Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

ADDITIONAL MATHEMATICS **0606/13**

Paper 1 **May/June 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.

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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.

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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

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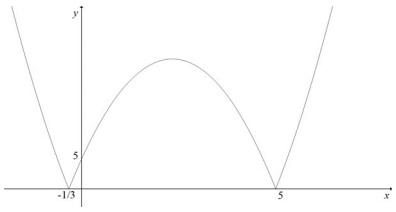
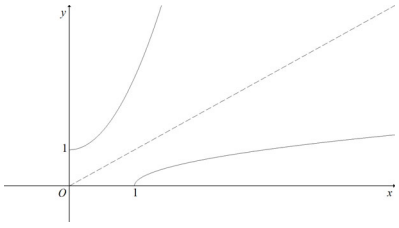
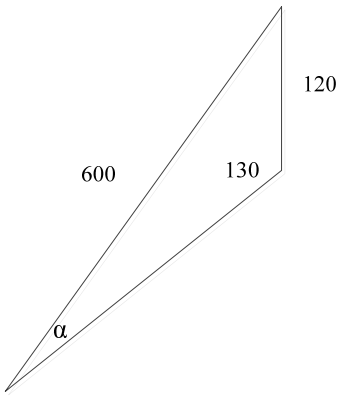
Question	Answer	Marks	Guidance
1	$A \cap B = \varnothing$	**B1**	
	$Z \subset (X \cap Y)$	**B2**	**B1** for identifying $X \cap Y$
2	$a = \frac{3}{2}$	**B1**	
	$b = \frac{7}{3}$	**B1**	
	$c = 3$	**B1**	
3	$x^2 + (3-m)x + m - 4 = 0$	**M1**	For equating line and curve and attempting to obtain a quadratic equation equated to zero
	Discriminant: $(3-m)^2 - 4(m-4)$	**M1**	**Dep** For use of $b^2 - 4ac$, could be implied by use of quadratic formula
	$(m-5)^2$	**A1**	
	Always positive or zero for any *m,* so line and curve will always touch or intersect	**A1**	For a suitable comment/conclusion
4(i)		**B1**	For $\frac{6x^2}{(2x^3+5)}$
		M1	For attempt to differentiate a quotient
	$\frac{dy}{dx} = \frac{(x-1)\frac{6x^2}{(2x^3+5)} - \ln(2x^3+5)}{(x-1)^2}$	**A1**	For all other terms correct
	When $x = 2$, $\frac{dy}{dx} = \frac{24}{21} - \ln 21$ or $\frac{8}{7} - \ln 21$, or -1.90	**A1**	
4(ii)	$-1.90p$ oe	**B1**	

Question	Answer	Marks	Guidance
5(i)		**B1**	For shape with maximum in 1st quadrant
		B1	For $\left(-\frac{1}{3}, 0\right)$ and $(5, 0)$
		B1	For $(0, 5)$
		B1	All correct with cusps and correct shape for $x < -\frac{1}{3}$ and $x > 5$
5(ii)		**M1**	For attempt to find maximum point
	Maximum point when $x = \frac{7}{3}$	**A1**	For $x = \frac{7}{3}$
	$y = \frac{64}{3}$ so $k = \frac{64}{3}$	**A1**	
6(i)	$\frac{1}{\cos\theta} - \frac{\sin\theta}{\cos\theta} \times \sin\theta$ oe	**M1**	For dealing with sec, tan and cosec in terms of sin and cos
	$\frac{1 - \sin^2\theta}{\cos\theta}$	**M1**	For simplification and use of identity
	$\frac{\cos^2\theta}{\cos\theta}$	**A1**	For simplification to AG
6(ii)	$\cos 2\theta = \frac{\sqrt{3}}{2}$	**M1**	For use of part **(i)** and attempt to solve to get as far as $2\theta = ...$
	$2\theta = 30^\circ, 330^\circ$	**M1**	For dealing with double angle correctly, may be implied by one correct solution
	$\theta = 15^\circ, 165^\circ$	**A1**	For both
6(iii)	$\sin\left(\phi + \frac{\pi}{3}\right) = \pm\frac{1}{\sqrt{2}}$ $\phi + \frac{\pi}{3} = \frac{\pi}{4}, \frac{3\pi}{4}, \frac{5\pi}{4}, \frac{7\pi}{4}, \frac{9\pi}{4}$	**M1**	For correct attempt to solve, may be implied by $\phi + \frac{\pi}{3} = \frac{\pi}{4}$
		M1	**Dep** For dealing with compound angle correctly
	$\phi = \frac{5\pi}{12}, \frac{11\pi}{12}, \frac{17\pi}{12}, \frac{23\pi}{12}$	**A2**	**A1** for one correct pair, **A1** for a second correct pair with no extra solutions in the range.

