Cambridge IGCSE

Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

ADDITIONAL MATHEMATICS **0606/11**

Paper 1 **October/November 2019**

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 October/November 2019 series for most Cambridge IGCSE™, Cambridge International A and AS Level 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 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.

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.

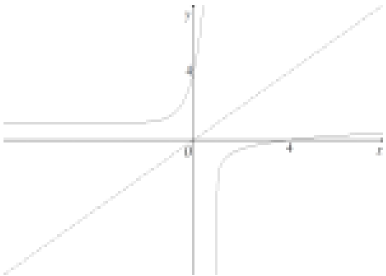
B Mark for a correct result or statement independent of Method marks.

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	$A' \cap B$ oe	B1	
	$(X \cap Y) \cup (X \cap Z)$ or $X \cap (Y \cup Z)$	B1	
2	$2x^2 + 3x + k = kx - 3$	M1	For an attempt to equate and simplify to a 3 term quadratic equation, allow an error in one term
	$2x^2 + (3-k)x + (k+3) = 0$	A1	
	$(3-k)^2 - 4 \times 2 \times (k+3)$	M1	For attempt to use the discriminant, allow previous error, leading to a quadratic equation in terms of k
	$k^2 - 14k - 15 = 0$ giving critical values of -1 and 15	A1	For critical values
	$-1 < k < 15$	A1	
3	Either $7^x \times 7^{2y}$ or $49^{\frac{x}{2}} \times 49^y$ or $5^{5x} \times 5^{2y}$ or $25^{\frac{5x}{2}} \times 25^y$	M1	For expressing the terms on the left hand side of either one of the 2 equations in terms of powers of 7, 49, 5 or 25
	$7^x \times 7^{2y} = 7^0$ or $49^{\frac{x}{2}} \times 49^y = 49^0$	A1	
	$5^{5x} \times 5^{2y} = 5^{-2}$ or $25^{\frac{5x}{2}} \times 25^y = 25^{-1}$	A1	
	leading to $x + 2y = 0$ and $5x + 2y = -2$	M1	For attempt to solve two linear equations, with integer coefficients and constants, in terms of x and y
	$x = -\frac{1}{2}$, $y = \frac{1}{4}$	A1	
4(i)	$\frac{\mathrm{d}}{\mathrm{d}x}\left(\ln\left(4x^2+1\right)\right) = \frac{8x}{4x^2+1}$	B1	
	$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{(2x-3)\frac{8x}{(4x^2+1)} - 2\ln\left(4x^2+1\right)}{(2x-3)^2}$	M1	For attempt to differentiate a quotient
		A1	For all other terms, not including $\frac{8x}{4x^2+1}$, correct
4(ii)	When $x = 2$, $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{16}{17} - 2\ln 17$ $= -4.73$	M1	For attempt to find value of $\frac{\mathrm{d}y}{\mathrm{d}x}$ when $x = 2$ and multiply by h
	Change in $y = -4.73h$	A1	

Question	Answer	Marks	Guidance
5(i)	$\mathrm{f} > 1$	**B1**	Must be using correct notation
	$\mathrm{g} \in \mathbb{R}$	**B1**	Must be using correct notation
5(ii)	$\mathrm{g}(0) = 1,\ \mathrm{g}(1) = 2$ and attempt at $\mathrm{f}(2)$	**M1**	For attempt at g^2 and correct order
	$\mathrm{f}(2) = 164.8$ awrt 165	**A1**	
5(iii)		**B3**	**B1** for correct f and $(0,4)$, must be in first and second quadrant **B1** for correct f^{-1} and $(4,0)$, must be in first and fourth quadrant **B1** for $y = x$ and/or symmetry implied, by 'matching intercepts'. No intersection.
6	$\frac{\mathrm{d}y}{\mathrm{d}x} = k(8x+5)^{-\frac{1}{2}}$	**M1**	For attempt to differentiate, must be in the form $k(8x+5)^{-\frac{1}{2}}$
	$\frac{\mathrm{d}y}{\mathrm{d}x} = 4(8x+5)^{-\frac{1}{2}}$	**A1**	
	When $x = \frac{1}{2}$, $y = 3$	**B1**	
	Normal: $y - 3 = -\frac{3}{4}\left(x - \frac{1}{2}\right)$	**M1**	For attempt at the normal when $x = \frac{1}{2}$, using correct process for *their* $\frac{\mathrm{d}y}{\mathrm{d}x}$ and *their* y.
	$6x + 8y - 27 = 0$	**A1**	

