Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **October/November 2018**

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 2018 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.

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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.

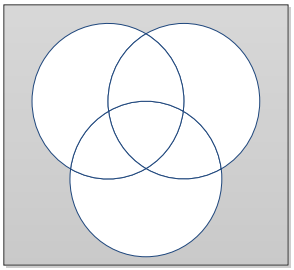
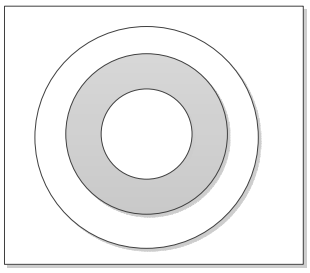
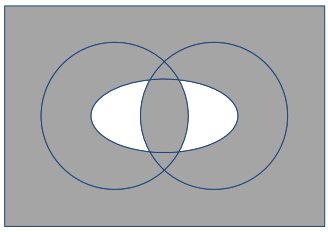
B Mark for a correct result or statement independent of Method marks.

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	Partial Marks
1	$x = 2$	**B1**	
	$3 - 5x = -3x + 13$ oe	**M1**	
	$x = -5$	**A1**	
2	  	**3**	**B1** for each correct diagram
3(i)	$\frac{81}{4} - \left(x - \frac{7}{2}\right)^2$	**3**	**B1** $b = \frac{7}{2}$ **M1** $\pm 8 \pm \left(\frac{7}{2}\right)^2$ seen or expand given form and equate for 8 or 7 **A1** fully correct
3(ii)	maximum *their* $\frac{81}{4}$ when $x =$ *their* $\frac{7}{2}$ from *their* correct form	**2**	**B1** **B1**
3(iii)	$\left(z^2 - \frac{7}{2}\right)^2 = \frac{81}{4}$ oe	**M1**	replace x by z^2 in *their* **(i)** and equate to zero.
	$z^2 = \frac{7}{2} \pm \frac{9}{2}$	**M1**	
	$z = \pm\sqrt{8}$	**A1**	

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Question	Answer	Marks	Partial Marks
4(i)	integrate: increase in powers of at least one term	**M1**	*
	$\frac{\mathrm{d}y}{\mathrm{d}x} = x^2 - \frac{1}{(x+1)^3} + (C)$	**A1**	
	$C = \frac{1}{8}$	**A1**	
4(ii)	integrate *their* **(i)**: increase in powers of at least one term	**M1**	**Dep***
	$y = \frac{1}{3}x^3 + \frac{1}{2(x+1)^2} + \frac{1}{8}x + (D)$	**A1**	two correct terms in x
	$D = \frac{29}{12}$	**A1**	
5(i)	$\frac{1}{5}\begin{pmatrix} 4 & -3 \\ -1 & 2 \end{pmatrix}$	**2**	**B1** $\begin{pmatrix} 4 & -3 \\ -1 & 2 \end{pmatrix}$ **B1** $\frac{1}{5}$
5(ii)	post multiply by $\mathbf{A}^{-1}$ $\mathbf{C} = \mathbf{B}\mathbf{A}^{-1}$	**M1**	
	$\frac{1}{5}\begin{pmatrix} 0 & 5 \\ -13 & 16 \end{pmatrix}$	**A1**	
5(iii)	$\mathbf{I} - \mathbf{B} = \begin{pmatrix} 0 & -4 \\ 2 & -4 \end{pmatrix}$ or $\mathbf{AB} = \begin{pmatrix} -4 & 23 \\ -7 & 24 \end{pmatrix}$	**B1**	
	$\mathbf{D} = \mathbf{A}(\mathbf{I} - \mathbf{B})$ or $\mathbf{D} = \mathbf{A} - \mathbf{AB}$	**M1**	
	$\mathbf{D} = \begin{pmatrix} 6 & -20 \\ 8 & -20 \end{pmatrix}$	**A1**	

