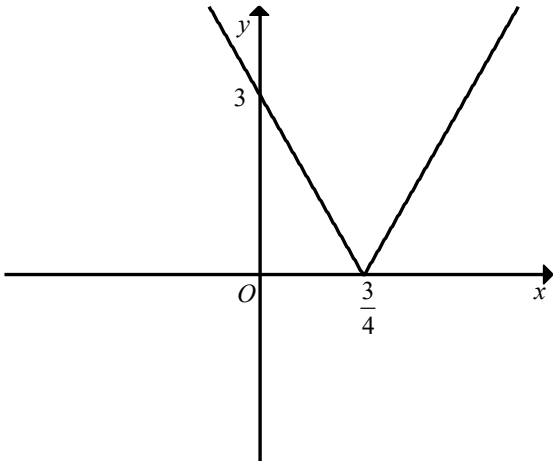
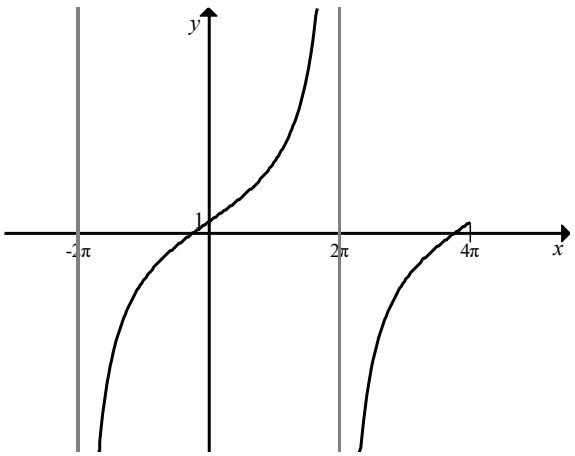
Question	Answer	Marks	Partial Marks
1	$-2 \leqslant x \leqslant \frac{5}{4}$ mark final answer	**B2**	**B1** for the correct critical values
2	Attempts to find $y = 4x - 5x^{-2}$	**M1**	at least one term correct
	$\frac{dy}{dx} = 4 + 10x^{-3}$	**A1**	
	Correct completion to given answer $\frac{2(2x^3+5)}{x^3}$	**A1**	
	Alternative version		
	$\frac{dy}{dx} = \frac{12x^4 - 8x^4 + 10x}{x^4}$ or equivalent unsimplified form	**(2)**	**M1** for an attempt at the quotient rule with correct structure $\frac{dy}{dx} = \frac{x^2(their 12x^2) - \left(4x^3 - 5\right)(their 2x)}{\left(x^2\right)^2}$
	Correct completion to given answer $\frac{2(2x^3+5)}{x^3}$	**(A1)**	
3	$\sqrt{y} = mx^3 + c$ soi	**M1**	
	$m = \frac{21-5}{10-2}$ oe or 2	**M1**	
	$c = 5 - 2(2)$ oe or 1	**M1**	**FT** *their m*
	$y = (2x^3 + 1)^2$ oe, isw	**A1**	
	Alternative method		
	$\sqrt{y} = mx^3 + c$ soi	**(M1)**	
	$21 = 10m + c$ and $5 = 2m + c$ and solves to find $m = 2$ or $c = 1$	**(M1)**	
	Finds the other unknown	**(M1)**	**FT** *their m* or *c*
	$y = (2x^3 + 1)^2$ oe, isw	**(A1)**	
4(a)	Range of f is equal to the domain of f oe	**1**	

Question	Answer	Marks	Partial Marks
4(b)	$f^2(x) = 4x - 3$ soi	**B2**	**B1** for correct order of composition
	Correct sketch with both intercepts indicated 	**B2**	**FT** *their* $(4x - 3)$ providing B1 has been awarded and the expression is of the form $mx + c$ **B1 FT** for correct sketch with one intercept correct
4(c)	[When $x = -1$] $y = 7$ [When $x = 3$] $y = 9$	**B1**	**FT** *their* $(4x - 3)$ providing it has been formed using a correct order of composition and the expression is of the form $mx + c$
	$a = \frac{9-7}{3+1}$ oe or $7 = -a + b$ and $9 = 3a + b$ and solves correctly for one unknown	**M1**	**FT** *their* y-coordinates
	$a = \frac{1}{2}$, $b = \frac{15}{2}$	**A1**	
5(a)	4π	**B1**	
5(b)	Correct sketch with y-intercept and asymptotes marked 	**3**	**B1** for correct shape for both sections **B2** for asymptotes drawn at -2π, 2π and the y-intercept marked as 1; must have attempted correct shape or **B1** for any two of these; must have attempted correct shape or If 0 scored then **SC1** for correct graph between -2π and 2π with asymptotes marked at -2π, 2π and the y-intercept marked as 1

