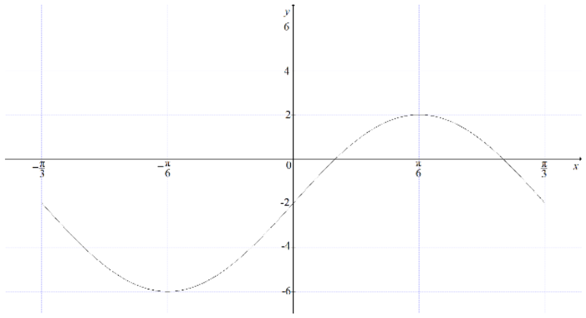
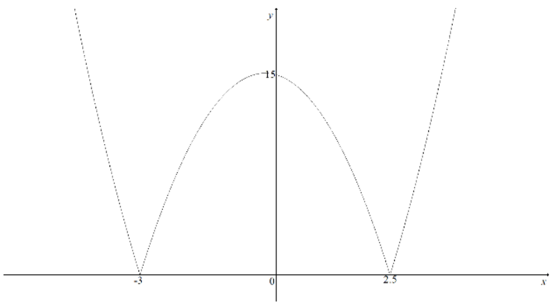
Question	Answer	Marks	Guidance
1		3	**B1** for a curve starting at $\left(-\frac{\pi}{3},-2\right)$ and finishing at $\left(\frac{\pi}{3},-2\right)$ **B1** for a curve, must have implied symmetry about $\frac{\pi}{6}$ and $-\frac{\pi}{6}$, one complete cycle only. **B1** for a curve passing through (0, –2) and distinct maximum at $\left(\frac{\pi}{6}, 2\right)$ and distinct minimum at only $\left(-\frac{\pi}{6},-6\right)$
2(a)	$2\left(x+\frac{1}{4}\right)^2-\frac{121}{8}$	2	**B1** for $a=\frac{1}{4}$ **B1** for $b=-\frac{121}{8}$
2(b)	$\left(-\frac{1}{4},-\frac{121}{8}\right)$	2	**FTB1** for each, follow through on *their a* and *b* from **(a)** or **SC1** if differentiation is used ie $\frac{dy}{dx}=4x+1=0$ then $\left(-\frac{1}{4},-\frac{121}{8}\right)$
2(c)		3	**B1** for a correct shape. Must have the parabola part of the curve in the first and second quadrant with cusps and correct curvature and a max in the **2nd** quadrant. Ignore labelling of their maximum point if incorrect coordinates **B1** for a curve $\left(\frac{5}{2},0\right)$ and (–3, 0) **B1** for a curve (0, 15)
2(d)	$k=\frac{121}{8}$	B1	**FT** Follow through on *their* $-b$

Question	Answer	Marks	Guidance
3(a)	$3y^2+2y-1[=0]$ oe or $4x^2-4x-3[=0]$ oe	M1	**M1** for obtaining a 3 term quadratic equation in y or x **and** an attempt to solve
	$x=\frac{3}{2},\ x=-\frac{1}{2}$ oe	A1	
	$y=\frac{1}{3},\ y=-1$ oe	A1	Allow **A1** for the one correct pair e.g. $\left(\frac{3}{2},\frac{1}{3}\right)$ or $\left(-\frac{1}{2},-1\right)$
3(b)	$\left[\log_3 x+3=\right]\frac{10}{\log_3 x}$ oe or $\frac{1}{\log_x 3}\left[+3=10\log_x 3\right]$ oe	B1	For change of base
	$(\log_3 x)^2+3\log_3 x-10=0$ or $10(\log_x 3)^2-3\log_x 3-1=0$ $\log_3 x=-5\ \ \log_3 x=2$ or $\log_x 3=-\frac{1}{5}\ \ \log_x 3=\frac{1}{2}$	M1	**Dep** on previous **B** mark, for attempt to obtain a 3-term quadratic equation and attempt to solve to obtain 2 solutions of the form $\log_3 x=p$ or $\log_x 3=q$
	$3^{-5}\quad 3^2$ isw	2	**A1** for each
4(a)	$\mathrm{p}'(x)=3ax^2+26x+b$ $\mathrm{p}'(0)=b$	B1	Must see at least $\mathrm{p}'(x)=3ax^2+26x+b$ to award the mark
4(b)	$\mathrm{p}\left(-\frac{2}{3}\right):8a-27c=318$ oe	M1	For use of $x=-\frac{2}{3}$, at least once **and** attempt at simplification leading to an equation in a and c only Allow one sign error.
	$\mathrm{p}(-1):a-c=16$ oe	M1	For use of $x=-1$ **and** attempt at simplification leading to an equation in a and c only
	$a=6, c=-10$	2	**M1 dep** on both previous **M** marks and attempt to solve simultaneously to obtain both a and c **A1** for both
4(c)	$2x^2+3x-5$	B1	Allow if seen embedded i.e.: $(3x+2)(2x^2+3x-5)$ or as a quotient in long division