Question	Answer	Marks	Guidance
7(i)	$\lg y = \lg A + x \lg b$	B1	For statement, may be implied by subsequent work
	Either $6 = \lg A + 3.4 \lg b$ or $3.6 = \lg A + 2.2 \lg b$	M1	For one correct equation
		M1	For another correct equation and attempt to solve simultaneously
	$\lg b = 2$, $b = 100$	A1	
	$\lg A = -0.8$, $A = 10^{-0.8}$ or 0.158	A1	
	Or Gradient = $\lg b = 2$	M1	equating gradient to $\lg b$ and attempt to evaluate
	$b = 100$	A1	Must be identified as b
	$6 = \lg A + 3.4 \lg b$ or $3.6 = \lg A + 2.2 \lg b$	M1	For a correct equation and attempt to find $\lg A$
	$\lg A = -0.8$, $A = 10^{-0.8}$ or 0.158	A1	Must be identified as A
7(ii)	$\lg 900 = -0.8 + 2x$ oe	M1	For correct use of $y = 900$
	$x = 1.88$	A1	
8(i)	$BC^2 = \left(7+\sqrt{5}\right)^2 + \left(7-\sqrt{5}\right)^2$ $= 49 + 14\sqrt{5} + 5 + 49 - 14\sqrt{5} + 5$ $= 108$	M1	For use of Pythagoras' theorem and attempt to expand and simplify
	$BC = 6\sqrt{3}$	A1	
	Perimeter $= 22 + 6\sqrt{5} + 6\sqrt{3}$	A1	

Question	Answer	Marks	Guidance
8(ii)	**Either** $\frac{1}{2}\left(4+3\sqrt{5}+11+2\sqrt{5}\right)\left(7+\sqrt{5}\right)$ $=\frac{1}{2}\left(15+5\sqrt{5}\right)\left(7+\sqrt{5}\right)$ $=\frac{1}{2}\left(105+35\sqrt{5}+15\sqrt{5}+25\right)$	**M1**	**Either** For a valid method and attempt to expand out and simplify
	Or $\left(4+3\sqrt{5}\right)\left(7+\sqrt{5}\right)+\frac{1}{2}\left(7+\sqrt{5}\right)\left(7-\sqrt{5}\right)$ $= 28 + 21\sqrt{5} + 4\sqrt{5} + 15 + \frac{1}{2}(49 - 5)$	**M1**	**Or** For a valid method and attempt to expand out and simplify
	Area = $65+25\sqrt{5}$	**A2**	**A1** for each term
9(i)	**Either** $15^2=10^2+10^2-200\cos AOB$ $\cos AOB=-0.125$	**M1**	For use of cosine rule
	$AOB=1.696$ so 1.70 to 2 dp	**A1**	Must have justification to 2 dp
	Or $\sin\left(\frac{AOB}{2}\right)=\frac{7.5}{10}$ $\frac{AOB}{2}=0.8481$	**M1**	For use of basic trig
	$AOB=1.696$ so 1.70 to 2 dp	**A1**	

Question	Answer	Marks	Guidance
9(ii)	Angle $DOC = \frac{\pi}{3}$	B1	
	Either $AOD = BOC = 0.5\left(2\pi - \frac{\pi}{3} - 1.696\right)$ $AOD = BOC = 1.77$	M1	For attempt to get AOD or BOC
	Arc lengths = 17.7	M1	For attempt at arc length using their previous answer
	Perimeter = $15 + 10 + (2 \times 17.7) = 60.4$	A1	
	Or Arc AB = 17 or Arc $CD = \frac{10\pi}{3}$	M1	For either arc length
	$(20\pi - \text{arc } AB - \text{arc } CD)$	M1	
	Perimeter = 60.4	A1	
9(iii)	**Either** Area of each sector = $\frac{1}{2}10^2(1.770)$	M1	For area of sector using their BOC
	Area of triangles = $\left(\frac{1}{2} \times 100 \times \sin\frac{\pi}{3}\right) + \left(\frac{1}{2} \times 100 \sin 1.70\right)$	M1	For area of one triangle using the sine rule oe
	Total area = $177 + 43.3 + 49.6$	M1	For plan
	Area = awrt 270	A1	
	Or Area of upper segment = $\frac{1}{2}10^2(1.696 - \sin 1.696)$	M1	For area of a sector or area of a triangle using the sine rule oe
	Area of lower segment = $\frac{1}{2}10^2\left(\frac{\pi}{3} - \sin\frac{\pi}{3}\right)$	M1	For whichever has not been obtained in previous part
	Shaded area = 100π – are of the 2 segments Area = $314.2 - 35.2 - 9.06$	M1	For plan
	Area = awrt 270	A1	

