Question Number	Scheme	Marks
4. (a)	$\log_3(a+1)-\log_3 a=4\Rightarrow\log_3\left(\dfrac{a+1}{a}\right)=4$	M1
	$\Rightarrow\left(\dfrac{a+1}{a}\right)=3^4$	A1
	$\Rightarrow a+1=81a\Rightarrow a=\dfrac{1}{80}$	dM1, A1
		(4)
(b)	Area $\approx\dfrac{1}{2}\left\{\log_3\left(\dfrac{2}{1}\right)+\log_3\left(\dfrac{6}{5}\right)+2\left(\log_3\left(\dfrac{3}{2}\right)+\log_3\left(\dfrac{4}{3}\right)+\log_3\left(\dfrac{5}{4}\right)\right)\right\}$	M1, A1
	$=\dfrac{1}{2}\log_3\left(\dfrac{2}{1}\times\dfrac{6}{5}\times\dfrac{3^2}{2^2}\times\dfrac{4^2}{3^2}\times\dfrac{5^2}{4^2}\right)=\dfrac{1}{2}\log_3 15=\log_3\sqrt{15}$	dM1, A1
		(4)
(c)	States 'increase the number of strips'	B1
		(1)
		(9 marks)

Question Number	Scheme	Marks
10 (a)	$\left(\dfrac{dy}{dx}=\right)x-2187x^{-\frac{5}{2}}$	M1, A1
	Sets $x-2187x^{-\frac{5}{2}}=0\Rightarrow x^{\frac{7}{2}}=2187\left(\text{or e.g. } x=\left(\sqrt[7]{2187}\right)^2\right)\Rightarrow x=9$ *	dM1A1*
		(4)
(b)	e.g. $\displaystyle\int\left\{\frac{1}{2}x^2+1458x^{-\frac{3}{2}}-74\right\}dx=\frac{1}{6}x^3-2916x^{-\frac{1}{2}}-74x$ or $\displaystyle\int\left\{\frac{1}{2}x^2+1458x^{-\frac{3}{2}}-\text{"94.5"}\right\}dx=\frac{1}{6}x^3-2916x^{-\frac{1}{2}}-94.5x$	M1A1ft
	y value at P is 20.5	B1
	e.g. Area $R=\left[\dfrac{1}{6}x^3-2916x^{-\frac{1}{2}}-74x\right]_4^9-(9-4)\times\text{"20.5"}$ $=\left(\dfrac{1}{6}\times9^3-2916\times9^{-\frac{1}{2}}-74\times9\right)-\left(\dfrac{1}{6}\times4^3-2916\times4^{-\frac{1}{2}}-74\times4\right)-(9-4)\times\text{"20.5"}$	dM1
	$\left(-1516\dfrac{1}{2}+1743\dfrac{1}{3}-102\dfrac{1}{2}\right)=124\dfrac{1}{3}$	A1
		(5)
		Total 9

Question Number	Scheme	Marks
6(a)	Sets $f\left(-\frac{3}{2}\right)=0 \Rightarrow (9p+4q=102)$	M1
	Sets $f(-2)=-5 \Rightarrow (4p+q=43)$	M1
	Solves to get values for p and q	dM1
	(i) $p=10$ * (ii) $q=3$ following two correct equations	A1*, A1
		(5)
(b)	$f'(x)=12x^2+20x+8$	B1
	Solves $f'(x)=0 \Rightarrow 4(3x+2)(x+1)=0 \Rightarrow x=-\frac{2}{3},-1$	M1, A1
	$-1<x<-\frac{2}{3}$	A1
		(4)
		Total 9

Question Number	Scheme	Notes	Marks
4	$2\log_3(1-x)=\log_3(1-x)^2$ or $3=\log_3 3^3$	Correct power law used or implied	B1
	$\log_3(32-12x)-\log_3(1-x)^2=\log_3\frac{32-12x}{(1-x)^2}$ Combines 2 log terms correctly		M1
	$\frac{32-12x}{(1-x)^2}=27$	Obtains this equation in any form	A1
	$\Rightarrow 27x^2-42x-5=0 \Rightarrow x=\ldots$	Solves 3TQ	M1
	$x=-\frac{1}{9}$	This value only i.e. the $\frac{5}{3}$ must clearly be discarded if seen.	A1
			(5)
			Total 5

