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

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.

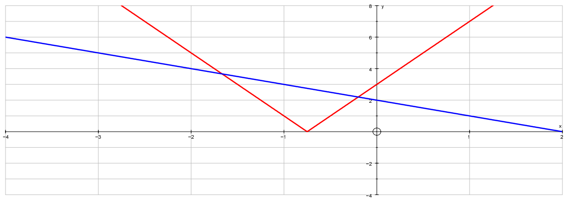
Cambridge is publishing the mark schemes for the March 2016 series for most Cambridge IGCSE® and Cambridge International A and AS Level components.

CAMBRIDGE
International Examinations

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 $a>11,\quad a<-5$	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**	 **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 $y = \lvert 3+2x \rvert$, 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)	$f\left(\frac{1}{2}\right)=\frac{a}{8}+\frac{7}{4}-\frac{9}{2}+b\ \ (=0)$ $a+8b=22$	M1	for attempt at $f\left(\frac{1}{2}\right)$
	$8a+28-18+b=5(-a+7+9+b)$ $13a-4b=70$	M1	for attempt at $f(2)=5f(-1)$ 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 $= \frac{\pi}{4}r + 2r\tan\frac{\pi}{8}$ $= 5.6394 + 5.9484$	B1,B1	**B1** for arc length, **B1** for twice AC
	$= 11.6$	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
	$1.08 \leqslant$ 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)	$\frac{1}{\operatorname{cosec}\theta-1}-\frac{1}{\operatorname{cosec}\theta+1}=\frac{\operatorname{cosec}\theta+1-\operatorname{cosec}\theta+1}{\operatorname{cosec}^2\theta-1}$	M1 A1	for attempt to obtain a single fraction 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: $\frac{1}{\operatorname{cosec}\theta-1}-\frac{1}{\operatorname{cosec}\theta+1}=\frac{\sin\theta}{1-\sin\theta}-\frac{\sin\theta}{1+\cos\theta}$	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)	$2\tan^2\theta=6+\tan\theta$ $(2\tan\theta+3)(\tan\theta-2)=0$	M1	for attempt to use (i), to obtain a quadratic equation and valid attempt to solve
	$\tan\theta=-\frac{3}{2},\quad \tan\theta=2$	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'