Question	Answer	Marks	Guidance
4(d)	$(3x+2)(x-1)(2x+5)$	**B1**	
5(a)	$r^3 = \frac{1}{8}$ soi	**M1**	Allow unsimplified $ar^{14} = \frac{1}{8}ar^{11}$ or $\frac{5r^{11}-5r^{12}}{5r^{14}-5r^{15}} = 8$ oe
	$r = \frac{1}{2}$	**A1**	
	$5 = \frac{a}{1-r}$	**M1**	For use of sum to infinity with *their* r, must be $-1 < r < 1$
	$a = \frac{5}{2}$	**A1**	
5(b)	$their(\mathbf{a}) \times \frac{\left(1-(their\ r)^n\right)}{(1-their\ r)}$	**M1**	For use of the sum to n terms
	$(their\ r)^n = 0.0002$ (12.29)	**M1**	**M1 dep** For simplification and attempt to obtain the critical value using either an equation or an inequality leading to $n =$ or $n >$
	13	**A1**	Accept $n \geqslant 13$
6(a)	$f > -4$	**B1**	Allow $y > -4$ or $-4 < f < \infty$ or $f \in (-4, \infty)$
6(b)	$\left[f^{-1}(x) =\right] \frac{1}{3}\ln(x+4)$	**2**	**M1** for a correct method to find the inverse, allow one sign error Must be in the form of $3x = \ln(y \pm 4)$ or $3y = \ln(x \pm 4)$ **A1** allow $y =$

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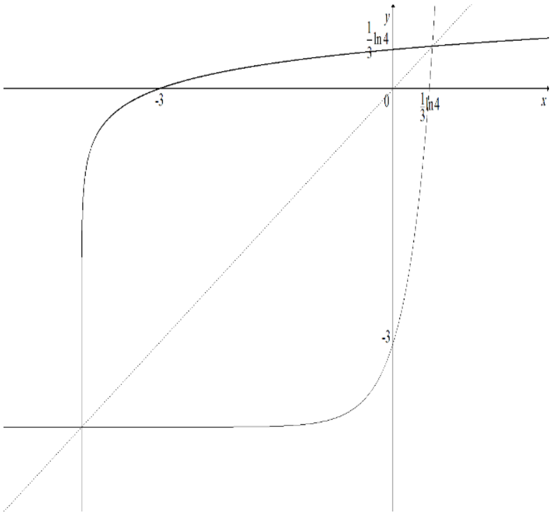
6(c)		4	**B1** for f(x) with correct shape in quadrant 1, 3 and 4 and appropriate asymptotic behaviour **B1** for –3 on the y-axis and $\frac{1}{3}\ln 4$ on the x-axis for f(x) must have the correct shape **B1** for $f^{-1}(x)$ with correct shape in quadrant 1, 2 and 3 and appropriate asymptotic behaviour **B1** for –3 on the x-axis and $\frac{1}{3}\ln 4$ on the y-axis for $f^{-1}(x)$ must have correct shape and intersect at least once
7	$\frac{1}{3}\sin 3x - 2\cos 2x + x$	2	**M1** for $a\sin 3x + b\cos 2x + x$, $a \neq \pm 3$ and $b \neq \pm 8$ **A1** all correct
	$\left(\frac{1}{3}\sin\frac{3\pi}{2} - 2\cos\pi + \frac{\pi}{2}\right) - (-2)$	M1	**Dep** on previous **M** mark for correct substitution (seen or implied) of **both** limits in x
	$\frac{11}{3}$	A1	
	$\frac{\pi}{2}$	B1	From correct substitution (seen or implied) of **both** limits in x
8(a)	1.75	B1	
8(b)	$\cos BOC = \frac{7}{25}$, $\tan BOC = \frac{24}{7}$, $\sin BOC = \frac{24}{25}$ BOC = 1.287 soi	B1	
	Arc length = r × *their* 1.287	B1	Follow through on *their BOC*
	Perimeter = 12.25 + *their* 9.009 + 14	M1	For a complete method
	35.3	A1	
8(c)	$\left(\frac{1}{2}\times 7^2 \times 1.75\right) + \left(\frac{1}{2}\times 7^2 \times \textit{their } BOC\right)$ oe or $\pi \times 7^2 - \frac{1}{2}\times 7^2 \times (2\pi - 1.75 - \textit{their}\,1.287)$	M1	For a complete method
	74.4	A1	
9(a)(i)	665 280	B1	
9(a)(ii)	221 760	B1	

