1	$(a+x)^5 = a^5 + {}^5C_1 a^4 x + {}^5C_2 a^3 x^2 + \ldots$ soi $\left(-\frac{2}{a} \times (\textit{their}\ 5a^4) + (\textit{their}\ 10a^3)\right)(x^2)$ 0	**M1** **M1** **A1** [3]	Ignore subsequent terms **AG**
2	$\mathrm{f}(x) = x^3 - 7x\,(+c)$ $5 = 27 - 21 + c$ $c = -1 \to \mathrm{f}(x) = x^3 - 7x - 1$	**B1** **M1** **A1** [3]	Sub $x = 3$, $y = 5$. Dep. on c present
3	$4x^2 + x^2 = 1/2$ soi Solve as quadratic in x^2 $x^2 = 1/4$ $x = \pm 1/2$	**B1** **M1** **A1** **A1** [4]	E.g. $(4x^2 - 1)(2x^2 + 1)$ or x^2 = formula Ignore other solution
4 **(i)**	$4\cos^2\theta + 15\sin\theta = 0$ $4(1 - s^2) + 15s = 0 \to 4\sin^2\theta - 15\sin\theta - 4 = 0$	**M1** **M1A1** **[3]**	Replace $\tan\theta$ by $\frac{\sin\theta}{\cos\theta}$ and multiply by $\sin\theta$ or equivalent Use $c^2 = 1 - s^2$ and rearrange to **AG** **(www)**
(ii)	$\sin\theta = -1/4$ $\theta = 194.5$ or 345.5	**B1** **B1B1**√ [3]	Ignore other solution Ft from 1st solution, SC B1 both angles in rads (3.39 and 6.03)
5 **(i)**	$\frac{dy}{dx} = -\frac{8}{x^2} + 2$ cao $\frac{d^2y}{dx^2} = \frac{16}{x^3}$ cao	**B1B1** **B1** [3]	
(ii)	$-\frac{8}{x^2} + 2 = 0 \to 2x^2 - 8 = 0$ $x = \pm 2$ $y = \pm 8$ $\frac{d^2y}{dx^2} > 0$ when $x = 2$ hence MINIMUM $\frac{d^2y}{dx^2} < 0$ when $x = -2$ hence MAXIMUM	**M1** **A1** **A1** **B1**√ **B1**√ [5]	Set = 0 and rearrange to quadratic form If A0A0 scored, SCA1 for just (2, 8) $\left\{\begin{array}{l}\text{Ft for "correct" conclusion if} \\ \frac{d^2y}{dx^2}\ \text{incorrect or} \\ \text{any valid method inc. a good sketch}\end{array}\right\}$

6	**(i)**	$x^2 - x + 3 = 3x + a \rightarrow x^2 - 4x + (3 - a) = 0$	**B1** [1]	**AG**
	(ii)	$5 + (3 - a) = 0 \rightarrow a = 8$	**B1**	Sub $x = -1$ into **(i)**
		$x^2 - 4x - 5 = 0 \rightarrow x = 5$	**B1** [2]	**OR B2** for $x = 5$ www
	(iii)	$16 - 4(3 - a) = 0$ (applying $b^2 - 4ac = 0$)	**M1**	**OR** $\mathrm{d}y/\mathrm{d}x = 2x - 1 \rightarrow 2x - 1 = 3$
		$a = -1$	**A1**	$x = 2$
		$(x - 2)^2 = 0 \rightarrow x = 2$	**A1**	$y = 2^2 - 2 + 3 \rightarrow y = 5$
		$y = 5$	**A1** [4]	$5 = 6 + a \rightarrow a = -1$
7	**(i)**	$BC^2 = r^2 + r^2 = 2r^2 \rightarrow BC = r\sqrt{2}$	**B1** [1]	**AG**
	(ii)	Area sector $BCFD = \frac{1}{4}\pi(r\sqrt{2})^2$ soi	**M1**	Expect $\frac{1}{2}\pi r^2$
		Area $\Delta\, BCAD = \frac{1}{2}(2r)r$	**M1**	Expect r^2 (could be embedded)
		Area segment $CFDA = \frac{1}{2}\pi r^2 - r^2$ .oe	**A1**	
		Area semi-circle $CADE = \frac{1}{2}\pi r^2$	**B1**	
		Shaded area $\frac{1}{2}\pi r^2 - \left(\frac{1}{2}\pi r^2 - r^2\right)$		
		or $\pi r^2 - \left(\frac{1}{2}\pi r^2 + \left(\frac{1}{2}\pi r^2 - r^2\right)\right)$	**DM1**	Depends on the area $\Delta\, BCD$
		$= r^2$	**A1** [6]	