Question	Answer	Marks	Partial Marks
6(a)	8400	**2**	**M1** for $5 \times 8 \times 7 \times 6 \times 5$ oe
6(b)(i)	3 628 800	**2**	**M1** for $7! \times 6!$
6(b)(ii)	1266	**2**	**M1** for ${}^{13}C_5 - {}^{7}C_5$
7(a)	–729 729	**2**	**B1** for ${}^{15}C_5 \left(x^2\right)^{10} \left(-\frac{3}{x^4}\right)^5$ oe
7(b)	$\frac{9(8)(7)}{6}a^3 = 7 \times \frac{9(8)}{2}a^2$ oe	**M2**	**M1** for $\frac{9(8)(7)}{6}a^3[x^3]$ oe or $\frac{9(8)}{2}a^2\left[x^2\right]$ oe
	$a = 3$ nfww	**A1**	
8(a)	$\frac{\mathrm{d}y}{\mathrm{d}x} = 3\mathrm{e}^{3x+2}\tan x + \mathrm{e}^{3x+2}\sec^2 x$	**3**	**B1** for $\frac{\mathrm{d}(\mathrm{e}^{3x+2})}{\mathrm{d}x} = 3\mathrm{e}^{3x+2}$ **M1** for correct structure of product rule **A1 FT** *their* $\frac{\mathrm{d}(\mathrm{e}^{3x+2})}{\mathrm{d}x} = 3\mathrm{e}^{3x+2}$ for all other components of product rule correct
	Correct small changes relationship e.g. $\frac{\delta y}{h} = \textit{their}\left.\frac{\mathrm{d}y}{\mathrm{d}x}\right\|_{x=0.1}$	**M1**	
	$13.1h$ or $13.07[68\ldots]h$	**A1**	**dep** on first three marks awarded
8(b)	$y:\ -\frac{1}{3}\cos(3x+\pi) + c$	**B2**	**B1** for $-\frac{1}{3}\cos(3x+\pi)$ or for $k\cos(3x+\pi) + c$ where k is $\frac{1}{3}$ or $k < 0$
	$\frac{4}{3} = -\frac{1}{3}\cos\left(\frac{3\pi}{9}+\pi\right) + c$	**M1**	**FT** *their k* providing **B1** has been awarded
	$\left[y = -\frac{1}{3}\cos\left(\frac{5\pi}{4}+\pi\right) + \frac{7}{6} =\right]\ \ \frac{7-\sqrt{2}}{6}$ or exact equivalent	**A1**	
9(a)	$n = 31$ OR $n = \frac{150+d}{d}$	**2**	**M1** for $\frac{n}{2}\{9+159\} = 2604$ oe OR **M1** for $159 = 9 + d(n-1)$ oe

Question	Answer	Marks	Partial Marks
	$d = 5$	**2**	**M1FT** for $[u_{31} =]159 = 9 + 30d$ or $\frac{31}{2}\{18 + 30d\} = 2604$ **FT** *their* derived value of n OR **M1 FT** for $\frac{1}{2}\left(\frac{150+d}{d}\right)\left\{18 + \left(\frac{150+d}{d} - 1\right)d\right\} = 2604$ **FT** *their* derived expression for n in terms of d
	$r = \frac{11}{16}$ oe, isw or 0.6875	**2**	**M1FT** $[u_{12} =]9 + 11(their 5)$ or 64 and $[u_8 =]9 + 7(their 5)$ or 44 soi **FT** *their* value of d
	$\left[S_6 = \frac{64(1 - 0.6875^6)}{1 - 0.6875} =\right]$ 183 or 183.2 or 183.17[4…]	**A1**	
9(b)(i)	cos 45° = 0.707… cos 135 ° = –0.707… therefore $-1 < \cos\theta < 1$ oe OR $-1 < \cos\theta < 1$ oe → $0° < \theta < 180°$ oe	**B1**	
9(b)(ii)	$\left[\frac{a}{1-r} =\right]$ $\frac{\sin\theta}{1 - \cos\theta}$	**M1**	
	$\frac{\sin\theta}{1 - \cos\theta} \times \frac{1 + \cos\theta}{1 + \cos\theta}$	**A1**	
	$\frac{\sin\theta(1 + \cos\theta)}{1 - \cos^2\theta} = \frac{\sin\theta(1 + \cos\theta)}{\sin^2\theta}$	**A1**	
	$\frac{1}{\sin\theta} + \frac{\cos\theta}{\sin\theta} = \text{cosec}\,\theta + \cot\theta$	**A1**	
10(a)	[magnitude direction =] $\sqrt{20^2 + 21^2}$ oe	**B1**	
	[velocity vector =] $\frac{58}{29}(20\mathbf{i} + 21\mathbf{j})$	**M1**	Correctly written column vectors are acceptable all through Q10
	[position vector =] $-30\mathbf{j} + t(40\mathbf{i} + 42\mathbf{j})$ or $(40t)\mathbf{i} + (-30 + 42t)\mathbf{j}$ oe	**A1**	

