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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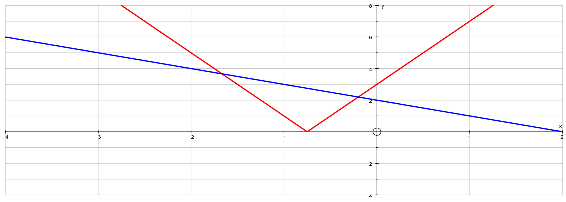
Abbreviations

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	$ax+9=-2x^2+3x+1$ $2x^2+(a-3)x+8=0$	M1	for attempt to equate the line and the curve and obtain a 3 term quadratic equation
	For 2 distinct roots, $(a-3)^2>64$	M1	for use of the discriminant
	Critical values -5 and 11	A1	for critical values
	$a>11,\quad a<-5$	A1	for correct range
2	$a=-\frac{13}{6},\ b=0,\ c=1$	B3	**B1** for each
3	$\log_5\sqrt{x}+\log_{25}x=3$ $\frac{1}{2}\log_5 x+\frac{\log_5 x}{\log_5 25}=3$ $\log_5 x=3$	B1,B1	**B1** for $\frac{1}{2}\log_5 x$ **B1** for $\frac{\log_5 x}{\log_5 25}$
	$x=125$ cao	B1	for final answer
	Alternative scheme: $\frac{\log_{25}\sqrt{x}}{\log_{25}5}+\log_{25}x=3$	B1	for change of base
	$\frac{\frac{1}{2}\log_{25}x}{\log_{25}5}+\log_{25}x=3$ $\log_{25}x=\frac{3}{2}$	B1	for $\frac{1}{2}\log_{25}x$ (must be from correct work)
	$x=125$ cao	B1	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 $y = \lvert 3+2x \rvert$, touching the x-axis for $(-1.5, 0)$, $(0, 3)$
(ii)	$2 - x = 3 + 2x$ leading to $x = -\frac{1}{3}$	B1	for $x = -\frac{1}{3}$
	$2 - x = -3 - 2x$ leading to $x = -5$	M1 A1	for correct attempt to deal with 'negative' branch. for $x = -5$
	Alternative: $(2-x)^2 = (3+4x)^2$ leading to $15x^2 + 28x + 5 = 0$ $x = -\frac{1}{3}$, $x = -5$	M1 A1,A1	for equating and squaring to obtain a 3 term quadratic equation **A1** for each.
5 (a) (i)	${}^{9}P_{6} = 60480$	B1	Must be evaluated
(ii)	${}^{4}P_{2} \times {}^{3}P_{2} \times 2 = 144$	M1,A1	**M1** for attempt a product of 3 perms
(iii)	840×2 1680	B1,B1	**B1** for either 840, or realising that there are 2 possible positions for the symbols
(b) (i)	${}^{10}C_{6} \times {}^{5}C_{3}$ 2100	M1 A1	for unsimplified form
(ii)	${}^{8}C_{4} \times {}^{4}C_{2}$ 420	M1 A1	for unsimplified form
6 (i)	$\mathrm{f}(x) > 6$	B1	Allow **B1** for $y > 6$
(ii)	$\mathrm{f}^{-1}(x) = \frac{1}{4}\ln(x-6)$	M1 A1	for a complete method must be $\mathrm{f}^{-1}(x) =$ or $y = \ldots$
	Domain: $x > 6$ Range: $\mathrm{f}^{-1}(x) \in \mathbb{R}$	B1 B1	must be using the correct variable in both
(iii)	$\mathrm{f}'(x) = 4\mathrm{e}^{4x}$	B1	
(iv)	$6 + \mathrm{e}^{4x} = 4\mathrm{e}^{4x}$ leading to $x = \frac{1}{4}\ln 2$	M1 A1	for a complete, correct method

Question	Answer	Marks	Guidance
7 (i)	$\mathrm{f}\left(\frac{1}{2}\right)=\frac{a}{8}+\frac{7}{4}-\frac{9}{2}+b \quad (=0)$ $a+8b=22$	M1	for attempt at $\mathrm{f}\left(\frac{1}{2}\right)$
	$8a+28-18+b=5(-a+7+9+b)$ $13a-4b=70$	M1	for attempt at $\mathrm{f}(2)=5\mathrm{f}(-1)$ Allow if the 'wrong way' round
		DM1	for attempt to solve simultaneous equations
	leading to $a=6,\ b=2$	A1	**A1** for both
(ii)	$(2x-1)(3x^2+5x-2)$	B2,1,0	–1 each error
(iii)	$(2x-1)(3x-1)(x+2)$	M1	for attempt to factorise their quadratic factor
		A1FT	must be 3 linear factors
8 (i)	$\lg y=\lg A+b\lg x$	B1	may be implied by later work
	Gradient = 1.2	M1	for attempt at gradient
	so $b=1.2$	A1	for $b=1.2$
	Intercept $=1.44$	M1	for attempt to find y-intercept
	$A=27.5$	A1	for , allow awrt 28
(ii)	when $x=100$, $\lg x=2$	M1	for correct use of graph or equation
	$\lg y=3.84$ (allow 3.8 to 3.9)	A1	
(iii)	when $y=8000$, $\lg 8000=3.9$, $\lg x=2.05$	M1	for correct use of graph or equation
	leading to $x=113$, $10^{2.05}$ or 112	A1	

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	**M1**	for valid method
	$r = 7.180(3..)$	**A1**	Must show enough accuracy to get **A1**
(iii)	Perimeter $= \frac{\pi}{4}r + 2r\tan\frac{\pi}{8}$	**B1,B1**	**B1** for arc length, **B1** for twice *AC*
	$= 5.6394 + 5.9484$		
	$= 11.6$	**B1**	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
	$1.08 \leqslant \text{Area} \leqslant 1.11$	**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**	for $\frac{3}{2} \times 2(2x-1)^{\frac{1}{2}}$
		M1	for attempt at differentiation of a product
		A1	for all else correct
(ii)	$3\int x(2x-1)^{\frac{1}{2}}\,dx = x(2x-1)^{\frac{3}{2}} - \int (2x-1)^{\frac{3}{2}}\,dx$	**M1**	for attempt to use part (i)
	$= x(2x-1)^{\frac{3}{2}} - \frac{1}{2} \times \frac{2}{5}(2x-1)^{\frac{5}{2}}$	**B1,B1**	**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
	$\int x(2x-1)^{\frac{1}{2}}\,dx = \frac{1}{3}(2x-1)^{\frac{3}{2}}\left(x - \frac{1}{5}(2x-1)\right)$	**M1**	for taking out a common factor of $(2x-1)^{\frac{3}{2}}$
	$= \frac{(2x-1)^{\frac{3}{2}}}{15}(3x+1)$	**DM1** **A1**	for attempt to obtain a linear factor
(iii)	$\left(\frac{1}{15} \times 4\right) - 0$	**M1**	for attempt to use limits correctly
		A1FT	**FT** on *their* $\frac{px+q}{15}$

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