Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

ADDITIONAL MATHEMATICS **0606/22**

Paper 22 **March 2017**

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 will not enter into discussions about these mark schemes.

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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
www	without wrong working

Question	Answer	Marks	Guidance
1	$-\frac{5}{3}$ isw	**B1**	or exact equivalent
	Solve $5 - 3x = -10$ or $(5-3x)^2 = 100$	**M1**	
	$x = 5$	**A1**	
2 (i)	\$12 000	**B1**	
(ii)	$\frac{8000}{12000} = e^{-0.2t}$ oe	**M1**	
	[t =] 2(.0273...) years	**A1**	

Question	Answer	Marks	Guidance
3 (i)	multiply out correctly	**B1**	or divide out correctly
(ii)	Finding another factor	**B1**	$(x-1)$ or $(x+2)$ or $(x-2)$; method must be seen
	Either $(x-1)^2(x^2-4)$ Or $(x-1)(x+2)(x^2-3x+2)$ Or $(x-1)(x-2)(x^2+x-2)$	**B1**	For stating a relevant quadratic factor for *their* linear factors
	Attempts to factorise quadratic	**M1**	
	$(x-1)^2(x+2)(x-2)$ oe	**A1**	mark final answer
			Alternative method: **B1** for finding a second linear factor using any valid method and **B1** for finding a third linear factor using any valid method and **B1** for finding the final linear factor using any valid method and **B1** for fully correct product stated; mark final answer If fully correct product stated but no method shown then **B1** only.
4	Eliminates y $3x + k = 2x^2 - 3x + 4$	**M1**	**Alternative calculus method:** Equates gradients $4x - 3 = 3$
	Collects terms $2x^2 - 6x + 4 - k = 0$ soi	**A1**	Finds point of tangency (1.5, 4)
	Applies $b^2 - 4ac$ $(-6)^2 - 4(2)(4-k)$ or better	**M1**	Substitutes into $y = 3x + k$ $4 = 3(1.5) + k$
	$k < -\frac{1}{2}$ oe	**A1**	

Question	Answer	Marks	Guidance
5	$\sqrt{20} = \sqrt{4\times5} = 2\sqrt{5}$ seen	**B1**	may be later in working; must be convinced that calculator has not been used
	$\left(3+\sqrt{5}\right)x + \frac{1}{2}x\left(their\, 2\sqrt{5}\right) = 13+5\sqrt{5}$ oe		
	leading to $\left(3+their\, 2\sqrt{5}\right)x = 13+5\sqrt{5}$	**M1**	equates *their* area to given area and factorises to collect x terms; may still have $\sqrt{20}$
	$[x=]\frac{13+5\sqrt{5}}{3+their\, 2\sqrt{5}} \times \frac{3-their\, 2\sqrt{5}}{3-their\, 2\sqrt{5}}$	**M1**	divides and attempts to rationalise; may still have $\sqrt{20}$ or forms a pair of simultaneous equations e.g. $3p+10q=13$ $2p+3q=5$
	$[x=]\frac{39-26\sqrt{5}+15\sqrt{5}-50}{9-20}$	**M1**	numerator must have at least 3 terms; denominator may be −11 or solves their simultaneous equations to find one unknown
	$1+\sqrt{5}$ www	**A1**	or $p=1,\ q=1$
6 (a) (i)	$-2x^{\frac{5}{2}}$ oe or $a = -2$ and $b = \frac{5}{2}$ oe	**B2**	mark final answer **B1** for −2 and **B1** for $\frac{5}{2}$
(ii)	$[x=]\left(\frac{-6250}{their(-2)}\right)^{their\frac{2}{5}}$ oe	**M1**	may be in steps
	25	**A1**	
(b) (i)	Valid explanation	**B1**	e.g. If $x > 0.75$ then all the arguments are positive as required. oe
(ii)	$1 = \log_a a$	**M1**	may be seen in e.g. $\log_a(ax) = 1+\log x$
	$2\log_a(4x-3) = \log_a(4x-3)^2$ soi	**M1**	
	completion to given result	**A1**	

Question	Answer	Marks	Guidance
(iii)	$x^2(16x-24)=0$ oe or $x(16x-24)=0$ oe	**M1**	e.g. equates, anti-logs, rearranges and factorises or divides OR rearranges, combines using correct log law, anti-logs and factorises or divides
	$[x=]\frac{24}{16}$ or $\frac{3}{2}$ oe	**A1**	inclusion of $x = 0$ is **A0**
7 (a)	$[r^2=]5^2+10^2-2\times5\times10\times\cos120$ oe	**M1**	or for $[r^2=]5^2+10^2-2\times5\times10\times\cos60°$ or for $[r^2=]5^2+10^2-2\times5\times10\times\cos240°$
	[r =] 13.2 or 13.22875.... rot to 4 or more sf	**A1**	not from wrong working
	$\frac{\sin x}{5}=\frac{\sin120}{their13.2}$ or better	**M1**	or $\frac{\sin y}{10}=\frac{\sin120}{their13.2}$ or better
	[x =] awrt 19.1	**A1**	or [y =] awrt 40.9
	360 – 120 – *their x*	**A1FT**	or 180 + *their y*
(b)	94 [km/h] west	**B2**	**B1** for 94 [km/h]
8 (i)	$y-(-4)=\frac{1}{6}(x-6)$	**B1**	or $y=\frac{1}{6}x+c$ and $c = –5$
	$[m_{AB}=]\frac{7-4}{3-8}$ or $-\frac{3}{5}$ oe	**M1**	
	$y-7=-\frac{3}{5}(x-3)$ or $y-4=-\frac{3}{5}(x-8)$	**A1**	or $y=-\frac{3}{5}x+c$ and $c=\frac{44}{5}$
	$their\left(\frac{1}{6}x-5\right)=their\left(-\frac{3}{5}x+\frac{44}{5}\right)$	**M1**	valid method of solution for *their* equations; must be of equivalent difficulty
	$x = 18$	**A1**	
	$y = –2$ isw	**A1**	

