1 **(i)** $a = 12$, $ar = -6 \rightarrow r = -\frac{1}{2}$ $ar^9 = \frac{-3}{128}$	M1 M1 A1 [3]	Attempt at r from "ar" ar^9 must be correct. co
(ii) $S_\infty = \frac{a}{1-r}$ used $\rightarrow 8$	M1 A1 [2]	Correct formula used. M1 needs $\lvert r\rvert < 1$
2 **(i)** $\left(x - \frac{2}{x}\right)^6 = x^6 - 12x^4 + 60x^2$	B1 ×3 [3]	co
(ii) $\times (1 + x^2) \rightarrow 60 - 12 = 48$	M1 A1√ [2]	Must be exactly 2 terms. √ from his **(i)**.
3 $\mathrm{f} : x \mapsto a + b\cos x$		
(i) $\mathrm{f}(0) = 10$, $a + b = 10$ $\mathrm{f}(^2/_3\pi) = 1$, $a - \frac{b}{2} = 1$ $\rightarrow a = 4$, $b = 6$	B1 B1 [2]	EITHER OF THESE both co
(ii) Range is –2 to 10.	B1√ [1]	√ for his "$a - b$" to "$a + b$"
(iii) $\cos\left(\frac{5}{6}\pi\right) = -\cos\left(\frac{1}{6}\pi\right) = -\frac{\sqrt{3}}{2}$ $\rightarrow 4 - 3\sqrt{3}$	B1 B1 [2]	For $\cos 30° = \frac{1}{2}\sqrt{3}$ used somewhere. co
4 **(i)** $2\sin x \tan x + 3 = 0$ $2\sin x \frac{\sin x}{\cos x} + 3 = 0$ $2\frac{(1-\cos^2 x)}{\cos x} + 3 = 0$ $\rightarrow 2\cos^2 x - 3\cos x - 2 = 0$	M1 M1 [2]	For using tan = sin ÷ cos For using $\sin^2 + \cos^2 = 1$ and everything correct Answer given – check.
(ii) $2\cos^2 x - 3\cos x - 2 = 0$ $\rightarrow \cos x = -\frac{1}{2}$ or 2 $x = 120°$ or $240°$	M1 A1 B1√ [3]	Solution of quadratic. co. √ for 360 – his answer.

5 $\dfrac{dy}{dx} = \dfrac{6}{\sqrt{3x-2}}$		
(i) $x = 2$, tangent has gradient 3	M1	Use of $m_1m_2 = -1$ with dy/dx
$\rightarrow$ normal has gradient $-\dfrac{1}{3}$	M1 A1	Correct form of line eqn. for normal
$\rightarrow\ y - 11 = -\dfrac{1}{3}(x-2)$	[3]	
(ii) Integrate $\rightarrow\ 6\dfrac{\sqrt{3x-2}}{\frac{1}{2}} \div 3$	B1 B1	Without the ÷3 For ÷3, even if B0 above
$\rightarrow\ y = 4\sqrt{3x-2} + c$ through (2,11)	M1	Using (2, 11) for c
$\rightarrow\ y = 4\sqrt{3x-2} + 3$	A1 [4]	co
6 $\overrightarrow{OA} = \mathbf{i} - 2\mathbf{j} + 4\mathbf{k}$, $\overrightarrow{OB} = 3\mathbf{i} + 2\mathbf{j} + 8\mathbf{k}$, $\overrightarrow{OC} = -\mathbf{i} - 2\mathbf{j} + 10\mathbf{k}$		
(i) $(\pm)$ $2\mathbf{i} + 4\mathbf{j} + 4\mathbf{k}$ $(\pm)$ $4\mathbf{i} + 4\mathbf{j} - 2\mathbf{k}$	B1 B1	co co
$\overrightarrow{AB}.\overrightarrow{CB} = 16$	M1	Needs to be scalar.