Question	Answer	Marks	Partial Marks
10(b)	[direction vector =] $24\mathbf{i} + 7\mathbf{j}$ or x-component: $\cos\alpha = \frac{24}{25}$ and y-component: $\sin\alpha = \frac{7}{25}$	**B1**	
	[velocity vector =] $\frac{75}{\sqrt{24^2+7^2}}(24\mathbf{i}+7\mathbf{j})$ oe	**M1**	**FT** *their* direction vector
	$72\mathbf{i}+21\mathbf{j}$ oe	**A1**	
	[position vector =] $-10\mathbf{i} + 18\mathbf{j} + t(72\mathbf{i} + 21\mathbf{j})$ or $(-10 + 72t)\mathbf{i} + (18 + 21t)\mathbf{j}$	**A1**	**FT** *their* velocity vector
10(c)	Solves $40t = -10 + 72t$ and $-30 + 42t = 18 + 21t$ or solves one equation and substitutes the value of t into the other equation	**M1**	**FT** *their* position vectors of P and Q at time t
	Shows correctly that the values of t are not consistent e.g. $t = \frac{10}{32}$ and $t = \frac{48}{21}$ oe so do not collide oe	**A1**	
11	A correct and simplified equation e.g. $n+1 = \frac{437}{n-3}$	**B2**	**B1** for an equation with $\left[\frac{(n+1)!}{n!} =\right]$ $n + 1$ and 437 or $\left[\frac{(n-3)!}{(n-4)!}\text{ oe } =\right]$ $n - 3$ and 437 OR for $\frac{(n+1)!}{437(n-4)!} = \frac{n!}{(n-3)!}$
	$n^2 - 2n - 440$ [= 0]	**B1**	**dep** on **B2**
	$n = 22$ as only solution	**B1**	**dep** on all previous marks awarded

Question	Answer	Marks	Partial Marks
12(a)	$15(1-\sin^2(3x+1.5))+7\sin(3x+1.5)-13\,[=0]$	**M1**	
	$15\sin^2(3x+1.5)-7\sin(3x+1.5)-2\,[=0]$	**A1**	
	$(5\sin(3x+1.5)+1)(3\sin(3x+1.5)-2)\,[=0]$	**M1**	Factorises or solves *their* 3-term quadratic in $\sin(3x + 1.5)$ **dep** on previous **M1**
	$3x + 1.5 = -0.201[3\ldots]$ or $3x + 1.5 = 0.729[7\ldots]$ or $3x + 1.5 = 2.41[1\ldots]$ or $3x+1.5=\sin^{-1}\left(their-\frac{1}{5}\right)$ or $3x+1.5=\sin^{-1}\left(their\frac{2}{3}\right)$	**M1**	**dep** on previous **M1** **FT** providing $-1 \leqslant their\ -\frac{1}{5} \leqslant 1$ and/or $-1 \leqslant their\ \frac{2}{3} \leqslant 1$
	$x = 0.304$ or $0.3039[54\ldots]$ and $x = -0.257$ or $-0.2567[57\ldots]$ and no extras	**A1**	

Question	Answer	Marks	Partial Marks
12(b)	$30(\cos(3x+1.5))(-3\sin(3x+1.5))$ $+21\cos(3x+1.5)$ $[=0]$	**M2**	**M1** for correctly differentiating $\cos(3x + 1.5)$ or $\sin(3x + 1.5)$
	$(3\cos(3x+1.5))\big(7-30\sin(3x+1.5)\big)[=0]$ oe	**M1**	**FT** a derivative of the form $a\cos(3x+1.5)\sin(3x+1.5)+b\cos(3x+1.5)[=0]$ where $a < 0$ and $b > 0$
	$3x + 1.5 = \frac{\pi}{2}$ or 1.57[0…] or $\cos^{-1}(0)$ or $3x + 1.5 = 0.235[5\ldots]$ or $3x+1.5=\sin^{-1}\left(\frac{\textit{their } 7}{\textit{their } 30}\right)$	**M1**	**dep** on previous **M1** **FT** (*their* 3)$\cos(3x + 1.5)$ × $\{(\textit{their } 7)-(\textit{their } 30)\sin(3x+1.5)\}$ providing *their* 3 ≠ 0 and *their* 30 > *their* 7
	x = 0.0236 or 0.02359[87…] and x = 0.469 or 0.4686[96…] and no extras	**A1**	**dep** on all previous marks awarded
13	$4\times8^{2x}+8^{x}-3[=0]$ or $4\times(2^{3x})^{2}+2^{3x}-3[=0]$ oe	**B1**	
	$\left(4(8^{x})-3\right)\left(8^{x}+1\right)$ or $\left(4(2^{3x})-3\right)\left(2^{3x}+1\right)$ oe	**M1**	**FT** *their* 3-term quadratic in 8^x or 2^{3x}
	$8^{x}=\frac{3}{4}$ or $2^{3x}=\frac{3}{4}$ oe, nfww	**A1**	
	$x=\log_{8}(0.75)$ or $\frac{1}{3}\log_{2}(0.75)$ or –0.138[34…] oe	**A1**	and no other solutions

