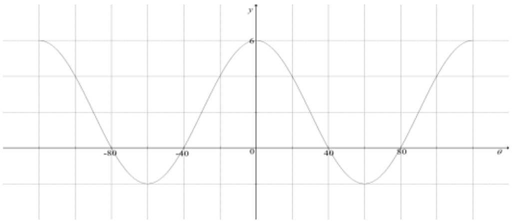
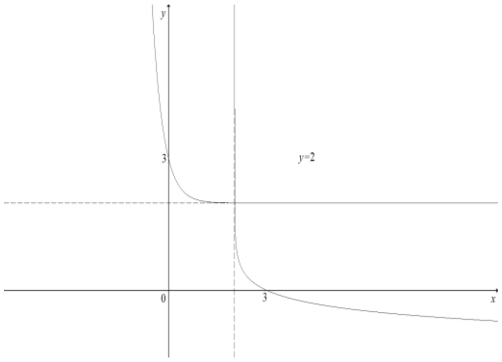
Question	Answer	Marks	Guidance
1(a)	4	**B1**	
1(b)	120^{o}	**B1**	
1(c)		**3**	To score marks, must have minimum points in the correct quadrants and symmetry about the *y*-axis. **B1** for correct θ intercepts $\pm 40^{o}$, $\pm 80^{o}$ and no others **B1** for *y*-intercept of 6 **B1** for a completely correct shape with no errors.
2(a)	$\log_p \frac{12a}{6} = \log_p 4^3$ soi	**2**	**B1** for correct use of addition and subtraction rule **B1** for correct use of power rule
	$a = 32$	**B1**	
2(b)	$4\log_3 x = \frac{9}{\log_3 x}$ or $\frac{4}{\log_x 3} = 9\log_x 3$ soi	**B1**	For change of base
	$(\log_3 x)^2 = \frac{9}{4}$ or $(\log_x 3)^2 = \frac{4}{9}$ soi	**B1**	
	$x = 3^{\pm 1.5}$ or exact equivalents	**2**	**B1** for each solution
3	$\frac{3x^2}{x^3+3}$	**B1**	
	When $x = 1$, $\frac{dy}{dx} = \frac{3}{4}$ oe	**M1**	For finding the value of *their* $\frac{dy}{dx}$
	$y = \ln 4$	**B1**	
	$y - \ln 4 = -\frac{4}{3}(x-1)$	**2**	**M1** for attempt at normal equation using *their* $\frac{dy}{dx}$ and *their y* Allow **A1** if $c = \frac{4}{3} + \ln 4$ seen
	$\left(\frac{4+3\ln 4}{7}, \frac{4+3\ln 4}{7}\right)$	**2**	**M1 dep** for attempt to use $y = x$ and obtain at least one solution
4(a)	$\mathrm{f} > 2$	**B1**	
4(b)	$\mathrm{f}^{-1}(x) = -\frac{1}{3}\ln(x-2)$ or $\frac{1}{3}\ln\left(\frac{1}{x-2}\right)$ isw	**2**	**M1** for a complete attempt at inverse, allow sign slip but brackets must be used correctly.

Question	Answer	Marks	Guidance
4(c)		4	**B1** for correct $y = \mathrm{f}(x)$ with *y*-intercept of 3. Must have correct asymptotic behaviour and be in the first and second quadrant. **B1dep** for correct reflection of $y = \mathrm{f}(x)$ to obtain $y = \mathrm{f}^{-1}(x)$ with *x*-intercept of 3. Must have correct asymptotic behaviour and be in the first and fourth quadrant. **B1** for asymptote of $y = 2$ stated or drawn through $y = 2$, must have a correctly shaped $y = \mathrm{f}(x)$ **B1** for asymptote of $x = 2$ stated or drawn or drawn through $x = 2$, must have a correctly shaped $y = \mathrm{f}^{-1}(x)$
4(d)	$\left(2 + \mathrm{e}^{-3x}\right)^{\frac{3}{2}} + 4$ soi	**B1**	For correct order
	$2 + \mathrm{e}^{-3x} = 4$	**M1**	For forming an equation, must be correct order
	$x = -\frac{1}{3}\ln 2$	2	**M1 dep** for correct attempt to solve for *x*.
5(a)	$\mathrm{p}'(x) = 15x^2 + 2ax + 39$ soi	**B1**	
	$\mathrm{p}'(-3)$: $135 - 6a + 39 = 0$ oe	**B1**	
	$\mathrm{p}(-3)$: $-135 + 9a - 117 + b = 0$ oe	**B1**	
	$a = 29$	**B1**	
	$b = -9$	**B1**	
5(b)	$[(x+3)](5x^2 + 14x - 3)$	2	**M1** for attempt by any valid method, to obtain a quadratic with 2 correct terms or correct follow through on *their a* and *b*.
	$x = -3, \ \frac{1}{5}$	**A1**	For both

