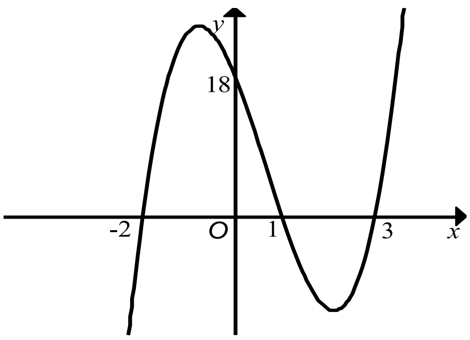
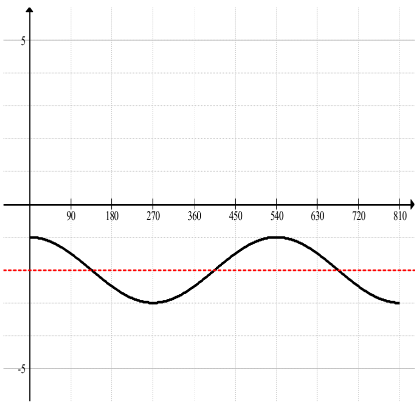
Question	Answer	Marks	Partial Marks
1	$1+4e^{2x}+6e^{4x}+4e^{6x}+e^{8x}$	**B2**	mark final answer for **B2** **B1** for any 3 correct simplified terms in a sum or all 5 simplified terms listed but not summed or for a correct, simplified expansion that is not their final answer or **M1** for a correct unsimplified expansion e.g. $1+4e^{2x}+\frac{4\times3}{2}(e^{2x})^2+\frac{4\times3\times2}{6}(e^{2x})^3+(e^{2x})^4$ If 0 scored, **SC1** for a complete, correct, simplified expansion as final answer found by multiplying out the brackets
2	Correct graph and intercepts 	**B3**	**B1** for correct shape; the ends must extend above and below the *x*-axis **B1** for correct roots indicated; must have attempted a cubic shape **B1** for correct *y*-intercept indicated; must have attempted a cubic shape
3	Uses b^2-4ac : $6^2-4(2k-1)(k+1)$	**M1**	
	$-8k^2-4k+40*0$ oe	**M1**	**dep** on first **M1** where * is = or any inequality sign condone one sign or arithmetic slip in simplification
	Factorises or solves *their* 3-term quadratic expression or equation for CVs e.g. $(5+2k)(8-4k)$ oe	**M1**	
	Finds correct CVs: -2.5 oe, 2	**A1**	
	$-2.5 \leqslant k \leqslant 2$	**A1**	mark final answer

Question	Answer	Marks	Partial Marks
4	$\frac{m}{27}-\frac{29}{9}+\frac{39}{3}+n=0$ oe	**B1**	
	$m - 29 + 39 + n = 6$ oe	**B1**	
	Eliminates one unknown correctly for a pair of linear equations in *m* and *n* and solves for one unknown	**M1**	
	$m = 6$, $n = -10$	**A2**	**A1** for either
	[p(2) =] 48 – 116 + 78 – 10 = 0 oe, nfww	**A1**	
5(a)	1	**B1**	
5(b)	$360 \div \frac{2}{3}$ oe	**M1**	
	540	**A1**	If 0 scored, **SC1** for 3π
5(c)	Correct sketch for domain $0° \leqslant x \leqslant 810°$ 	**B2**	**B1** for correct cosine shape from (0, −1) with amplitude 1 for $0° \leqslant x \leqslant 810°$ **B1** for attempt at correct cosine shape with period 540° for $0° \leqslant x \leqslant 810°$ If 0 scored, **SC1** for a fully correct graph for $0° \leqslant x \leqslant 540°$ **Maximum of 1 mark if not fully correct.**
6(a)	$\sqrt{(11-5)^2+(6--4)^2}$ oe	**M1**	
	11.7 or 11.66[19...] rot to 4 or more figs	**A1**	
6(b)(i)	[y =] 1	**B1**	

