Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

ADDITIONAL MATHEMATICS **0606/12**

Paper 12 **March 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 March 2019 series for most Cambridge IGCSE™, Cambridge International A and 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.

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.

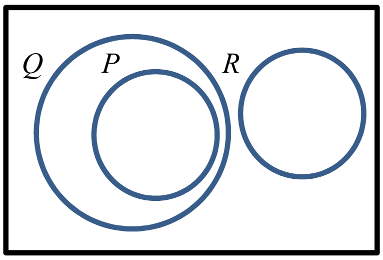
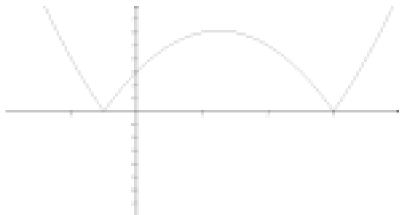
A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. For accuracy marks to be given, the associated Method mark must be earned or implied.

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(a)(i)	6	**B1**	
1(a)(ii)	1	**B1**	
1(b)		2	**B1** for P contained within Q **B1** for Q and R separate
1(c)	$S' \cap T'$ or $(S \cup T)'$ oe	**B1**	
	$(X \cap Y) \cup (X \cap Z)$ or $X \cap (Y \cup Z)$ oe	**B1**	
2		4	**B1** for general shape with maximum point in 1st quadrant **B1** for $\left(-\frac{1}{2}, 0\right)$ and $(3, 0)$ soi **B1** for $(0, 3)$ soi **B1 dep** on first B1, with cusps and correct shape for $x < -\frac{1}{2}$ and $x > 3$
3(i)	$729 - 162x + 15x^2$	3	**B1** for 729 **B1** for $-162x$ **B1** for $15x^2$ Mark final answer
3(ii)	$(729 - 162x + 15x^2)\left(x^2 - 4 + \frac{4}{x^2}\right)$	**B1**	for expansion of $\left(x - \frac{2}{x}\right)^2$
	Term independent of $x = -2916 + 60$	**M1**	for attempt to find independent term, must be considering 2 products using *their* answer to part **(i)**
	$= -2856$	**A1**	
4(i)	$p'(x) = 6x^2 + 2ax + b$	**B1**	for $p'(x) = 6x^2 + 2ax + b$
	$p'(-3) = 54 - 6a + b$, $= -24$ leading to $6a - b = 78$	**B1**	must be convinced of correct substitution and simplification AG

Question	Answer	Marks	Partial Marks
4(ii)	$\text{p}\left(\frac{1}{2}\right): \frac{2}{8}+\frac{a}{4}+\frac{b}{2}-49=0$	**M1**	for attempt at $\text{p}\left(\frac{1}{2}\right)$ equated to 0
	$6a-b=78$ $a+2b=195$ oe	**M1**	**M Dep** on previous M for attempt to solve both equations
	leading to $a=27$	**A1**	
	$b=84$	**A1**	
4(iii)	$(2x-1)(x^2+14x+49)$	**2**	**M1** for factorisation by observation or by long division
4(iv)	$(2x-1)(x+7)^2$	**B1**	
5(i)	$\log_4 16+\log_4 p$	**M1**	for dealing with product correctly
	$2+p$	**A1**	
5(ii)	$7\log_4 x-\log_4 256$	**M1**	for dealing with power and division correctly
	$7p-4$	**A1**	
5(iii)	$2+p-(7p-4)=5$ leading to $p=\frac{1}{6}$	**M1**	for use of parts **(i)** and **(ii)** to obtain a value for p
	so $x=4^{\frac{1}{6}}$	**M1**	for correct attempt to deal with $\log_4$ in order to obtain x
	$x=1.26$	**A1**	
6(a)	**BA** and **CB**	**2**	**B1** for one correct product of 2 matrices **B1** for a second correct product of 2 matrices, with no other incorrect products
6(b)(i)	$\frac{1}{16}\begin{pmatrix}3 & 2\\ -5 & 2\end{pmatrix}$ oe	**2**	**B1** for $\frac{1}{16}$ soi **B1** for $\begin{pmatrix}3 & 2\\ -5 & 2\end{pmatrix}$

