Question	Answer	Marks
1(a)	$(2+3x)\left(x-\frac{2}{x}\right)^6$ Term in x^2 in $\left(x-\frac{2}{x}\right)^6 = 15x^4 \times \left(\frac{-2}{x}\right)^2$	B1
	Coefficient = 60	B1
		2
1(b)	Constant term in $\left(x-\frac{2}{x}\right)^6 = 20x^3 \times \left(\frac{-2}{x}\right)^3$ (-160)	B2, 1
	Coefficient of x^2 in $(2+3x)\left(x-\frac{2}{x}\right)^6$ $= 120 - 480 = -360$	B1FT
		3

Question	Answer	Marks
2(a)	$3\cos\theta = 8\tan\theta \rightarrow 3\cos\theta = \frac{8\sin\theta}{\cos\theta}$	M1
	$3(1 - \sin^2\theta) = 8\sin\theta$	M1
	$3\sin^2\theta + 8\sin\theta - 3 = 0$	A1
		3
2(b)	$(3\sin\theta - 1)(\sin\theta + 3) = 0 \rightarrow \sin\theta = \frac{1}{3}$	M1
	$\theta = 19.5°$	A1
		2

Question	Answer	Marks
3(a)	Volume after 30 s = 18000 $\frac{4}{3}\pi r^3 = 18000$	M1
	$r = 16.3$ cm	A1
		2
3(b)	$\frac{\mathrm{d}V}{\mathrm{d}r} = 4\pi r^2$	B1
	$\frac{\mathrm{d}r}{\mathrm{d}t} = \frac{\mathrm{d}r}{\mathrm{d}V} \times \frac{\mathrm{d}V}{\mathrm{d}t} = \frac{600}{4\pi r^2}$	M1
	$\frac{\mathrm{d}r}{\mathrm{d}t} = 0.181$ cm per second	A1
		3

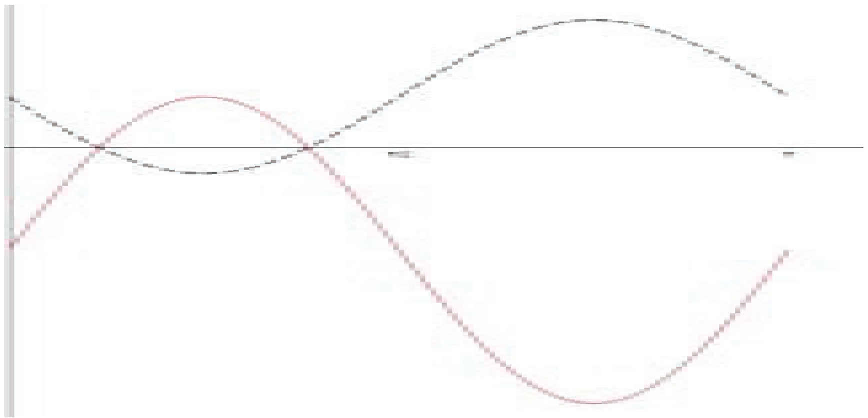
Question	Answer	Marks
4	1st term is −6, 2nd term is −4.5 (**M1** for using *k*th terms to find both *a* and *d*)	M1
	$\rightarrow a = -6,\ d = 1.5$	A1 A1
	$S_n = 84 \rightarrow 3n^2 - 27n - 336 = 0$	M1
	Solution $n = 16$	A1
		5

Question	Answer	Marks
5(a)	$\text{ff}(x) = a-2(a-2x)$	M1
	$\text{ff}(x) = 4x-a$	A1
	$\text{f}^{-1}(x) = \dfrac{a-x}{2}$	M1 A1
		4
5(b)	$4x-a=\dfrac{a-x}{2} \rightarrow 9x = 3a$	M1
	$x=\dfrac{a}{3}$	A1
		2

Question	Answer	Marks
6(a)	$2x^2+kx+k-1 = 2x+3 \rightarrow 2x^2+(k-2)x+k-4=0$	**M1**
	Use of $b^2-4ac=0 \rightarrow (k-2)^2 = 8(k-4)$	**M1**
	$k=6$	**A1**
		3
6(b)	$2x^2+2x+1 = 2\left(x+\frac{1}{2}\right)^2+1-\frac{1}{2}$ $a=\frac{1}{2}$, $b=\frac{1}{2}$	**B1 B1**
	vertex $\left(-\frac{1}{2},\frac{1}{2}\right)$ (**FT** on *a* and *b* values)	**B1FT**
		3

