\pi}{3}$ oe	M1	
	For subtracting and doubling: $their\,3^2\times their\,\frac{2\pi}{3}-their\,3^2\times\sin their\,\frac{2\pi}{3}$	M1	
	$6\pi-\frac{9}{2}\sqrt{3}$ or exact equivalent	A1	