8	(i)	$x^2 - 4x = 12$ $x = -2$ or 6 3^{rd} term $= (-2)^2 + 12 = 16$ or $6^2 + 12 = 48$	M1 A1 A1A1 [4]	$4x - x^2 = 12$ scores M1A0 SC1 for 16, 48 after $x = 2, -6$
	(ii)	$r^2 = \frac{x^2}{4x}\left(=\frac{x}{4}\right)$ soi $\frac{4x}{1-\frac{x}{4}} = 8$ $x = \frac{4}{3}$ or $r = \frac{1}{3}$ 3^{rd} term $= \frac{16}{27}$ (or 0.593)	M1 M1 A1 A1 [4]	 Accept use of unsimplified $\frac{x^2}{4x}$ or $\frac{4x}{x^2}$ or $\frac{4}{x}$
		ALT $\frac{4x}{1-r} = 8 \to r = 1 - \frac{1}{2}x$ **or** $\frac{4x}{1-r} = 8 \to x = 2(1-r)$ $x^2 = 4x\left(1 - \frac{1}{2}x\right)$ $\quad$ $r = \frac{2(1-r)}{4}$ $x = \frac{4}{3}$ $\quad$ $r = \frac{1}{3}$	 M1 M1 A1	
9	(i)	$-(1)(x-3)^2 + 4$	B1B1B1 [3]	
	(ii)	Smallest (m) is 3	B1√ [1]	Accept $m \geqslant 3$, $m = 3$. **Not** $x \geqslant 3$. Ft *their b*
	(iii)	$(x-3)^2 = 4 - y$ Correct order of operations $f^{-1}(x) = 3 + \sqrt{4-x}$ cao Domain is $x \leqslant 0$	M1 M1 A1 B1 [4]	Or x/y transposed. Ft *their a, b, c* Accept $y =$ if clear

10 **(i)**	PM = 2**i** – 10**k** + $\frac{1}{2}$(6**j** + 8**k**) oe	**M1**	Any valid method
	PM = 2**i** + 3**j** – 6**k**	**A1**	
	$\div\sqrt{4+9+36}$	**M1**	
	Unit vector = $\frac{1}{7}(2\mathbf{i}+3\mathbf{j}-6\mathbf{k})$	**A1** [4]	
(ii)	AT = 6**j** + 8**k**, PT = a**i** + 6**j** – 2**k** soi	**B1**	Allow 1 vector reversed at this stage.
	(or TA and TP)		(**AM** or **MT** could be used for **AT**)
	$(\cos ATP) = \frac{(6\mathbf{j}+8\mathbf{k}).(a\mathbf{i}+6\mathbf{j}-2\mathbf{k})}{\sqrt{36+64}\sqrt{a^2+36+4}}$	**M1**	
	$= \frac{36-16}{\sqrt{36+64}\sqrt{a^2+36+4}}$		
	$\frac{20}{10\sqrt{a^2+40}}$	**A1**√	Ft from their **AT** and **PT**
	$\frac{2}{\sqrt{a^2+40}} = \frac{2}{7}$ oe and attempt to solve	**M1**	
	$a = 3$	**A1** [5]	Withheld if only 1 vector reversed
	ALT Alt (Cosine Rule) Vectors (AT, PT etc.)	**B1**	
	$\cos ATP = \frac{a^2+36+4+36+64-(100+a^2)}{2\sqrt{(a^2+40)}\sqrt{100}}$	**M1A1**	
	then as above		

11 (i)	$\frac{dy}{dx} = \left[\frac{1}{2}(1+4x)^{-1/2}\right] \times [4]$	**B1B1**	
	At $x = 6, \frac{dy}{dx} = \frac{2}{5}$	**B1**	
	Gradient of normal at $P = -\frac{1}{2}$	**B1**√	**OR** eqn of norm $y - 5 = their - \frac{5}{2}(x-6)$
	Gradient of $PQ = -\frac{5}{2}$ hence PQ is a normal, or $m_1 m_2 = -1$	**B1** [5]	When $y = 0, x = 8$ hence result
(ii)	Vol for curve $= (\pi)\int(1+4x)$ and attempt to integrate y^2	**M1**	
	$= (\pi)\left[x + 2x^2\right]$ ignore '+ c'	**A1**	
	$= (\pi)[6 + 72 - 0]$	**DM1**	Apply limits $0 \to 6$ (allow reversed if corrected later)
	$= 78(\pi)$	**A1**	
	Vol for line $= \frac{1}{3} \times (\pi) \times 5^2 \times 2$	**M1**	**OR** $(\pi)\left[\frac{\left(-\frac{5}{2}x + 20\right)^3}{3 \times -\frac{5}{2}}\right]_6^8$
	$= \frac{50}{3}(\pi)$	**A1**	
	Total Vol $= 78\pi + 50\pi/3 = 94\frac{2}{3}\pi$ (or $284\pi/3$)	**A1** [7]	