Question	Answer	Marks	Guidance
10	$1.5 = 2 + \cos 3x$ $\cos 3x = -0.5$	**M1**	For correct attempt to find points of intersection
	$3x = \frac{2\pi}{3}, \frac{4\pi}{3}$	**M1**	For dealing with $3x$ correctly
	$x = \frac{2\pi}{9}$ or $40°$	**A1**	
	$x = \frac{4\pi}{9}$ or $80°$	**A1**	
	Either $\int_{\frac{2\pi}{9}}^{\frac{4\pi}{9}} 1.5 - (2 + \cos 3x)\ dx$	**M1**	For subtraction method – condone omission of or incorrect limits
	$\left[-0.5x - k\sin 3x\right]_{\frac{2\pi}{9}}^{\frac{4\pi}{9}}$	**M1**	For attempt to integrate – condone omission of or incorrect limits
	$\left[-0.5x - \frac{1}{3}\sin 3x\right]_{\frac{2\pi}{9}}^{\frac{4\pi}{9}}$	**A1**	All correct – condone omission of or incorrect limits
	$\left(-\frac{2\pi}{9} + \frac{\sqrt{3}}{6}\right) - \left(-\frac{\pi}{9} - \frac{\sqrt{3}}{6}\right)$	**M1**	Dep for application of limits, must be in radians
	Area $= \frac{\sqrt{3}}{3} - \frac{\pi}{9}$	**A1**	
	Or $\left(1.5 \times \frac{2\pi}{9}\right)$	**M1**	For attempt at rectangle (must include subtraction subsequently)
	$\left[2x + k\sin 3x\right]_{\frac{2\pi}{9}}^{\frac{4\pi}{9}}$	**M1**	For attempt to integrate – condone omission of or incorrect limits
	$\left[2x + \frac{1}{3}\sin 3x\right]_{\frac{2\pi}{9}}^{\frac{4\pi}{9}}$	**A1**	All correct – condone omission of or incorrect limits
	$\left(\left(\frac{8\pi}{9} - \frac{\sqrt{3}}{6}\right) - \left(\frac{4\pi}{9} + \frac{\sqrt{3}}{6}\right)\right)$	**M1**	Dep for application of limits, must be in radians
	Area $= \frac{\sqrt{3}}{3} - \frac{\pi}{9}$	**A1**	

Question	Answer	Marks	Guidance
11(a)(i)	362 880	**B1**	
11(a)(ii)	$7!\ \times 2$	**B1**	For 7!
	10 080	**B1**	For $7!\ \times 2$ leading to 10080
11(a)(iii)	Total = $4!\ \times 4!\ \times 3! = 3456$	**B3**	**B1** for treating as 4 separate units 4! **B1** for either number of ways of arranging the maths books amongst themselves 4! or the number of ways of arranging the physics books amongst themselves 3!
11(b)(i)	18 564	**B1**	
11(b)(ii)	Total 3738	**B4**	**B1** 4 boys 3150 **B1** 5 boys 560 **B1** 6 boys 28
12	$\frac{\mathrm{d}y}{\mathrm{d}x} = k\cos\left(x+\frac{\pi}{3}\right) \ +c$	**M1**	For attempt to integrate
	$\frac{\mathrm{d}y}{\mathrm{d}x} = -2\cos\left(x+\frac{\pi}{3}\right) \ +c$	**A1**	All correct, condone omission of $+c$
	$5 = -2\cos\frac{2\pi}{3} + c$	**M1**	Dep for attempt to find c
	$\frac{\mathrm{d}y}{\mathrm{d}x} = -2\cos\left(x+\frac{\pi}{3}\right)+4$	**A1**	
	$y = p\sin\left(x+\frac{\pi}{3}\right) \quad (+qx+d)$	**M1**	attempt to integrate a second time to obtain $y = p\sin\left(x+\frac{\pi}{3}\right)$
	$y = -2\sin\left(x+\frac{\pi}{3}\right)+4x+d$	**A1**	All correct, condone omission of $+d$
	$\frac{5\pi}{3} = -2\sin\frac{2\pi}{3}+\frac{4\pi}{3}+d$	**M1**	Dep for attempt to find a second arbitrary constant
	$y = -2\sin\left(x+\frac{\pi}{3}\right)+4x+\frac{\pi}{3}+\sqrt{3}$ or $y = -2\sin\left(x+\frac{\pi}{3}\right)+4x+2.78$	**A1**	