1	$\frac{n}{2}[122+(n-1)(-4)]$ $n=\frac{n}{2}[122+(n-1)(-4)]$ $2n(n-31)=0$ $n=31$	**M1** **A1** **DM1** **A1** **[4]**	Attempt sum formula with $a = 61$, $d = -4$ Equated to n cao Attempt to solve. Accept div. by n cao
2	$y=\frac{4}{x^2}-x\quad(+c)$ Sub (2, 4) $\longrightarrow c=5$	**M1A1** **DM1A1** **[4]**	Attempt integration. cao Dependent on c present
3	$A=\pi r^2\ \rightarrow(\frac{dA}{dr})=2\pi r$ $\frac{dA}{dt}=\frac{dA}{dr}\times\frac{dr}{dt}$ **used** $\frac{dr}{dt}=3$ soi 300π (or 942)	**B1** **M1** **B1** **A1** **[4]**	
4	**(i)** $(2x-x^2)^6=64x^6-192x^7+240x^8$ **(ii)** $\times(2+x)$ coeff of $x^8 = 2\times240-192$ 288	**B1B1B1** **[3]** **M1** **A1√** **[2]**	cao Looks at exactly 2 terms
5	$\frac{dy}{dx}=2-2(x-1)^{-3}$ Sub $x=2\rightarrow\frac{dy}{dx}=2-2=0\Rightarrow$ stat value at $x=2$ $\frac{d^2y}{dx^2}=6(x-1)^{-4}$ (and sub $x=2$) (At $x=2$, $\frac{d^2y}{dx^2}=6$) $>0\implies$ Minimum	**B2,1,0** **B1** **M1** **A1** **[5]**	–1 each error in 2, –2, $(x-1)^{-3}$ **AG** Reasonable attempt to diff form $(x-1)^{-n}$ Correct $\frac{d^2y}{dx^2}$ and 'minimum' is required **Or** other valid method for last 2 marks
6	**(i)** $AC=r-r\cos\theta$ **(ii)** arc $AB=\frac{4\pi}{3}$ arc $AD=\frac{\pi}{2}\times their\ AC=\frac{\pi}{2}\times(4-4\cos\frac{\pi}{3})=\pi$ $BD=4\sin\frac{\pi}{3}-their\ AC=2\sqrt{3}-2$ Perimeter $=\frac{7\pi}{3}+2\sqrt{3}-2$	**B1** **[1]** **B1** **M1A1** **M1A1** **A1** **[6]**	 Allow $\pi\times their\ AC$ for M1. Allow 3.14 Allow 1.46 cao Accept $\sqrt{12}$
7	**(i)** $2(1-\sin^2\theta)=3\sin\theta$ $(2\sin\theta-1)(\sin\theta+2)=0$ $\theta=30°$ or $150°$ **(ii)** $n=\frac{their\ 30}{10}=3$ $(their\ 3)\theta=720+their150=870$ $\theta=290°$	**M1** **M1** **A1A1** **[4]** **B1√** **M1** **A1** **[3]**	Use $c^2+s^2=1$ Attempt to solve cao ft provided n is an integer Allow full list up to at least 870 cao

8 **(i)** $y^2 = 3y \Rightarrow y(y-3) = 0 \Rightarrow y = 3$ (or 0) $x = \frac{1}{2}$ or 5 $(\Rightarrow a = 5)$ **AG**	**M1** **A1** **[2]**	**OR** form equation in x and attempt solution **OR** sub x=5 each eq (M1) → y = 3(twice) (A1) (5,3) subst only once scores 0/2
(ii) $\left[\frac{(2x-1)^{\frac{3}{2}}}{\frac{3}{2}}\right] [\div 2]$, $\left[\frac{2}{3} \times \frac{x^2}{2} - \frac{x}{3}\right]$ $\left[\frac{27}{3} - 0\right]$, $\left[\frac{25}{3} - \frac{5}{3} - \left(\frac{1}{12} - \frac{1}{6}\right)\right]$ Subtract areas at some stage $\frac{9}{4}$ oe	**B1B1B1** **M1** **M1** **A1** **[6]**	Or Δ = ½(5 – ½)×3 Apply limits ½ and 5 for, at least, curve Dependent on some integration cao 9/4 with no working scores 0/6, but 9 – 27/4 = 9/4 scores 1/6 (M1 subtraction)