Question	Answer	Marks
7(a)	$BC^2 = r^2 + 4r^2 - 2r.2r \times \cos\left(\frac{\pi}{6}\right) = 5r^2 - 2r^2\sqrt{3}$	**M1**
	$BC = r\sqrt{\left(5-2\sqrt{3}\right)}$	**A1**
		2
7(b)	Perimeter = $\frac{2\pi r}{6} + r + r\sqrt{\left(5-2\sqrt{3}\right)}$	**M1 A1**
		2
7(c)	Area = sector – triangle	
	Sector area = $\frac{1}{2}4r^2\frac{\pi}{6}$	**M1**
	Triangle area = ½ r. $2r$ sin $\frac{\pi}{6}$	**M1**
	Shaded area = $r^2\left(\frac{\pi}{3} - \frac{1}{2}\right)$	**A1**
		3

Question	Answer	Marks
8(a)	Volume $= \pi \int x^2 \mathrm{d}y = \pi \int \dfrac{36}{y^2} \mathrm{d}y$	*M1
	$= \pi \left[\dfrac{-36}{y} \right]$	A1
	Uses limits 2 to 6 correctly → (12π)	DM1
	Vol of cylinder $= \pi.1^2.4$ or $\int 1^2.\mathrm{d}y \quad = [y]$ from 2 to 6	M1
	Vol $= 12\pi - 4\pi = 8\pi$	A1
		5
8(b)	$\dfrac{\mathrm{d}y}{\mathrm{d}x} = \dfrac{-6}{x^2}$	B1
	$\dfrac{-6}{x^2} = -2 \rightarrow x = \sqrt{3}$	M1
	$y = \dfrac{6}{\sqrt{3}} = 2\sqrt{3}$ Lies on $y = 2x$	A1
		3

Question	Answer	Marks
9(a)	f(x) from −1 to 5	**B1B1**
	g(x) from −10 to 2 (**FT** from part (**a**))	**B1FT**
		3
9(b)		**B2, 1**
		2
9(c)	Reflect in x-axis	**B1**
	Stretch by factor 2 in the y direction	**B1**
	Translation by –π in the x direction OR translation by $\begin{pmatrix} 0 \\ -\pi \end{pmatrix}$.	**B1**
		3

Question	Answer	Marks
10(a)	$\dfrac{dy}{dx} = 54 - 6(2x-7)^2$	**B2,1**
	$\dfrac{d^2y}{dx^2} = -24(2x-7)$ (**FT** only for omission of '×2 ' from the bracket)	**B2,1 FT**
		4
10(b)	$\dfrac{dy}{dx} = 0 \to (2x-7)^2 = 9$	**M1**
	$x = 5$, $y = 243$ or $x = 2$, $y = 135$	**A1 A1**
		3
10(c)	$x = 5$ $\dfrac{d^2y}{dx^2} = -72 \to$ Maximum (**FT** only for omission of '×2 ' from the bracket)	**B1FT**
	$x = 2$ $\dfrac{d^2y}{dx^2} = 72 \to$ Minimum (**FT** only for omission of '×2 ' from the bracket)	**B1FT**
		2

Question	Answer	Marks
11(a)	Express as $(x-4)^2+(y+2)^2=16+4+5$	**M1**
	Centre $C(4, -2)$	**A1**
	Radius = $\sqrt{25}$ = 5	**A1**
		3
11(b)	$P(1,2)$ to $C(4, -2)$ has gradient $-\frac{4}{3}$ (**FT** on coordinates of C)	**B1FT**
	Tangent at P has gradient = $\frac{3}{4}$	**M1**
	Equation is $y-2=\frac{3}{4}(x-1)$ or $4y = 3x + 5$	**A1**
		3
11(c)	Q has the same coordinate as P $y = 2$	**B1**
	Q is as far to the right of C as P $x = 3 + 3 + 1 = 7$ Q (7, 2)	**B1**
		2

Question	Answer	Marks
11(d)	Gradient of tangent at $Q = -\frac{3}{4}$ by symmetry (**FT** from part (**b**))	**B1FT**
	Eqn of tangent at Q is $y-2=-\frac{3}{4}(x-7)$ or $4y + 3x = 29$	**M1**
	$T\,(4, \frac{17}{4})$	**A1**
		3