Question	Answer	Marks	Guidance
5(a)	Substitute $x=\frac{1}{2}$ and $x=3$, and equate each to zero to produce two equations	M1	**SC B1** for a correct equation, if M0 otherwise.
	Obtain $\frac{1}{16}a+\frac{1}{8}b=-\frac{3}{4}$	A1	OE $a+2b+12=0$
	Obtain $81a+27b=-27$	A1	OE $3a+b+1=0$
	Solve simultaneous equations to obtain $a=2$ and $b=-7$	A1	
		4	
5(b)	Divide by $2x^2-7x+3$ or successively by $2x-1$ and $x-3$	M1	OE method, such as inspection.
	Obtain quotient x^2+5	A1	Condone $2\left(x^2+5\right)$ from synthetic division.
	State fully factorised form $(2x-1)(x-3)(x^2+5)$	A1	
		3	
5(c)	Attempt solution of at least $\cot 2\theta=3$	M1	
	Obtain $\tan 2\theta=\frac{1}{3}$ and hence $\theta=0.161$	A1	Or greater accuracy $0.16087\ldots$
		2	

Question Number	Scheme	Marks
10 (a)	$y=\dfrac{9x-x^2}{2\sqrt{x}}=\dfrac{9}{2}x^{\frac{1}{2}}-\dfrac{1}{2}x^{\frac{3}{2}}\Rightarrow\quad\dfrac{dy}{dx}=\dfrac{9}{4}x^{-\frac{1}{2}}-\dfrac{3}{4}x^{\frac{1}{2}}$	M1, A1
	Sets $\dfrac{9}{4}x^{-\frac{1}{2}}-\dfrac{3}{4}x^{\frac{1}{2}}=0\Rightarrow x=\dfrac{9}{4}\times\dfrac{4}{3}\Rightarrow x=3$	dM1, A1
		(4)
(b)	$\displaystyle\int\left\{\frac{9}{2}x^{\frac{1}{2}}-\frac{1}{2}x^{\frac{3}{2}}\right\}dx=3x^{\frac{3}{2}}-\frac{1}{5}x^{\frac{5}{2}}$	M1, A1
	Upper limit is 9	B1
	Area $R=\left[3x^{\frac{3}{2}}-\dfrac{1}{5}x^{\frac{5}{2}}\right]_1^9=\left(3\times27-\dfrac{1}{5}\times243\right)-\left(3\times1-\dfrac{1}{5}\times1\right)$	dM1
	$=\dfrac{148}{5}$	A1
		(5)
		Total 9

Question	Answer	Marks	Guidance
3	Attempt use of quotient rule (or equivalent) to differentiate $\dfrac{8x}{2x+3}$ or $\dfrac{-12x^2+15}{(2x+3)}$	*M1	
	Obtain $\dfrac{dy}{dx}=\dfrac{24}{(2x+3)^2}-6$	A1	OE Allow unsimplified.
	Equate first derivative to zero, and attempt solution of a quadratic equation to find two values of x	DM1	$4x^2+12x+5=0$
	Obtain at least one of the stationary points $(-\frac{5}{2},\ 30)$ and $(-\frac{1}{2},\ 6)$, or both x-values, $-\frac{5}{2}$ and $-\frac{1}{2}$	A1	
	Obtain both stationary points	A1	
		5	

Question Number	Scheme	Marks
9 (i)	$2\log_3(4x+5)-\log_3(x+3)=2\Rightarrow\log_3\frac{(4x+5)^2}{(x+3)}=2$	M1, M1
	$\Rightarrow\frac{(4x+5)^2}{(x+3)}=9$	A1
	$\Rightarrow 16x^2+31x-2=0$	
	$(16x-1)(x+2)=0\Rightarrow x=\frac{1}{16}$ only	dM1, A1
		(5)
(ii) (a)	States that $\log a+\log b=\log(ab)$ or else uses rule and proceeds from given equation $\log a+\log b=\log(a+b)$ to $\log ab=\log(a+b)$	B1
	Deduces $ab=a+b\Rightarrow ab-a=b\Rightarrow a(b-1)=b\Rightarrow a=\frac{b}{b-1}$ *	M1, A1*
(b)	States either $b>1$ or $b\neq1$ as a would not be defined	B1
	$b>1$ as logs only exist for positive numbers	B1
		(5)
		(10 marks)

Question Number	Scheme	Marks
4(a)	$(2+px)^6=(2^6+)\ 6\times2^5(px)+\frac{6\times5}{2}\times2^4(px)^2+...$ or $\left(1+\frac{"p"}{2}x\right)^6=1+6\times\left(\frac{"p"}{2}x\right)+\frac{6\times5}{2}\times\left(\frac{"p"}{2}x\right)^2+...$	M1
	2^6 or 64	B1
	$+192px$ or $+240p^2x^2$	A1
	$(64+)192px+240p^2x^2$	A1
		(4)
(b)	$\left(3-\frac{1}{2}x\right)(2+px)^6\Rightarrow\left(3-\frac{1}{2}x\right)(64+192px+240p^2x^2)$	
	Attempts $3\times"240p^2"$ and $\left(-\frac{1}{2}\right)\times"192p"$	M1
	$3\times"240p^2"+\left(-\frac{1}{2}\right)\times"192p"=-\frac{3}{4}$	dM1
	$2880p^2-384p+3=0\Rightarrow p=...$	ddM1
	$(p=)\ \frac{1}{8},\frac{1}{120}$	A1
		(4)
		(8 marks)