Question	Answer	Marks	Partial Marks
6(b)(ii)	$m_{AC} = \frac{6--4}{11-5}$ or $\frac{10}{6}$ nfww oe	**B1**	
	$m_{BD} = \frac{-1}{their\ \frac{10}{6}}$ oe	**M1**	
	$y - their\ 1 = -\frac{3}{5}(x-8)$ oe isw	**A1**	**FT** *their* 1 from (b)(i) and *their* perpendicular gradient
6(b)(iii)	$\begin{pmatrix}-5\\3\end{pmatrix}$ and $\begin{pmatrix}5\\-3\end{pmatrix}$	**B2**	**B1** for either If 0 scored, **SC1** for −5**i** + 3**j** and 5**i** −3**j**
7(a)	[Arc length + 2 × tangent length] $18 \times \frac{7\pi}{9} + 2 \times 18 \times \tan\frac{7\pi}{18}$ oe	**M2**	**M1** for [Arc length] $18 \times \frac{7\pi}{9}$ oe or [Tangent length] $18 \times \tan\frac{7\pi}{18}$ oe or [Tangent length] $\frac{18}{\tan\frac{\pi}{9}}$ oe or [Tangent length] $\frac{18}{\sin\frac{\pi}{9}} \times \sin\frac{7\pi}{18}$ oe
	143 or 142.9 or awrt 142.9 (cm)	**A1**	
7(b)	[Area of kite – area of sector] $18 \times their\left(18 \times \tan\frac{7\pi}{18}\right) - \frac{1}{2} \times 18^2 \times \frac{7\pi}{9}$ oe	**M2**	**FT** *their BC* or *CD* from (a) providing it is not 18 **M1** for [area of sector] $\frac{1}{2} \times 18^2 \times \frac{7\pi}{9}$ oe or [area of kite] $18 \times their\left(18 \times \tan\frac{7\pi}{18}\right)$ oe or [area of kite] $18 \times their(18 \times \tan 70)$ oe
	494 or 494.3 or awrt 494.3 (cm^2)	**A1**	

Question	Answer	Marks	Partial Marks
8(a)	Factorises or solves $3t^2 - 30t + 72 = 0$ or $t^2 - 10t + 24 = 0$	**M1**	
	$t = 4$, $t = 6$	**A1**	
	Integrates v to find F(t): $\frac{3t^3}{3} - \frac{30t^2}{2} + 72t$	**M2**	**M1** for any two terms correct
	Correct substitution for F(6) – F(4) or F(4) – F(6)	**M1**	**dep** on at least **M1** for integration **FT** *their* 4 and *their* 6 provided they are **both positive**
	4 (m)	**A1**	**dep** on all previous marks being awarded
8(b)	$[a =]6t - 30$	**B1**	
	[When $t = 2$: $a = 6(2) - 30 =$] -18 (ms^{-2}) cao	**B1**	
9	Correctly eliminates x or y e.g. $4x^2 + 3x\left(-\frac{4}{x}\right) + \left(-\frac{4}{x}\right)^2 = 8$ oe or $4\left(-\frac{4}{y}\right)^2 + 3\left(-\frac{4}{y}\right)y + y^2 = 8$ oe	**M1**	
	Rearranges to a 3-term quadratic in x^2 or y^2 soi e.g. $4x^4 - 20x^2 + 16 = 0$ or $y^4 - 20y^2 + 64 = 0$	**A1**	
	Factorises or solves *their* 3-term quadratic in x^2 or y^2 soi : $(x^2 - 1)(x^2 - 4)$ or $(y^2 - 16)(y^2 - 4)$	**M1**	
	$x^2 = 1$, $x^2 = 4$ oe, nfww or $y^2 = 16$, $y^2 = 4$ oe, nfww	**A1**	
	$x = \pm 1$ $x = \pm 2$ $y = \mp 4$ $y = \mp 2$ oe, nfww	**A2**	**A1** for all 4 x values or all 4 y values
10(a)	$\frac{1}{3}e^{3x+3} + c$ or $\frac{1}{3}e^3 \times e^{3x} + c$ nfww	**B2**	**B1 for** ke^{3x+3} or $ke^3 \times e^{3x}$ where $k \neq \frac{1}{3}$ or 0

Question	Answer	Marks	Partial Marks
10(b)(i)	$\frac{\mathrm{d}(\sin 4x)}{\mathrm{d}x} = 4\cos 4x$ soi	**B1**	
	Applies correct form of product rule: $4x \cos 4x + [1] \sin 4x$ isw	**B1**	**FT** *their* $4 \cos 4x$ if possible
10(b)(ii)	$\left[\int (4x\cos 4x)\,\mathrm{d}x =\right] x\sin 4x - \int \sin 4x\,\mathrm{d}x$	**M1**	**FT** use of *their* $mx \cos 4x + n \sin 4x$ where m and n are constants
	$x\sin 4x + \frac{1}{4}\cos 4x[+c]$ soi	**A1**	
	$\frac{\pi}{3}\sin\left(4\times\frac{\pi}{3}\right) + \frac{1}{4}\cos\left(4\times\frac{\pi}{3}\right) - \left[\frac{\pi}{4}\sin\left(4\times\frac{\pi}{4}\right) + \frac{1}{4}\cos\left(4\times\frac{\pi}{4}\right)\right]$	**A1**	
	Correct completion to **given answer** $\frac{1}{8} - \frac{\pi\sqrt{3}}{6}$	**A1**	
11(a)	$500 = \frac{4}{6}\pi x^3 + \pi x^2 y$ oe	**M1**	
	$y = \frac{1}{\pi x^2}\left(500 - \frac{4}{6}\pi x^3\right)$ oe, isw	**A1**	if first **M0**, **SC1** for $y = \frac{1}{\pi x^2}\left(500 - \frac{4}{3}\pi x^3\right)$ oe seen
	$S = 2\pi x^2 + \pi x^2 + 2\pi x\left(\frac{500}{\pi x^2} - \frac{2}{3}x\right)$	**M1**	**dep** on first **M1**
	Correct completion to given answer: $S = \frac{5}{3}\pi x^2 + \frac{1000}{x}$	**A1**	
11(b)	Differentiates S: $\frac{10}{3}\pi x - \frac{1000}{x^2}$ oe	**B2**	**B1** for each term
	$\frac{10}{3}\pi x - \frac{1000}{x^2} = 0$ and attempt to solve	**M1**	**FT** *their* $\frac{\mathrm{d}S}{\mathrm{d}x}$ providing at least **B1** awarded
	$x = \sqrt[3]{\frac{300}{\pi}}$ isw or 4.57[07...] nfww	**A1**	
12(a)(i)	$A(0,1)$ and $B(1, 0)$	**B1**	

