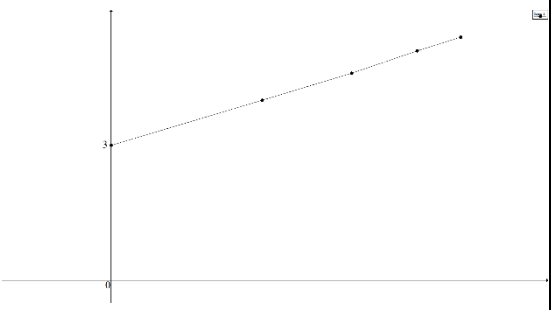
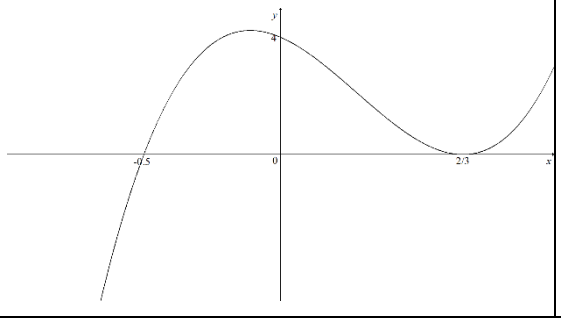
Question	Answer	Marks	Guidance
1	$a=4$	**B1**	
	$b=3$	**B1**	
	$c=-5$	**B1**	
2(a)	$c=0$	**B1**	
	$\mathrm{P}\left(-\frac{1}{2}\right)$: $a+4b=-34$ oe	**B1**	Allow multiples but must be in terms of *a*, *b* and one numeric term.
	$\mathrm{P}'(x)=3ax^2-22x+b$ $\mathrm{P}'(2)=12a-44+b$ soi	**M1**	For attempt to differentiate and substitute in $x=2$
	$12a+b=62$	**A1**	Allow multiples but must be in terms of *a*, *b* and one numeric term.
	$a=6,\ b=-10$	**2**	**M1 dep** for attempt to solve *their* simultaneous equations. **A1** for both
2(b)	$x\left(6x^2-11x-10\right)$	**M1**	For $x\left(\left(\textit{their } a\right)x^2-11x+\textit{their } b\right)$
	$x(3x+2)(2x-5)$	**A1**	
3(a)	$\pm\begin{pmatrix}-5\\12\end{pmatrix}$	**B1**	
	$\begin{pmatrix}-5\\12\end{pmatrix}$	**B1**	
3(b)	13	**B1**	**FT** on *their* (a)
3(c)	$3\left(\textit{their } \overrightarrow{AB}\right)=2\overrightarrow{OX}-2\begin{pmatrix}2\\-6\end{pmatrix}$	**M1**	Condone $3\left(\textit{their } \overrightarrow{AB}\right)=2\begin{pmatrix}2\\-6\end{pmatrix}-2\overrightarrow{OX}$
	$\begin{pmatrix}-\frac{11}{2}\\12\end{pmatrix}$	**A1**	

Question	Answer	Marks	Guidance
4(a)	$\ln y = \ln A + b\ln x$ soi	**B1**	May be implied by parts **(b)** and **(c)**
	<table><tr><td>$\ln x$</td><td>0</td><td>0.69</td><td>1.1</td><td>1.4</td><td>1.6</td></tr><tr><td>$\ln y$</td><td>3</td><td>4</td><td>4.6</td><td>5.1</td><td>5.4</td></tr></table> 	**2**	**M1** for attempt to plot a correct graph, allow one point error on the graph. **A1** All points correct on the graph.
4(b)	Vertical intercept = $\ln A$ $(=3)$	**M1**	**Dep** on a straight line graph
	20	**A1**	
	Gradient = b	**M1**	**Dep** on a straight line graph
	$b = 1.5$ (allow 1.4 to 1.6)	**A1**	
4(c)	Reading off graph for $\ln x = 1.25$ to obtain $\ln y$ or use of *their* equation	**M1**	**Dep** on a straight line graph
	$120 \leqslant y \leqslant 150$	**A1**	
5(a)(i)	5040	**B1**	
5(a)(ii)	2520	**B1**	
5(a)(iii)	There are 504 codes less than 1000 $5040 - 504 = 4536$	**2**	**M1** for *their* **(i)** -504 or $9\times$(a product of 3 relevant numbers)
5(b)	With family: 462	**B1**	
	Without family: 55	**B1**	
	Total: 517	**B1**	
6(a)	$\lg 50x^3$	**3**	**B1** for $\lg x^3$ or $\lg 2$ or $\lg 100$ **B1** for $\lg \frac{x^3}{2}$

