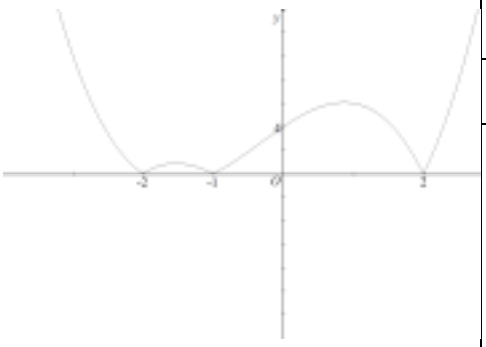
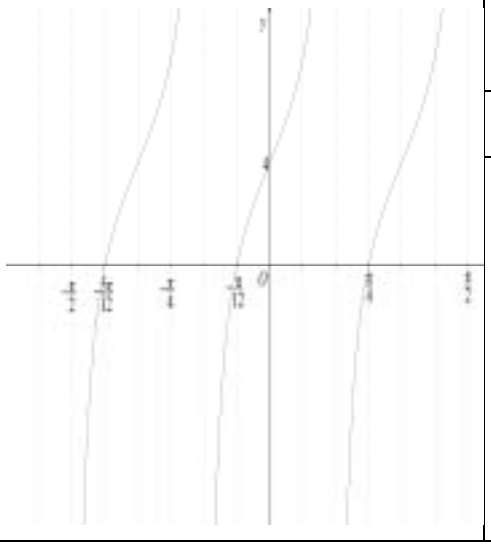
Question	Answer	Marks	Partial Marks
1		**B1**	Shape
		B1	Correct x-coordinates
		B1	Correct y-coordinate and max in first quadrant
2	$\frac{\mathrm{d}r}{\mathrm{d}t} = 0.5$	**B1**	
	$\frac{\mathrm{d}V}{\mathrm{d}r} = 4\pi r^2$	**B1**	
	$\frac{\mathrm{d}V}{\mathrm{d}t} = \frac{\mathrm{d}V}{\mathrm{d}r} \times \frac{\mathrm{d}r}{\mathrm{d}t}$ $\frac{\mathrm{d}V}{\mathrm{d}t} = \pi r^2$	**M1**	For attempt to use a correct form of the chain rule
	When $r = \frac{1}{4}$, $\frac{\mathrm{d}V}{\mathrm{d}t} = 0.125\pi$	**A1**	
3(a)	$4096 - 384x + 15x^2$	**B1**	For 4096
		B1	For $-384x$
		B1	For $15x^2$
3(b)	$(4096 - 384x + 15x^2)\left(x^2 - 2 + \frac{1}{x^2}\right)$	**B1**	For $\left(x^2 - 2 + \frac{1}{x^2}\right)$
	Term independent of x : $-2(4096) + 15$	**M1**	For use of 2 appropriate terms
	–8177	**A1**	
4(a)(i)	720	**B1**	
4(a)(ii)	600	**B1**	**FT** on *their* (i) $\times \frac{5}{6}$

Question	Answer	Marks	Partial Marks
4(a)(iii)	Starting with 8: $1\times4\times3\times2\times1=24$	**B1**	
	Starting with 3, 5 or 7: $3\times4\times3\times2\times2=144$	**M1**	May be considering each case separately, need all three cases for M1
		A1	
	Total = 168	**A1**	
4(a)(iii)	**Alternative** Plan for adding numbers ending in 2 and numbers ending in 8	**M1**	
	Ending in 2: $\left(\frac{1}{6}\times720\right)\times\frac{4}{5}=96$	**B1**	Allow unsimplified
	Ending in 8: $\left(\frac{1}{6}\times720\right)\times\frac{3}{5}=72$	**B1**	Allow unsimplified
	Total = 168	**A1**	
4(b)	${}^{n}C_{3}=6\,{}^{n}C_{2}$	**B1**	$\frac{n(n-1)(n-2)}{3!}$
	$\frac{n(n-1)(n-2)}{3!}=\frac{6n(n-1)}{2!}$	**B1**	$\frac{6n(n-1)}{2!}$
	$n(n-1)\left[(n-2)-18\right]=0$	**M1**	Valid attempt to solve, must have at least one previous B mark
	$n=20$	**A1**	
4(b)	**Alternative** ${}^{n}C_{3}=6\,{}^{n}C_{2}$ $(n-2)!2!=(n-3)!3!$	**B1**	For dealing with $(n-2)!$ and $(n-3)!$ to obtain $(n-2)$
	$(n-2)=6\times3$	**B1**	For dealing with 2! and 3! To obtain 6
	$n=20$	**M1**	Valid attempt to solve, must have at least one previous B mark
		A1	
5(a)	f > 9	**B1**	Allow *y* but not *x*
5(b)	It is a one-one function because of the restricted domain	**B1**	