Question	Answer	Marks	Partial Marks
12(a)(ii)	$[y=]\frac{1}{2(2)+1}$ and $[y=]\frac{2-1}{5}$ **and** evaluates both expressions as $\frac{1}{5}$	**B2**	**B1** for $[y=]\frac{1}{2(2)+1}$ **and** $5y=2-1$ oe
	Alternative 1 $[y=]\frac{1}{2(2)+1}=\frac{1}{5}$ or $[y=]\frac{2-1}{5}=\frac{1}{5}$ **and** solves $5\times\frac{1}{5}=x-1$ oe to get $x = 2$ or $\frac{1}{5}=\frac{1}{2x+1}$ oe to get $x = 2$	**(B2)**	**B1** for $\frac{1}{2(2)+1}=\frac{1}{5}$ and $5\times\frac{1}{5}=x-1$ oe or $\frac{2-1}{5}=\frac{1}{5}$ and $\frac{1}{5}=\frac{1}{2x+1}$ oe
	Alternative 2 $2x^2-x-6=0$ **and** solves or factorises to get $(2x+3)(x-2)$ and states $x = 2$ OR shows $2(2^2)-2-6=0$ oe	**(B2)**	**B1** for $(2x+1)(x-1)=5$ or $2x^2-x-6=0$
	Alternative 3 $(2x+1)(x-1)=5$ oe **and** shows $(2\times 2+1)(2-1)=5$	**(B2)**	**B1** for $(2x+1)(x-1)=5$
12(b)	$\frac{1}{2}\times 1\times 0.2$ oe or $\frac{2^2}{5\times 2}-\frac{2}{5}-\left(\frac{1^2}{5\times 2}-\frac{1}{5}\right)$ oe	**B1**	
	$[\mathrm{F}(x)=]\ \frac{1}{2}\ln(2x+1)\ [+c]$ oe or $\frac{1}{2}\ln(x+0.5)\ [+c]$ oe	**B2**	**B1** for $\frac{1}{2}\ln 2x+1$ or $\frac{1}{2}\ln x+0.5$ or $k\ln(2x+1)$ or $k\ln(x+0.5)$, $k\neq 0.5$ or 0
	$\mathrm{F}(2)-\mathrm{F}(0)-$ *their* 0.1	**M1**	**FT** *their* $\mathrm{F}(x)$ providing at least **B1** for integration of curve awarded
	$0.5\ln 5-0.1$ or exact equivalent	**A1**	

Question	Answer	Marks	Partial Marks
13(a)	$[\text{fg}(x)=]\ \dfrac{2\left(\frac{1}{x}\right)^2-1}{3\left(\frac{1}{x}\right)}$ oe	**M1**	
	$[\text{fg}(x)=]\dfrac{2-x^2}{3x}$ or $\dfrac{2}{3x}-\dfrac{x}{3}$	**A1**	mark final answer
13(b)(i)	$\text{f}^{-1}>0$	**B1**	
13(b)(ii)	$2x^2-3xy-1=0$ or $2y^2-3xy-1=0$	**B1**	
	Correctly applies quadratic formula: $[x=]\dfrac{-(-3y)\pm\sqrt{(-3y)^2-4(2)(-1)}}{2(2)}$ oe or $[y=]\dfrac{-(-3x)\pm\sqrt{(-3x)^2-4(2)(-1)}}{2(2)}$ oe	**M1**	**FT** *their* $2x^2-3xy-1=0$ or $2y^2-3xy-1=0$ with at most one sign error in the equation
	Justifies the positive square root at some point	**B1**	
	$\text{f}^{-1}(x)=\dfrac{3x+\sqrt{9x^2+8}}{4}$ cao	**A1**	must be a function of x