Question	Answer	Marks	Partial Marks
6(b)(ii)	$\mathbf{X}^{-1}\mathbf{XZ} = \mathbf{X}^{-1}\mathbf{Y}$ $\mathbf{Z} = \frac{1}{16}\begin{pmatrix} 3 & 2 \\ -5 & 2 \end{pmatrix}\begin{pmatrix} 4 & 1 \\ 2 & 0 \end{pmatrix}$	**M1**	for pre-multiplication by *their* inverse matrix
	attempt at matrix multiplication	**M1**	**M1 Dep** on previous M mark, must have at least 2 correct elements
	$\mathbf{Z} = \frac{1}{16}\begin{pmatrix} 16 & 3 \\ -16 & -5 \end{pmatrix}$ oe	**A1**	
7(i)	Area = $\frac{1}{2}\left(8+6\sqrt{5}\right)\left(10-2\sqrt{5}\right)$	**M1**	for a correct method of finding the area of the trapezium
	$=10+22\sqrt{5}$	**A2**	**A1** for 10 with sufficient working seen **A1** for $22\sqrt{5}$ with sufficient working seen
7(ii)	$\cot\theta = \frac{4}{10-2\sqrt{5}}$	**B1**	
	$=\frac{4\left(10+2\sqrt{5}\right)}{\left(10-2\sqrt{5}\right)\left(10+2\sqrt{5}\right)}$	**M1**	for attempt to rationalise an expression for $\cot\theta$, some evidence of expansion must be seen
	$=\frac{1}{2}+\frac{\sqrt{5}}{10}$	**A1**	
8(a)(i)	0	**B1**	
8(a)(ii)	Area under curve = $\frac{1}{2}(2\times10)+(4\times10)+\frac{1}{2}(10+20)\times4$	**M1**	for attempt to find the total area under the graph
	= 110	**A1**	
8(b)(i)	When $t=\frac{7\pi}{12}$, $v=-2.5$	**M1**	for substitution of $t=\frac{7\pi}{12}$ and correct attempt to evaluate
	Speed = 2.5	**A1**	must be positive
8(b)(ii)	$a=6\cos 2t$	**M1**	for differentiation to get acceleration, must be of the form $m\cos 2t$
	When acceleration = 0, $\cos 2t = 0$	**M1**	**M Dep** on previous M mark for equating to zero and correct attempt to solve to get a solution in radians.
	$t=\frac{\pi}{4}$ or 0.785	**A1**	

Question	Answer	Marks	Partial Marks
9(i)	$\frac{1}{2}r^2\theta = 36$ $\theta = \frac{72}{r^2}$	M1	for use of the area of the sector
	$P = 2r + r\theta$	M1	for attempt to find P making use of the area
	$P = 2r + \frac{72}{r}$	A1	for attempt to simplify to obtain AG
9(ii)	$\frac{\mathrm{d}P}{\mathrm{d}r} = 2 - \frac{72}{r^2}$	M1	for attempt to differentiate to obtain the form $a + \frac{b}{r^2}$ and equate to zero
	When $\frac{\mathrm{d}P}{\mathrm{d}r} = 0,\ r = 6$	A1	
	$P = 24$	A1	
	$\frac{\mathrm{d}^2P}{\mathrm{d}r^2} = \frac{144}{r^3}$ positive so minimum	B1	**FT** on *their* positive r, for a correct method to determine the nature of the stationary point leading to a correct conclusion. If the second derivative is evaluated, it must be correct for *their* r.
10(i)	$\frac{\mathrm{d}y}{\mathrm{d}x} = 2\mathrm{e}^{2x} + 3x \quad (+c)$	2	**M1** for attempt to integrate to obtain the form $m\mathrm{e}^{2x} + nx$ **A1** all correct
	$c = 8$	M1	**M1 Dep** on previous M mark for attempt to get c
	$y = \mathrm{e}^{2x} + \frac{3x^2}{2} + 8x \ (+d)$	2	**M1** for attempt to integrate again to obtain the form $p\mathrm{e}^{2x} + qx^2\,(+rx)$ **A1** all correct, **FT** on *their* $k\mathrm{e}^{2x}$ and *their* c
	$d = -6$	M1	**M1 Dep** on previous M mark for attempt to get d
	$y = \mathrm{e}^{2x} + \frac{3x^2}{2} + 8x - 6$	A1	

Question	Answer	Marks	Partial Marks
10(ii)	When $x = \frac{1}{4}$, $y = -2.26$ $\frac{dy}{dx} = 12.0$	**M1**	for attempt to obtain both y and $\frac{dy}{dx}$ using *their* work from **(i)**
	$y + 2.26 = -\frac{1}{12}\left(x - \frac{1}{4}\right)$	**2**	**M1 Dep** on previous M mark for attempt to obtain the equation of the normal **A1** allow unsimplified, must be using correct accuracy or exact equivalents.
11(a)	$2\sin x\left(\cos^2 x - 1\right) = 0$	**M1**	for obtaining in terms of sin and cos to obtain one solution correctly
	$\sin x = 0$, $x = 0^\circ$, 180°	**B1**	for $x = 0^\circ$, 180° and no other in the given range for the solution of this equation
	$\cos x = \pm\frac{1}{\sqrt{2}}$, $x = 45^\circ$, 135°	**A1**	for $x = 45^\circ$, 135° and no other in the given range for the solution of this equation
11(b)(i)	$\frac{1}{\cos\theta} - \frac{\sin^2\theta}{\cos\theta}$	**M1**	for dealing with cot and sec
	$\frac{\cos^2\theta}{\cos\theta}$	**M1**	for correct use of identity
	$\cos\theta$	**A1**	for all correct working to gain AG
11(b)(ii)	$\cos 3\theta = \frac{1}{2}$ $\theta = \frac{5\pi}{9}$ or $\frac{\pi}{9}$	**M1**	for use of part **(i)** and attempt to solve correctly to obtain a positive angle, may be implied by one correct solution
	$\theta = -\frac{5\pi}{9}$ or $-\frac{\pi}{9}$	**M1**	for use of part **(i)** and attempt to solve correctly to obtain a negative angle, may be implied by one correct solution
	$\theta = \pm\frac{\pi}{9}$, $\pm\frac{5\pi}{9}$	**A2**	**A1** for one correct pair of solutions **A1** for a second pair of solutions with no extra solutions within the range