Question	Answer	Marks	Guidance
5(c)	$\operatorname{cosec}2\theta = -3$ soi	**B1**	
	$\sin 2\theta = -\frac{1}{3}$ $2\theta = -19.47^{o}, 199.47^{o}, 340.53^{o}, 559.47^{o}, 700.53^{o}$ $\theta = 99.7^{o}, 170.3^{o}, 279.7^{o}, 350.3^{o}$	4	**M1** a correct double angle **M1** for correct order of operations to obtain one correct solution. May be implied by e.g. a correct solution or $\theta = -9.7^{o}$ or a correct angle in radians **A1** for 2 correct solutions **A1** for a further 2 correct solutions and no extra solutions within the range
6(a)(i)	$300 + \frac{1}{2}(10+V)40 + \frac{1}{2}50V = 2750$ or $700 + \frac{1}{2}(40\times(V-10)) + \frac{1}{2}50V = 2750$ oe	**M1**	Allow one slip, but must be considering complete area
	$V = 50$	**A1**	
6(a)(ii)	–1 nfww	2	**M1 FT** *their V* for a correct gradient calculation
6(b)(i)	$\left(\frac{\mathrm{d}v}{\mathrm{d}t} =\right) t\left(\frac{1}{2}\times 2t\times(t^2+5)^{-\frac{1}{2}}\right) + (t^2+5)^{\frac{1}{2}}$ soi	3	**B1** for $\frac{1}{2}\times 2t\times(t^2+5)^{-\frac{1}{2}}$ **M1** for a correct attempt at a product **A1** for all correct apart from $\frac{1}{2}\times 2t\times(t^2+5)^{-\frac{1}{2}}$
	$\frac{13}{3}$	**A1**	
6(b)(ii)	There is no change of sign for v as v is always positive, so no change in direction. oe	**B1**	
7(a)	$a(5x-2)^{\frac{1}{3}}$	**M1**	
	$\frac{3}{5}(5x-2)^{\frac{1}{3}}$ oe	**A1**	
	$\frac{3}{5}\left(18^{\frac{1}{3}} - 2\right)$ or exact equivalent	2	**Dependent M1** for correct use of limits

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7(b)	$2\ln(2x+1)$ oe	**B1**	
	$-\dfrac{4}{2x+1}$ oe	**B1**	
	$\left(2\ln 2-\dfrac{4}{2}\right)-(-4)$	**M1**	For correct substitution of limits, must be using the form $a\ln(2x+1)+\dfrac{b}{2x+1}$
	$\ln 4+2$	**2**	**A1** for each term
8(a)(i)	15 120	**B1**	
8(a)(ii)	Total: 3780	**3**	**B1**: Starts with 5, 7 or 9: 2520 soi **B1**: Starts with 6 or 8: 1260 soi
	Alternative		
	Total: 3780	**(3)**	**B1**: Ends with 2 or 4: 2100 soi **B1**: Ends with 6 or 8: 1680 soi
8(b)	2 nurses, 2 dentists, 5 doctors = 36 2 nurses, 3 dentists, 4 doctors = 60 2 nurses, 4 dentists, 3 doctors = 20	**2**	**M1** for two correct cases
	Total = 116	**A1**	
	Alternative		
	1 dentist only = 4 No nurses = 10 1 nurse only = 90	**(M1)**	
	Total = 116	**(2)**	**M1** for attempt to subtract at least 2 correct cases from 220
9(a)(i)	$d=3\lg\theta$	**B1**	
	$\dfrac{n}{2}\left(2(2\lg\theta)+(n-1)3\lg\theta\right)=4732\lg\theta$	**M1**	For use of the sum formula to obtain an equation in $\lg\theta$ only, using *their a* and *d* and $4732\lg\theta$
	$3n^2+n-9464=0$	**A1**	
	$n=56$ only	**2**	**M1** for attempt to solve *their* quadratic equation in *n*
9(a)(ii)	0.001 oe	**B1**	

Question	Answer	Marks	Guidance
9(b)(i)	$r = \frac{1}{3}$ soi	**B1**	
	$\lvert r \rvert < 1$ oe, so has a sum to infinity	**B1**	**Dep** on previous **B1**
9(b)(ii)	nth term $\left(\lg\phi^3\right)\left(\frac{1}{3}\right)^{n-1}$	**B1**	
	$3^{2-n}\lg\phi$	**2**	**B1** for $(3\lg\phi)3^{1-n}$ or $\frac{3\lg\phi}{3^{n-1}}$
9(b)(iii)	10	**B1**	