$\overrightarrow{AB}.\overrightarrow{CB} = \sqrt{36}\sqrt{36}\cos\theta$	M1	For product of 2 moduli and cosine
$\theta = 63.6°$	M1 A1 [6]	All correct.
(ii) Perimeter $= 6 + 6 + \sqrt{40}$ or $6 + 6 + 6\sin 31.8° \times 2$	M1	Correct overall method for perimeter.
$\rightarrow$ 18.32	A1 [2]	co
7 **(i)** $\sin \frac{1}{2}\theta = \dfrac{6}{10}$	M1	Use of trig with/without radians
Angle DOE = 1.287 radians.	A1 [2]	co – answer given.
(ii) P = 12 + 12 + 2 × 10 × angle BOD	M1	Use of $s = r\theta$ for arc length.
Angle $BOD = (\pi - 1.287)$	M1	Correct angle
$\rightarrow$ 61.1	A1 [3]	co
(iii) Sector DOE = ½ × 10^2 × 1.287	M1	Correct formula used with radians.
Triangle DOE = ½ × 10^2 × sin 1.287	M1	Correct formula used with radians.
Area = $\pi \times 10^2$ – (2 sectors – 2 triangles) (or 48 + 48 + 2×½×10^2×(π – 1.287) M1 M1		
$\rightarrow$ 281 <u>or</u> 282	A1 [3]	co

8 **(i)** Mid-point of $AC = (2, 3)$ Gradient of $AC = {}^1/_3$ Gradient of $BD = -3$ Equation $y - 3 = -3(x - 2)$	B1 M1 A1 [3]	Co Use of $m_1m_2 = -1$ Co
(ii) If $x = 0$, $y = 9$, $B\ (0, 9)$ Vector move $D\ (4, -3)$	B1√ M1 A1 [3]	√ on his equation. Valid method. co.
(iii) $AC = \sqrt{40}$ $BD = \sqrt{160}$ Area = 40 (or by matrix method M2 A1)	 M1 M1 A1 [3]	 Correct use on either AC or BD, Full and correct method. co
9 $y = x + \dfrac{4}{x}$		
(i) $x + \dfrac{4}{x} = 5 \rightarrow A\ (1, 5), B(4, 5)$	B1 B1	co. co.
$\dfrac{dy}{dx} = 1 - \dfrac{4}{x^2}$ $= 0$ when $x = 2$, $M\ (2, 4)$.	M1 DM1 A1 [5]	Differentiates. Setting to 0. co.
(ii) Vol of cylinder = $\pi 5^2.3$ Vol under curve = $\pi \int y^2\ dx$	B1 M1	Any valid method. Attempt at integrating y^2
Integral = $\dfrac{x^3}{3} - \dfrac{16}{x} + 8x$	A2, 1, 0	Allow if no π present.
Uses his limits "1 to 4" $\rightarrow 75\pi - 57\pi = 18\pi$	DM1 A1 [6]	Using his limits. co.
10 $f : x \mapsto 2x^2 - 8x + 14$		
(i) $y + kx = 12$, Sim Eqns. $\rightarrow 2x^2 - 8x + kx + 2 = 0$ Use of $b^2 - 4ac$ $\rightarrow (k - 8)^2 = 16 \rightarrow k = 12$ or 4.	M1 A1 M1 A1 [4]	Complete elimination of y (or x) Uses $b^2 - 4ac$ on eqn = 0, no "x" in a, b, c. co.co
(ii) $2x^2 - 8x + 14 = 2(x - 2)^2 + 6$	B1×3 [3]	
(iii) Range of f $\geqslant$ 6.	B1√ [1]	√ for c or from calculus.
(iv) Smallest $A = 2$	B1√ [1]	√ to answer to **(ii)**.
(v) Makes x the subject Order of operations correct.	M1 M1	Could interchange x, y first. Order must be correct.
$g^{-1}(x) = \sqrt{\dfrac{x-6}{2}} + 2$	A1 [3]	co