Question	Answer	Marks	Guidance
7(i)	$AC^2 = \left(2\sqrt{5}-1\right)^2 + \left(2+\sqrt{5}\right)^2$	**M1**	For use of Pythagoras' theorem and attempt to expand brackets
	$= 20 - 4\sqrt{5} + 1 + 4 + 4\sqrt{5} + 5$	**A1**	For correct unsimplified, must be convinced of non-calculator use
	$AC = \sqrt{30}$	**A1**	
7(ii)	$\tan ACB = \dfrac{2\sqrt{5}-1}{2+\sqrt{5}} \times \dfrac{2-\sqrt{5}}{2-\sqrt{5}}$	**M1**	For attempt at tan ACB and rationalisation
	$= \dfrac{4\sqrt{5}-2-10+\sqrt{5}}{4-5}$ oe	**M1**	**Dep** For seeing at least 3 terms in the numerator
	$= 12 - 5\sqrt{5}$	**A1**	
7(iii)	$\sec^2 ACB = \tan^2 ACB + 1$ $= 144 - 120\sqrt{5} + 125 + 1$	**M1**	For use of identity using *their* **(ii)**
	$= 270 - 120\sqrt{5}$	**A1**	
8(i)	$\mathrm{g} \geqslant 1$	**B1**	Must be using correct notation
8(ii)	$\mathrm{g}\left(\sqrt{62}\right) = 125$	**B1**	
	$\mathrm{f}^{-1}(x) = \dfrac{1}{3}\ln x$	**B1**	
	$\dfrac{1}{3}\ln 125 = \ln 5$	**B1**	For correct order and manipulation to obtain the given answer, need to see $\dfrac{1}{3}\ln 125$
8(iii)	$3\mathrm{e}^{3x} = 24$	**M1**	For dealing with derivatives correctly
	$x = \dfrac{1}{3}\ln 8$	**A1**	
	$x = \ln 2$	**A1**	
8(iv)		**B3**	**B1** for correct g with intercept **B1** for $y = x$ and/or implication of symmetry **B1** for correct g^{-1} with intercept
9(a)(i)	$7! = 5040$	**B1**	

Question	Answer	Marks	Guidance
9(a)(ii)	Treating the 4 trophies as 1 unit so there are 4! ways	**B1**	Maybe implied by a correct answer
	There are also 4! ways of arranging the football trophies amongst themselves	**B1**	
	Total = $4! \times 4! = 576$	**B1**	
9(a)(iii)	Treating the 4 football trophies as 1 unit and the 2 cricket trophies as 1 unit so there are 3! ways	**B1**	Maybe implied by a correct answer
	There are also 4! ways of arranging the football trophies amongst themselves and 2 ways of arranging the cricket trophies	**B1**	Maybe implied by a correct answer
	Total = $3! \times 4! \times 2 = 288$	**B1**	
9(b)(i)	3003	**B1**	
9(b)(ii)	28	**B1**	
9(b)(iii)	3003 – 1	**M1**	For *their* **(i)** – 1
	3002	**A1**	**FT**
10(i)		**M1**	Attempt to integrate to obtain $k(2x+3)^{\frac{1}{2}}$
	$\frac{dy}{dx} = (2x+3)^{\frac{1}{2}} \quad (+c)$	**A1**	All correct, condone omission of $+c$
	$5 = 3 + c$	**M1**	**Dep** For attempt at c
	$\frac{dy}{dx} = (2x+3)^{\frac{1}{2}} + 2$	**M1**	For a further attempt to integrate
	$y = \frac{1}{3}(2x+3)^{\frac{3}{2}} + 2x(+d)$	**A1**	All correct, condone omission of $+d$
	$-\frac{1}{3} = \frac{8}{3} + 1 + d$	**M1**	For attempt at d
	$y = \frac{1}{3}(2x+3)^{\frac{3}{2}} + 2x - 4$	**A1**	Must have $y =$

Question	Answer	Marks	Guidance
10(ii)	When $x = 3,\ y = 11$	**M1**	For attempt to find y using *their* **(i)**
		M1	**Dep** For attempt at normal
	Normal: $y - 11 = -\frac{1}{5}(x - 3)$	**A1**	All correct unsimplified
	$x + 5y - 58 = 0$	**A1**	For correct form
11(i)		**B1**	For correct triangle, may be implied by subsequent work
	$\frac{120}{\sin\alpha} = \frac{600}{\sin 130}$	**M1**	For use of the correct sine rule
	$\alpha = 8.81^{\circ}$	**A1**	Allow greater accuracy
	Bearing 041.2° or 041°	**A1**	Allow greater accuracy
11(ii)	$\frac{v_r}{\sin 41.19} = \frac{600}{\sin 130} = \frac{120}{\sin\alpha}$	**M1**	For use of sine rule using *their* α or cosine rule
	$v_r = 515.8$ awrt 516	**A1**	
	Time taken $= \frac{2500}{515.8}$	**M1**	For attempt to find time using *their* v_r, not 600, 720 or 480
	$= 4.85$ or 4.84	**A1**	