

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International General Certificate of Secondary Education

MARK SCHEME for the March 2016 series

0606 ADDITIONAL MATHEMATICS

0606/12

Paper 12, maximum raw mark 80

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Page 2	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – March 2016	0606	12

Abbreviations

awrt	answers which round to
cao	correct answer only
dep	dependent
FT	follow through after error
isw	ignore subsequent working
oe	or equivalent
rot	rounded or truncated
SC	Special Case
soi	seen or implied
www	without wrong working

Question	Answer	Marks	Guidance
1	$ax + 9 = -2x^2 + 3x + 1$ $2x^2 + (a - 3)x + 8 = 0$ For 2 distinct roots, $(a - 3)^2 > 64$ Critical values -5 and 11 $a > 11$, $a < -5$	M1 M1 A1 A1	for attempt to equate the line and the curve and obtain a 3 term quadratic equation for use of the discriminant for critical values for correct range
2	$a = -\frac{13}{6}$, $b = 0$, $c = 1$	B3	B1 for each
3	$\log_5 \sqrt{x} + \log_{25} x = 3$ $\frac{1}{2} \log_5 x + \frac{\log_5 x}{\log_5 25} = 3$ $\log_5 x = 3$ $x = 125$ cao Alternative scheme: $\frac{\log_{25} \sqrt{x}}{\log_{25} 5} + \log_{25} x = 3$ $\frac{\frac{1}{2} \log_{25} x}{\log_{25} 5} + \log_{25} x = 3$ $\log_{25} x = \frac{3}{2}$ $x = 125$ cao	B1,B1 B1 B1 B1	B1 for $\frac{1}{2} \log_5 x$ B1 for $\frac{\log_5 x}{\log_5 25}$ for final answer for change of base for $\frac{1}{2} \log_{25} x$ (must be from correct work) for final answer

Question	Answer	Marks	Guidance
4 (i)		B1 B1 B1 B1	for a line in correct position for $(0, 2)$, $(2, 0)$ for correct shape for $y = 3 + 2x $, touching the x -axis for $(-1.5, 0)$, $(0, 3)$
4 (ii)	$2 - x = 3 + 2x$ leading to $x = -\frac{1}{3}$ $2 - x = -3 - 2x$ leading to $x = -5$ Alternative: $(2 - x)^2 = (3 + 4x)^2$ leading to $15x^2 + 28x + 5 = 0$ $x = -\frac{1}{3}$, $x = -5$	B1 M1 A1 M1 A1,A1	for $x = -\frac{1}{3}$ for correct attempt to deal with ‘negative’ branch. for $x = -5$ for equating and squaring to obtain a 3 term quadratic equation A1 for each.
5 (a) (i)	${}^9P_6 = 60480$	B1	Must be evaluated
5 (a) (ii)	${}^4P_2 \times {}^3P_2 \times 2 = 144$	M1,A1	M1 for attempt a product of 3 perms
5 (a) (iii)	840×2 1680	B1,B1	B1 for either 840, or realising that there are 2 possible positions for the symbols
5 (b) (i)	${}^{10}C_6 \times {}^5C_3$ 2100	M1 A1	for unsimplified form
5 (b) (ii)	${}^8C_4 \times {}^4C_2$ 420	M1 A1	for unsimplified form
6 (i)	$f(x) > 6$	B1	Allow B1 for $y > 6$
6 (ii)	$f^{-1}(x) = \frac{1}{4} \ln(x - 6)$ Domain: $x > 6$ Range: $f^{-1}(x) \in \mathbb{R}$	M1 A1 B1 B1	for a complete method must be $f^{-1}(x) =$ or $y = \dots$ must be using the correct variable in both
6 (iii)	$f'(x) = 4e^{4x}$	B1	
6 (iv)	$6 + e^{4x} = 4e^{4x}$ leading to $x = \frac{1}{4} \ln 2$	M1 A1	for a complete, correct method

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – March 2016	0606	12

Question	Answer	Marks	Guidance
7 (i)	$f\left(\frac{1}{2}\right) = \frac{a}{8} + \frac{7}{4} - \frac{9}{2} + b \quad (=0)$ $a + 8b = 22$ $8a + 28 - 18 + b = 5(-a + 7 + 9 + b)$ $13a - 4b = 70$ <p>leading to $a = 6, b = 2$</p>	M1	for attempt at $f\left(\frac{1}{2}\right)$
(ii)	$(2x-1)(3x^2 + 5x - 2)$	B2,1,0	-1 each error
(iii)	$(2x-1)(3x-1)(x+2)$	M1 A1FT	for attempt to factorise their quadratic factor must be 3 linear factors
8 (i)	$\lg y = \lg A + b \lg x$ Gradient = 1.2 so $b = 1.2$ Intercept = 1.44 $A = 27.5$	B1 M1 A1	may be implied by later work for attempt at gradient for $b = 1.2$
(ii)	when $x = 100, \lg x = 2$ $\lg y = 3.84$ (allow 3.8 to 3.9)	M1 A1	for attempt to find y -intercept for , allow awrt 28
(iii)	when $y = 8000, \lg 8000 = 3.9, \lg x = 2.05$ leading to $x = 113, 10^{2.05}$ or 112	M1 A1	for correct use of graph or equation