Question	Answer	Marks	Guidance
(ii)	$[m =] -\frac{3}{2}$	**M1**	
	$y - their(-2) = -\frac{3}{2}\left(x - their 18\right)$ isw	**A1FT**	FT *their D*; $y = -\frac{3}{2}x + c$ and c = *their* 25
9 (a)	ke^{2x+1} (+ c)	**M1**	for some non-zero integer k where $k \neq 2$
	$k = \frac{1}{2}$	**A1**	
(b) (i)	$\frac{\mathrm{d}(\ln x)}{\mathrm{d}x} = \frac{1}{x}$ soi	**B1**	
	$\left[\frac{\mathrm{d}y}{\mathrm{d}x} =\right] \frac{\left(their 1\right)\ln x - x\left(their \frac{1}{x}\right)}{\left(\ln x\right)^2}$	**M1**	correct form of quotient rule or equivalent product rule applied; brackets may be omitted or misplaced for **M1**
	correct, isw	**A1**	may be unsimplified; allow recovery of brackets
(ii)	$\int \frac{\ln x - 1}{(\ln x)^2}\mathrm{d}x + \int \frac{1}{x^2}\mathrm{d}x = \frac{x}{\ln x} + \int \frac{1}{x^2}\mathrm{d}x$	**M1**	rearranges and uses their answer to (i)
	$\int \frac{1}{x^2}\mathrm{d}x = -\frac{1}{x}\left(+c\right)$	**B1**	
	$\frac{x}{\ln x} + \left(their -\frac{1}{x}\right)(+ c)$	**A1FT**	correct or correct **FT** completion; *their* $-\frac{1}{x}$ must not be $\frac{1}{x^2}$

Question	Answer	Marks	Guidance
10 (i)	$\tan(2x-10)=\frac{4}{3}$	**B1**	
	$2x-10=\tan^{-1}\left(\frac{4}{3}\right)$ soi	**M1**	
	31.6 and 121.6 isw	**A1**	or for 31.6 and 211.6 isw
	211.6 and 301.6 isw	**A1**	or for 121.6 and 301.6 isw
			Penalty of 1 mark if all 4 angles given correctly but prematurely approximated OR if any extra angles are given besides the correct 4
			If **A0 A0** then allow **SC1** for 53.1(30...), 233.1(30...), 413.1(30...), 593.1(30...) seen OR for 63.1(30…), 243.1(30…), 423.1(30…), 603.1(30…) seen
(ii)	$1-\cos^2 x-\cos^2 x=\cos x$	**M1**	uses $\sin^2 x=1-\cos^2 x$
	$2\cos^2 x+\cos x-1=0$ oe	**A1**	
	$(2\cos x-1)(\cos x+1)[=0]$	**M1**	factorises or solves *their* 3-term quadratic in $\cos x$
	$[x=]\ 60, 300, 180$	**A2**	**A1** for any two correct
11 (i)	$g\geqslant -\frac{1}{2}$	**B1**	
(ii)	g(1) = 0	**B1**	
	valid comment e.g. domain of f is $x \geqslant 2$	**B1**	**B1** for either
(iii)	$\frac{\left(\frac{x^2-2}{x}\right)^2-1}{2}$	**M1**	or $\frac{\left(x-\frac{2}{x}\right)^2-1}{2}$
	$\left(\frac{x^2-2}{x}\right)^2=\frac{x^4-4x^2+4}{x^2}$ soi	**B1**	or $\left(x-\frac{2}{x}\right)^2=x^2-4+\frac{4}{x^2}$
	$\frac{1}{2}x^2-\frac{5}{2}+\frac{2}{x^2}$	**A1**	or correct 3 term equivalent or $a = 0.5$, $b = -2.5$, $c = 2$

Question	Answer	Marks	Guidance
(iv)	$x \geqslant 2$	**B1**	
(v)	$x^2 - yx - 2 = 0$	**B1**	or $y^2 - xy - 2 = 0$
	$[x =] \frac{-(-y) \pm \sqrt{(-y)^2 - 4(1)(-2)}}{2}$	**M1**	or $[y =] \frac{-(-x) \pm \sqrt{(-x)^2 - 4(1)(-2)}}{2}$
	Explains why negative square root should be discarded	**B1**	at some point
	$f^{-1}(x) = \frac{x + \sqrt{x^2 + 8}}{2}$	**A1**	allow $y = \frac{x + \sqrt{x^2 + 8}}{2}$ If zero scored, allow **SC2** for showing correctly that the inverse of the given f^{-1} is f.
12 (i)	[length of rectangle =] $\frac{20 - 3x}{2}$	**B1**	
	$[A =]\ x \times their \frac{20 - 3x}{2} - \frac{1}{2} \times x \times x \times \sin 60$ oe	**M1**	
	Correct completion to given answer $A = 10x - \left(\frac{6 + \sqrt{3}}{4}\right)x^2$	**A1**	
(ii)	$10 - 2\left(\frac{6 + \sqrt{3}}{4}\right)x$ oe	**B1**	
	$their\left(10 - 2\left(\frac{6 + \sqrt{3}}{4}\right)x\right) = 0$ oe	**M1**	
	$x = 2.6$	**A1**	allow 2.586635... rot to 3 or more sf
	$A = 13$	**A1**	allow 12.9331.... rot to 3 or more sf