9 **(i)** $\overrightarrow{CD} = -3\begin{pmatrix}2\\1\\2\end{pmatrix} + 2\begin{pmatrix}4\\0\\6\end{pmatrix} = \begin{pmatrix}2\\-3\\6\end{pmatrix}$ Unit vector = $\frac{1}{7}\begin{pmatrix}2\\-3\\6\end{pmatrix}$	**B1** **M1A1** **[3]**	Allow M1A1 for $\frac{1}{7}\begin{pmatrix}-2\\3\\-6\end{pmatrix}$ or $(\frac{2}{7}\ \frac{-3}{7}\ \frac{6}{7})$ etc
(ii) $\overrightarrow{OE} = \begin{pmatrix}6\\3\\6\end{pmatrix} + \begin{pmatrix}1\\-1½\\3\end{pmatrix} = \begin{pmatrix}7\\1½\\9\end{pmatrix}$ $\overrightarrow{OE}.\overrightarrow{OD}$ = 56 + 0 + 108 = 164 $\lvert\overrightarrow{OE}\rvert$ = √132.25 (= 11.5); $\lvert\overrightarrow{OD}\rvert$ = √208 164 = √132.25 × √208 × cos θ $\theta = 8.6°$ cao	**M1A1** **M1** **M1** **M1** **A1** **[6]**	or equivalent method Use of $x_1x_2 + y_1y_2 + z_1z_2$ Correct method for moduli All connected correctly. Dependent on $\overrightarrow{OE}, \overrightarrow{EO}, \overrightarrow{OD}, \overrightarrow{DO}$ used
10 **(i)** $4(x-3)^2 - 25$ Vertex is (3, –25)	**B1B1B1** **B1√** **[4]**	Or $a = 4,\ b = 3,\ c = -25$ ft to *their* (b, c). Accept if not 'hence'
(ii) range is (g(x)) ≥ –9 Allow >	**B1B1** **[2]**	B1 for ≥ , B1 for –9 Accept e.g. [–9,∞]
(iii) $(x-3)^2 = \frac{1}{4}(y+25)$ $x - 3 = (\pm)\frac{1}{2}\sqrt{y+25}$ $g^{-1}(x) = 3 - \frac{1}{2}\sqrt{x+25}$ Domain is $x \geq -9$	**M1** **DM1** **A1** **B1√** **[4]**	 Attempt to square root both sides cao ft from *their* **(ii)**

11 (i) $\frac{dy}{dx} = [6] \times [\frac{1}{3}(6x+2)^{-\frac{2}{3}}]$	**B1B1**	Independent
Equation of tangent is $y - 2 = m(x-1)$	**M1**	Where m = numerical $\frac{dy}{dx}$
Equation of normal is $y - 2 = -\frac{1}{m}(x-1)$	**M1**	Including use of $m_1 m_2 = -1$
Both eqns correct with $m = \frac{1}{2}$ cao	**A1** **[5]**	SC 1/3 Blatant tangent/normal reversal
(ii) $B = (0, 1\frac{1}{2})$; $C = (2, 0)$	**B1**	Both cao
$BC = \sqrt{2^2 + (1\frac{1}{2})^2} = 2\frac{1}{2}$	**M1A1√** **[3]**	ft from *their* B and C
(iii) BC: $y - 1\frac{1}{2} = -\frac{3}{4}(x - 0)$ or	**M1**	or $y = -\frac{3}{4}x + 1\frac{1}{2}$
$y = -\frac{3}{4}(x-2)$		
Intersection (E) : $-\frac{3}{4}x + 1\frac{1}{2} = 2x$	**M1**	
$x = \frac{6}{11}$; $y = \frac{12}{11}$	**A1**	cao
Mid-point of $OA = (\frac{1}{2}, 1) \rightarrow E$ not mid-point	**B1** **[4]**	Dependent on correct x values or y values for both E and the mid-point of OA