Question Number	Scheme	Marks
	$y = x^3 - 4x^{\frac{5}{2}} - kx^{\frac{1}{2}} + 28x - 44$	
7.(a)	$y = x^3 - 4x^{\frac{5}{2}} - kx^{\frac{1}{2}} + 28x - 44 \Rightarrow \left(\frac{dy}{dx}\right) = 3x^2 - 10x^{\frac{3}{2}} - \frac{k}{2}x^{-\frac{1}{2}} + 28$	M1, A1
		(2)
(b)	Subs $x = 9$ into $\frac{dy}{dx}$ and sets = 0 $\Rightarrow 3\times81 - 10\times27 - \frac{k}{6} + 28 = 0$	M1
	$243 - 270 - \frac{k}{6} + 28 = 0 \Rightarrow \frac{k}{6} = 1 \Rightarrow k = 6$ *	A1*
		(2)
(c)	$\int x^3 - 4x^{\frac{5}{2}} - 6x^{\frac{1}{2}} + 28x - 44\, dx = \frac{1}{4}x^4 - \frac{8}{7}x^{\frac{7}{2}} - 4x^{\frac{3}{2}} + 14x^2 - 44x$	M1, A1, A1
	Correct value of $y = -53$ at *T*	B1
	Shaded area = $\text{"53"}\times 9 + \left[\frac{1}{4}x^4 - \frac{8}{7}x^{\frac{7}{2}} - 4x^{\frac{3}{2}} + 14x^2 - 44x\right]_0^9$	dM1
	$= 248$	A1
		(6)
		(10 marks)

Question	Answer	Marks	Guidance
1	Use correct logarithm property to simplify left-hand side	**M1**	Or equivalent method
	Use correct process to obtain equation without logarithms	**M1**	
	Obtain $\frac{2x+1}{x-3} = e^2$	**A1**	OE
	Obtain $x = \frac{3e^2+1}{e^2-2}$	**A1**	OE
		4	

Question Number	Please read notes for 8(i) before looking at scheme		Marks
8.(i)	$8^{2x+1}=6 \Rightarrow 2x+1=\log_8 6$ M1	$2^{6x+3}=6$	
	$\Rightarrow 2x+1=\dfrac{\log_2 6}{\log_2 8}$ A1	$\Rightarrow (6x+3)\log_2 2=\log_2 6$ M1 A1	
	$\Rightarrow 2x+1=\dfrac{\log_2 2+\log_2 3}{3}$ M1	$\Rightarrow (6x+3)=\log_2 2+\log_2 3$ M1	
	$\Rightarrow x=\dfrac{\log_2 3}{6}-\dfrac{1}{3}$ A1	$\Rightarrow x=\dfrac{\log_2 3}{6}-\dfrac{1}{3}$ A1	
			(4)
(ii)	$\log_5(7-2y)=2\log_5(y+1)-1$	$2\log_5(y+1)-\log_5(7-2y)=1$	
	$\log_5(7-2y)=\log_5(y+1)^2-1$	$\log_5(y+1)^2-\log_5(7-2y)=1$	M1
	$\log_5(7-2y)=\log_5(y+1)^2-\log_5 5$	$\log_5\dfrac{(y+1)^2}{(7-2y)}=1$	dM1
	$(7-2y)=\dfrac{(y+1)^2}{5}$	$\dfrac{(y+1)^2}{(7-2y)}=5$	A1
	$y^2+12y-34=0 \Rightarrow y=$	$y^2+12y-34=0 \Rightarrow y=$	ddM1
	$y=-6+\sqrt{70}$ oe only		A1
			(5)
			(9 marks)

Question	Scheme	Marks
4(a)	$\left(2+\dfrac{x}{8}\right)^{13}=8192+\ldots$	**B1**
	$+\binom{13}{1}2^{12}\left(\dfrac{x}{8}\right)^1+\binom{13}{2}2^{11}\left(\dfrac{x}{8}\right)^2+\binom{13}{3}2^{10}\left(\dfrac{x}{8}\right)^3+\ldots$	**M1**
	$\left(2+\dfrac{x}{8}\right)^{13}=(8192)+6656x+2496x^2+572x^3+\ldots$	**A1A1**
		(4)
(b)	$\dfrac{x}{8}=0.0125 \Rightarrow x=0.1$	**B1**
	$2.0125^{13}\approx 8192+665.6+24.96+0.572$	**M1**
	$=8883.132$ cao	**A1**
		(3)
(c)	As all the terms in the expansion are positive, the truncated series will give an underestimate of the actual value.	**B1**
		(1)
		(8 marks)