Question	Answer	Marks	Guidance
6(b)	$\log_4 a = \dfrac{1}{\log_a 4}$	**B1**	
	$2(\log_a 4)^2 - 5\log_a 4 - 3 = 0$	**M1**	For attempt to obtain a 3-term quadratic equation in $\log_a 4$ and an attempt to solve to obtain $\log_a 4 = ...$
	$\log_a 4 = -\dfrac{1}{2}$, $\log_a 4 = 3$ $a = \dfrac{1}{16}$, $a = 4^{\frac{1}{3}}$ oe	**3**	**M1 Dep** for dealing with logarithms correctly at least once, to obtain $a = \ldots$ **A1** for each correct solution nfww.
	Alternative:		
	$\log_a 4 = \dfrac{1}{\log_4 a}$	**(B1)**	
	$3(\log_4 a)^2 + 5\log_4 a - 2 = 0$	**(M1)**	For attempt to obtain a 3-term quadratic equation in $\log_a 4$ and an attempt to solve to obtain $\log_a 4 = ...$
	$\log_4 a = -2$, $3\log_4 a = 1$ $a = \dfrac{1}{16}$, $a = 4^{\frac{1}{3}}$ oe	**(3)**	**M1 Dep** for dealing with logarithms correctly at least once, to obtain $a = \ldots$ **A1** for each correct solution nfww.
7(a)	$\dfrac{dy}{dx} = 2\times 3\times (2x+1)(3x-2) + 2(3x-2)^2$	**2**	**M1** for attempt at differentiation of a product, allow one arithmetic error. **A1** all correct, allow unsimplified.
	$2(3x-2)(9x+1)$	**A1**	
7(b)	$\left(\dfrac{2}{3},\ 0\right)$	**B1**	Must be from a correct derivative
	$\left(-\dfrac{1}{9},\ \dfrac{343}{81}\right)$ or $\left(-\dfrac{1}{9},\ 4.23\right)$	**B1**	
7(c)		**3**	**B1** for a correct cubic shape with a maximum in the second quadrant. **B1** for $-\dfrac{1}{2}$ and $\dfrac{2}{3}$, must have a cubic shape **B1** for 4 must have a cubic shape

Question	Answer	Marks	Guidance
7(d)	$0 < k < \frac{343}{81}$ or $0 < k < 4.23$	**2**	**B1** for critical values 0 and *their* 4.23 or $\frac{343}{81}$
8	$4x^2 - 6x - 5 = 1 - 4x$ oe $2x^2 - x - 3 = 0$ oe	**2**	**M1** for attempt to eliminate *y* and simplify to a 3-term quadratic equation = 0. **A1** for a correct equation.
	Correct attempt to solve *their* quadratic equation to obtain 2 values for *x* or for *y*	**M1**	
	$x = -1, \quad \frac{3}{2}$	**A1**	
	$y = 5, \quad -5$	**A1**	
	$\frac{dy}{dx} = 8x - 6$ When $x = \frac{3}{2}$, $\frac{dy}{dx} = 6$	**M1**	For finding the value of $\frac{dy}{dx}$ using *their* $x = \frac{3}{2}$
	Equation of tangent: $y = 6x - 14$	**2**	**Dep M1** for attempt to find the equation of the tangent using *their* $x = \frac{3}{2}$ and *their* $y = -5$. **A1** allow unsimplified.
	$5 = 6x - 14$ oe	**M1**	For use of *their* $y = 5$ in *their* tangent equation
	$x = 3.17$	**A1**	
9(a)(i)	$-3\tan\frac{\theta}{2} + 11\left(2\tan\frac{\theta}{2}\right) = \frac{19\sqrt{3}}{3}$	**2**	**M1** for use of 12th term with *their* common difference. **A1** allow unsimplified.
	$\tan\frac{\theta}{2} = \frac{\sqrt{3}}{3}$ $\theta = \frac{\pi}{3}$	**2**	**Dep M1** for correct attempt to solve *their* $\tan\frac{\theta}{2} = \frac{\sqrt{3}}{3}$
9(a)(ii)	$\frac{10}{2}\left(2\left(-3\times\frac{\sqrt{3}}{3}\right) + 9\left(2\times\frac{\sqrt{3}}{3}\right)\right)$ oe	**M1**	For the use of the sum to 10 terms using *their* $\tan\frac{\theta}{2} = \frac{\sqrt{3}}{3}$
	$20\sqrt{3}$	**A1**	

Question	Answer	Marks	Guidance
9(b)(i)	Common ratio = $4\sin^2\phi$	**B1**	
	$1+4\sin^2\phi=4$	**M1**	For use of $1+$*their* $r=4$
	$\sin\phi=\pm\frac{\sqrt{3}}{2}$ $\phi=\pm\frac{\pi}{3}$	**2**	**M1** for a correct attempt to solve *their* $\sin\phi=\pm\frac{\sqrt{3}}{2}$ to obtain at least one solution.
9(b)(ii)	Common ratio = 3 soi	**M1**	For attempt to find numerical value of *their* common ratio.
	$3>1$ so no sum to infinity [as $-1<r<1$ to have a sum to infinity.] oe	**A1**	Must have correct common ratio.
10(a)	$\frac{(x-4)\left(\frac{1}{2}\times 6x\left(3x^2-2\right)^{-\frac{1}{2}}\right)-\left(3x^2-2\right)^{\frac{1}{2}}}{(x-4)^2}$	**3**	**B1** for $\frac{1}{2}\times 6x\left(3x^2-2\right)^{-\frac{1}{2}}$, allow unsimplified. **M1** for a correct attempt to differentiate a quotient. **A1** for all other terms correct.
	$\frac{\left(3x^2-2\right)^{-\frac{1}{2}}}{(x-4)^2}\left(3x(x-4)-\left(3x^2-2\right)\right)$	**M1**	For a correct attempt to simplify to obtain the given form.
	$\frac{-12x+2}{\sqrt{3x^2-2}(x-4)^2}$	**A1**	
10(b)	When $x=3$, $\frac{dy}{dx}=\frac{-36+2}{5}$	**M1**	For attempt using *their* $\frac{dy}{dx}$
	$-6.8h$	**2**	**Dep M1** for attempt at small changes using their -6.8. **A1** cao