Question	Answer	Marks	Partial Marks
6	$\log_2 8 = 3$ or $\log 3x - \log y = \log \frac{3x}{y}$ (any base) or $\log_2 2 = 1$ soi	**B1**	implied by one correct equation
	$x + 2y = 8$	**B1**	
	$\frac{3x}{y} = 2$	**B1**	
	solve correct equations for x or y	**M1**	
	$x = 2$ and $y = 3$	**A1**	
7(i)	167 960	**1**	
7(ii)	evidence of selecting from 16	**M1**	
	$[{}^{16}C_7 =]$ 11 440	**A1**	
7(iii)	$2 \times {}^{n}C_r$ with $n = 16$ or $r = 9$	**M1**	
	$\left[2 \times {}^{16}C_9 =\right]$ 22880	**A1**	
7(iv)	$4 \times {}^{n}C_r$ with $n = 16$ or $r = 9$	**M1**	
	$\left[4 \times {}^{16}C_9 =\right]$ 45760	**A1**	
8(i)	$\frac{12.1 - 5.5}{3.7 - 1.5}$ [= 3]	**B1**	correct expression for gradient
	$\frac{y^2 - 5.5}{e^{2x} - 1.5}$ = *their* grad or correctly use $y^2 =$ (*their m*) $e^{2x} + c$ with one point to find c	**M1**	
	$y = [\pm]\sqrt{3e^{2x} + 1}$	**A1**	
8(ii)	[±]34.8	**1**	

Question	Answer	Marks	Partial Marks
8(iii)	$50 = \sqrt{(their3)e^{2x} + their1}$ or $2500 = (their3)e^{2x} + their1$	**B1**	*
	$2x = \ln\left(\frac{2499}{3}\right)$	**M1**	**Dep*** obtain $2x$ explicitly
	3.36 cao	**A1**	
9(a)	$x + \frac{\pi}{4} = \frac{\pi}{3}$	**M1**	
	$\frac{\pi}{12}$ and $\frac{5\pi}{12}$ (0.262 and 1.31)	**A2**	**A1** for one correct
9(b)	correctly use $\sec y = \frac{1}{\cos y}$ and $\text{cosec}\, y = \frac{1}{\sin y}$	**M1**	
	$\tan y = \frac{4}{3}$	**A1**	obtain expression for tan$y$ or y explicitly
	53.1° and 233.1°	**A1**	
9(c)	correctly rewrite equation in terms of sin$z$ and cos$z$	**M1**	
	use $\sin^2 z = 1 - \cos^2 z$	**M1**	appropriate use of pythagorean identity for forming an equation in one trig ratio
	$8\cos^2 z - 2\cos z - 1 = 0$ oe	**A1**	
	$(4\cos z + 1)(2\cos z - 1) = 0$	**M1**	solve 3 term quadratic in cos$z$
	60° and 300° and 104.5° and 255.5°	**A2**	**A1** for any two correct
10(i)	$\frac{d}{dx}\sqrt{3+x} = \frac{1}{2}(3+x)^{-\frac{1}{2}}$	**B1**	
	correctly substitute *their* $\frac{1}{2}(3+x)^{-\frac{1}{2}}$ and *their* $2x$ into product rule	**M1**	
	$\frac{dy}{dx} = x^2 \times \frac{1}{2}(3+x)^{-\frac{1}{2}} + 2x(3+x)^{\frac{1}{2}}$	**A1**	

Question	Answer	Marks	Partial Marks
10(ii)	$y = 2$	**B1**	
	$\frac{dy}{dx} = \frac{17}{4}$	**B1**	
	$\frac{y-2}{x-1} = \frac{17}{4}$ $\left(y = \frac{17}{4}x - \frac{9}{4}\right)$ oe or use $y = mx + c$ and find c	**B1**	**FT** on *their* 2 and *their* $\frac{17}{4}$ from *their* $\frac{dy}{dx}$
10(iii)	set *their* $\frac{dy}{dx} = 0$	**M1**	
	obtain correct quadratic equation $5x^2 + 12x$ [= 0] soi	**A1**	
	(0, 0) and (–2.4, 4.46)	**A2**	**A1** for one point or two correct values of x
11(i)	$-5x + k + 5 = 7 - kx - x^2$	**M1**	*
	$b^2 - 4ac\ (=0) \rightarrow (k-5)^2 - 4(k-2)\ (=0)$	**M1**	**Dep***
	$k^2 - 14k + 33\ \ (=0)$	**A1**	
	$(k-11)(k-3)\ \ (=0)$	**M1**	**Dep dep *** solve quadratic in k
	$k = 11$ and $k = 3$	**A1**	
11(ii)	$y = -5x + 16$ and $y = 7 - 11x - x^2$ $y = -5x + 8$ and $y = 7 - 3x - x^2$	**B2**	**FT** *their k* **B1** for any two correct
	solve one tangent/curve pair for one variable from quadratic equation with repeated root	**M1**	
	(–3, 31) and (1, 3)	**A2**	**A1** for one correct point or two correct x values
11(iii)	find distance between any two points found in **(ii)**	**M1**	
	$\sqrt{800}$ oe	**A1**	