Question	Answer	Marks	Guidance
9 (i)	$\frac{7}{2}r^2\theta = \frac{1}{2}r^2(2\pi - \theta)$	M1	for a valid method
	$\theta = \frac{\pi}{4}$ oe	A1	allow in degrees
	(ii) $r + r + \frac{\pi}{4}r = 20$, leading to $r = 7.180(3..)$	M1	for valid method
	(iii) Perimeter $= \frac{\pi}{4}r + 2r \tan \frac{\pi}{8}$ $= 5.6394 + 5.9484$ $= 11.6$	B1,B1 B1	B1 for arc length, B1 for twice AC for 11.6
(iv)	Area $= (r \times AC) - \frac{1}{2}r^2 \frac{\pi}{4}$ $= 21.356 - 20.246$ or equivalent method using triangles	B1,B1	B1 for area of quadrilateral, allow unsimplified, B1 for sector area
	$1.08 \leq \text{Area} \leq 1.11$	B1	for area in given range
10 (i)	$x \times \frac{3}{2} \times 2(2x-1)^{\frac{1}{2}} + (2x-1)^{\frac{3}{2}}$	B1 M1 A1	for $\frac{3}{2} \times 2(2x-1)^{\frac{1}{2}}$ for attempt at differentiation of a product for all else correct
	(ii) $3 \int x(2x-1)^{\frac{1}{2}} dx = x(2x-1)^{\frac{3}{2}} - \int (2x-1)^{\frac{3}{2}} dx$ $= x(2x-1)^{\frac{3}{2}} - \frac{1}{2} \times \frac{2}{5}(2x-1)^{\frac{5}{2}}$	M1 B1,B1	for attempt to use part (i) B1 for $x(2x-1)^{\frac{3}{2}}$, allow if divided by 3 B1 for $\frac{1}{2} \times \frac{2}{5}(2x-1)^{\frac{5}{2}}$, allow if divided by 3
	$\int x(2x-1)^{\frac{1}{2}} dx = \frac{1}{3}(2x-1)^{\frac{3}{2}} \left(x - \frac{1}{5}(2x-1) \right)$ $= \frac{(2x-1)^{\frac{3}{2}}}{15} (3x+1)$	M1 DM1 A1	for taking out a common factor of $(2x-1)^{\frac{3}{2}}$ for attempt to obtain a linear factor
(iii)	$\left(\frac{1}{15} \times 4 \right) - 0$	M1 A1FT	for attempt to use limits correctly FT on their $\frac{px+q}{15}$

Question	Answer	Marks	Guidance			
11 (i)	$\frac{1}{\operatorname{cosec}\theta - 1} - \frac{1}{\operatorname{cosec}\theta + 1} = \frac{\operatorname{cosec}\theta + 1 - \operatorname{cosec}\theta + 1}{\operatorname{cosec}^2\theta - 1}$ $= \frac{2}{\cot^2\theta}$ $= 2 \tan^2\theta$	M1	for attempt to obtain a single fraction			
		A1	all correct as shown			
		M1	for use of correct identity			
		A1	for 'finishing off'			
	Alternative scheme:	$\frac{1}{\operatorname{cosec}\theta - 1} - \frac{1}{\operatorname{cosec}\theta + 1} = \frac{\sin\theta}{1 - \sin\theta} - \frac{\sin\theta}{1 + \cos\theta}$ $= \frac{(\sin\theta + \sin^2\theta) - (\sin\theta - \sin^2\theta)}{1 - \sin^2\theta}$ $= \frac{2\sin^2\theta}{\cos^2\theta}$ $= 2 \tan^2\theta$	M1	for attempt to obtain a single fraction in terms of $\sin\theta$ only		
			A1	all correct as shown		
			M1	for use of correct identity		
			A1	for 'finishing off'		
			(ii)	$2 \tan^2\theta = 6 + \tan\theta$ $(2 \tan\theta + 3)(\tan\theta - 2) = 0$ $\tan\theta = -\frac{3}{2}, \tan\theta = 2$	M1	for attempt to use (i), to obtain a quadratic equation and valid attempt to solve
					DM1	for attempt to solve trig equation
	$\theta = 63.4^\circ, 123.7^\circ, 243.4^\circ, 303.7^\circ$	A1,A1	for each 'pair'			