Question	Answer	Marks	Partial Marks
5(c)	$x=(2y+3)^2$ or equivalent	**M1**	For a correct attempt to find the inverse
	$y=\frac{\sqrt{x}-3}{2}$	**M1**	For correct rearrangement
	$\mathrm{f}^{-1}=\frac{\sqrt{x}-3}{2}$	**A1**	Must have correct notation
5(d)	$x>9$	**B1**	**FT** on *their* (a)
5(e)	$\mathrm{f}(\ln(x+4))=49$	**M1**	For correct order
	$(2\ln(x+4)+3)^2=49$ $\ln(x+4)=2$	**M1**	For correct attempt to solve, dep on previous M mark, as far as $x=$
	$x=\mathrm{e}^2-4$	**A1**	
6(a)	$A\left(-\frac{5}{2},\ 0\right)$	**B1**	
	$x(-5-2x)+3=0$ $2x^2+5x-3=0$ $(2x-1)(x+3)=0$	**M1**	For attempt to eliminate one variable, obtain a 3-term quadratic equation = 0 and attempt to solve
	$B\left(\frac{1}{2},\ -6\right)$	**A1**	Allow A1 if just the x-coordinates or just the y-coordinates are given
6(b)	Area of triangle $=\frac{1}{2}\left(\frac{5}{2}+\frac{1}{2}\right)\times 6$, $=9$	**M1**	For attempt at triangle using *their* values
	$\int_{\frac{1}{2}}^{1}-\frac{3}{x}\mathrm{d}x=\left[-3\ln x\right]_{\frac{1}{2}}^{1}$	**M1**	For attempt to integrate, must have ln
	$=3\ln\frac{1}{2}$	**M1**	correct application of limits, dep on previous M mark
	$=-3\ln 2$	**M1**	realisation that value of integral is negative and making the adjustment
		M1	application of log law, dep on previous M mark
	Area $=9+\ln 8$	**A1**	

Question	Answer	Marks	Partial Marks
7(a)	$\frac{dy}{dx} = (x^2-1)\frac{5}{2}(5x+2)^{-\frac{1}{2}} + 2x(5x+2)^{\frac{1}{2}}$	**B1**	For $\frac{5}{2}(5x+2)^{-\frac{1}{2}}$
		M1	For differentiation of a product
		A1	
	$\frac{dy}{dx} = \frac{(5x+2)^{-\frac{1}{2}}}{2}\left(5(x^2-1)+4x(5x+2)\right)$ or equivalent	**M1**	Dep on previous M mark for attempt to simplify
	$\frac{dy}{dx} = \frac{25x^2+8x-5}{2\sqrt{5x+2}}$	**A1**	
7(b)	$25x^2+8x-5=0$	**M1**	Equating their numerator in (a) to zero and attempt to solve
	$x = 0.315$	**A1**	
	$y = -1.70$	**A1**	
7(c)	Consideration of gradient or y values either side of stationary point, remembering that $x > 0$.	**M1**	Must be a complete method making use of *their* (a). Allow consideration of $25x^2+8x-5$ as a 'minimum curve'. Accept 2nd derivative method.
	Minimum	**A1**	
8(a)	$\mathbf{b}-\mathbf{a}$	**B1**	
8(b)	$\frac{1}{4}\mathbf{a}+\frac{1}{2}(\mathbf{b}-\mathbf{a})$ or $-\frac{3}{4}\mathbf{a}+\frac{1}{2}(\mathbf{a}+\mathbf{b})$	**B1**	For $\frac{1}{4}\mathbf{a}$ or $-\frac{3}{4}\mathbf{a}$
		B1	For $\frac{1}{2}(\mathbf{b}-\mathbf{a})$ or $\frac{1}{2}(\mathbf{a}+\mathbf{b})$
	$\frac{1}{2}\mathbf{b}-\frac{1}{4}\mathbf{a}$	**B1**	Correct and simplified
8(c)	$n\left(\frac{1}{2}\mathbf{b}-\frac{1}{4}\mathbf{a}\right)$	**B1**	**FT** on *their* answer to (b)
8(d)	$\frac{1}{2}(\mathbf{b}-\mathbf{a})+k\mathbf{b}$	**M1**	For use of *their* (a) and $k\mathbf{b}$
		A1	

Question	Answer	Marks	Partial Marks
8(e)	$\frac{1}{2}(\mathbf{b}-\mathbf{a})+k\mathbf{b}=n\left(\frac{1}{2}\mathbf{b}-\frac{1}{4}\mathbf{a}\right)$ $-\frac{1}{2}=-\frac{n}{4}$ $\frac{1}{2}+k=\frac{n}{2}$	**M1**	For equating *their* (c) and (d) and then equating like vectors to obtain 2 equations
	$n=2$	**A1**	
	$k=\frac{1}{2}$	**A1**	
9(a)(i)	$v=20\cos 2t$ when $t=\pi,\ v=20$	**B1**	
9(a)(ii)	$20\cos 2t=0$	**M1**	Equating *their* (i) to zero, must be a cosine and attempt to solve
	$t=\frac{\pi}{4}$	**A1**	
9(a)(iii)	$a=-40\sin 2t$	**M1**	Attempt to differentiate *their v*, dep on previous M mark, and use *their* value for (ii)
	–40	**A1**	
9(b)(i)	35	**B1**	
9(b)(ii)	$112.5=\frac{1}{2}(35+x)\times 5$	**M1**	Use of area under appropriate part of the graph
		A1	
	$x=10$	**A1**	
9(b)(iii)	$\frac{25}{5}=\frac{10}{t'}$	**M1**	Using a ratio method or otherwise, find extra time to stop = 2s or equivalent
	$t'=2$	**A1**	
	27	**A1**	

Question	Answer	Marks	Partial Marks
10(a)	$3x = -\frac{5\pi}{4} - \frac{\pi}{4}, \ \frac{3\pi}{4}$	**M1**	For a correct attempt to solve, may be implied by one correct solution
	$x = -\frac{\pi}{12}$	**A1**	
	$x = \frac{\pi}{4}$	**A1**	
	$x = -\frac{5\pi}{12}$	**A1**	
10(b)		**B1**	Shape – must have three 'parts' with asymptotes
		B1	For correct x-coordinates
		B1	For correct y-coordinate