Question	Answer	Marks	Guidance
9(b)	$8 \times 4 \times 3 \times 2 \times 1 \times 7$	**M1**	For either 8×7 or 4! or 24 as part of a product
	1344	**A1**	
10	$\tan(3x + 1.2)\left[= \frac{1}{\sqrt{2}}\right]$ or $\cos^2(3x + 1.2)\left[= \frac{2}{3}\right]$ or $\sin^2(3x + 1.2)\left[= \frac{1}{3}\right]$	**M1**	For an attempt to obtain an equation in $\sin(3x + 1.2)$, $\cos(3x + 1.2)$ or $\tan(3x + 1.2)$
	$x = -1.24, -0.195, 0.852$ or better	**4**	**M1 dep** for a correct attempt to obtain one correct solution **A1** for one correct solution in the range **M1 dep** for an attempt to obtain another solution within the range **A1** for 2 more correct solutions within the range and no extra solutions within the range
11	$\ln(3x+2) - \ln(2x+1) - \ln x$	**2**	**B1** for 1 correct term **B1** for the other two terms correct
	$\ln\frac{(3a+2)}{a(2a+1)} - \ln\frac{5}{3}$ $\ln\frac{3(3a+2)}{5a(2a+1)} = \left[\ln\frac{1}{5}\right]$ or $\ln\frac{(3a+2)}{a(2a+1)} = \ln\frac{1}{3}$	**2**	**M1** for application of limits correctly, **dep** on at least one **B** mark **M1** for application of log laws to obtain a single logarithm, dep on at least one **B** mark
	$a^2 - 4a - 3 = 0$ $a = 2 + \sqrt{7}$	**2**	**M1** for equating to $\ln\frac{1}{5}$ and attempt to solve resulting 3-term quadratic equation, dep on at least one **B** mark **A1** for $2 + \sqrt{7}$ must reject $2 - \sqrt{7}$

Question	Answer	Marks	Guidance
12(a)	$\left(\frac{dy}{dx}=\right)$ $\frac{(x-1)\times\frac{2}{3}\times 6x\left(3x^2-2\right)^{-\frac{1}{3}}-\left(3x^2-2\right)^{\frac{2}{3}}}{(x-1)^2}$ or $\left(\frac{dy}{dx}=\right)$ $(x-1)^{-1}\times\frac{2}{3}\times 6x\left(3x^2-2\right)^{-\frac{1}{3}}-(x-1)^{-2}\left(3x^2-2\right)^{\frac{2}{3}}$	**3**	**B1** for $\frac{2}{3}\times 6x\left(3x^2-2\right)^{-\frac{1}{3}}$ **M1** for differentiation of a quotient or product **A1** for all terms other than $\frac{2}{3}\times 6x\left(3x^2-2\right)^{-\frac{1}{3}}$ correct
	$\frac{\left(3x^2-2\right)^{-\frac{1}{3}}}{(x-1)^2}\left(x^2-4x+2\right)$	**2**	**M1 dep** for attempt to factorise, must be in the form $\frac{\left(3x^2-2\right)^{-\frac{1}{3}}}{(x-1)^2}\left[ax(x-1)-\left(3x^2-2\right)\right]$ **A1** all correct
12(b)	When $x=2, \frac{dy}{dx}=-\frac{2}{\sqrt[3]{10}}$ oe	**M1**	**Dep** on the differentiation **M** mark from part **(a)** For attempt to find the value of *their* $\frac{dy}{dx}$ when $x = 2$
	$-\frac{2}{\sqrt[3]{10}}p$ or $-0.928p$	**A1**	
13(a)	Midpoint (10, –9)	**B1**	
	Gradient of $l = -\frac{5}{3}$	**B1**	
	Equation of l: $y+9=-\frac{5}{3}(x-10)$ oe	**M1**	Must be using *their* perpendicular gradient and *their* mid-point
	$y=-4$	**A1**	

Question	Answer	Marks	Guidance
13(b)	Attempt to use *their* R and displacement vectors or Pythagoras to find S	**M1**	May be implied by one correct coordinate If Pythagoras is used: **M1** for an attempt to reach to a 3-term quadratic with one variable using *their* equation and *their* midpoint from **(a)** e.g. $34x^2 - 680x + 646 = 0$
	(1, 6)	**A1**	
	(19, –24)	**A1**	