1	$x^2 - 4x + c = 2x - 7 \rightarrow x^2 - 6x + c + 7 (= 0)$ $36 - 4(c + 7) < 0$ $c > 2$	**M1** **DM1** **A1** [3]	All terms on one side Apply $b^2 - 4ac < 0$. Allow $\leqslant$.
2	$[7C2] \times \left[\left(\frac{x}{3}\right)^5\right] \times \left[\left(\frac{9}{x^2}\right)^2\right]$ soi $21 \times \frac{1}{3^5}(x^5) \times 81\left(\frac{1}{x^4}\right)$ soi 7	**B2,1,0** **B1** **B1** [4]	Seen Identified as required term Accept $7x$
3 (i)	$[3]\left[(x-1)^2\right][-1]$	**B1B1B1** [3]	
(ii)	$f'(x) = 3x^2 - 6x + 7$ $= 3(x-1)^2 + 4$ > 0 hence increasing	**B1** **B1√** **DB1** [3]	Ft *their* **(i)** + 5 Dep B1√ unless other valid reason
4 (i)	Sector $OCD = \frac{1}{2}(2r)^2\theta$ $(= 2r^2\theta)$ Sector(s) $OAB/OEF = (2)\frac{1}{2}r^2(\pi - \theta)$ Total $= r^2(\pi + \theta)$	**B1** **B1** **B1** [3]	$2r^2\theta$ seen somewhere Accept with/without factor (2) **AG www**
(ii)	Arc $CD = 2r\theta$ Arc(s) AB/EF $(2)r(\pi - \theta)$ Straight edges $= 4r$ Total $2\pi r + 4r$ (which is independent of θ)	**B1** **B1** **B1** **B1** [4]	Accept with/without factor (2) Must be simplified

5 (i)	$-2p^2+16p-24+2p^2-6p+2$ Set scalar product = 0 and attempt solution $p=2.2$	**M1** **DM1** **A1** [3]	Good attempt at scalar product
(ii)	$4-2p=2(p-6)$ *or* $p=2(2p-6)$ $p=4\rightarrow\overrightarrow{OA}=\begin{pmatrix}-2\\2\\1\end{pmatrix}\quad\overrightarrow{OB}=\begin{pmatrix}-4\\4\\2\end{pmatrix}$ $\left\|\overrightarrow{OA}\right\|=\sqrt{(-2)^2+2^2+1}^2=3$	**M1** **A1** **M1A1** [4]	At least one of **OA** and **OB** correct For M1 accept a numerical p
	ALT 1 Compare AB with $OA\rightarrow 10-3p=p-6$ or $6-p=2p-6$. Similarly cf AB with OB	**M1**	
	ALT 2 $(OA.OB)/(\lvert OA\rvert\times\lvert OB\rvert)=1$ or $-1\rightarrow$ $10p-22=\sqrt{5p^2-36p}+$ $73\sqrt{5p^2-16p+20}$ $\rightarrow 125p^4-260p^3+941p^2-1448p+$ $976=0\rightarrow p=4$ with $OA.AB$ or $OB.AB$.	**M1**	. Similarly
	ALT 3 OA & OB have equal unit vectors. (Similarly with OA & AB or OB & AB.) Hence $\frac{1}{\sqrt{5p^2-36p+73}}\begin{pmatrix}p-6\\2p-6\\1\end{pmatrix}$ $=\frac{1}{\sqrt{5p^2-16p+20}}\begin{pmatrix}4-2p\\p\\2\end{pmatrix}$ $\rightarrow\frac{1}{\sqrt{5p^2-36p+73}}=\frac{2}{\sqrt{5p^2-16p+20}}$ $\rightarrow 15p^2-128p+272=0$ $\rightarrow(p-4)(15p-68)=0$ $\rightarrow p=4(or 68/15)$	**M1**	

6	(i) (a)	$1.92 + 1.84 + 1.76 + ...$ oe	B1	OR a=0.96, d= –.04 & ans
		$\frac{20}{2}[2\times1.92+19\times(-0.08)]$ oe	M1	doubled/adjusted
		23.2 cao	A1 [3]	Corr formula used with corr d & *their* a, n a = 1, n = 21 → 12.6 (25.2), a = 0.96, n = 21 → 11.76 (23.52)
	(b)	$1.92+1.92(.96)+1.92(.96)^2+...$	B1	
		$\frac{1.92(1-.96^{20}}{1-.96}$	M1	OR a=.96, r =.96 & ans /doubled/adjusted
		26.8 cao	A1 [3]	Corr formula used with r =.96 & *their* a, n a = .96, n = 21 → 13.82 (27.63) a = 1, n = 21 →14.39 (28.78)
	(ii)	$\frac{1.92}{1-.96}=48$ or $\frac{0.96}{1-0.96}=24$ & then Double **AG**	M1A1 [2]	a = 1→25 (50) but must be doubled for M1 $1.92\frac{(1-0.96^n)}{1-0.96}<48\rightarrow0.96^n>0$ (www) 'which is true' scores SCB1
7	(a)	$1+3\sin^2\theta+4\cos\theta=0$	M1	Attempt to multiply by $\cos\theta$
		$1+3(1-\cos^2\theta)+4\cos\theta+0$	M1	Use $c^2+s^2=1$
		$3\cos^2\theta-4\cos\theta-4=0$ **AG**	A1	
		$\cos\theta=-2/3$	B1	Ignore other solution
		$\theta=131.8$ *or* 228.2	B1B1√ [6]	Ft for 360 – 1st soln. –1 extra solns in range
	(b)	$c=b/a$ cao	B1	Radians 2.30 & 3.98 scores SCB1
		$d=a-b$	B1 [2]	Allow D = (0, a – b)
8	(i)	$3x+1\leqslant-1$ (Accept $3x+1=-1, 3a+1=-1$)	M1	Do not allow gf in (i) to score in (iii)
		$x\leqslant-2/3\Rightarrow$ largest value of a is – 2/3 (in terms of a)	A1 [2]	Accept $a\leqslant-2/3$ and $a=-2/3$
	(ii)	$\text{fg}(x)=3(-1-x^2)+1$	B1	No marks in this part for gf used
		$\text{fg}(x)+14=0\Rightarrow3x^2=12$ oe (2 terms)	B1	
		$x=-2$ only	B1 [3]	
	(iii)	$\text{gf}(x)=-1-(3x+1)^2$ oe	B1	No marks in this part for fg used
		$\text{gf}(x)\leqslant-50\Rightarrow(3x+1)^2\geqslant49$ (Allow $\leqslant$ *or* =	M1	OR attempt soln of $9x^2+6x-48+/\leqslant/\geqslant0$
		$3x+1\geqslant7$ *or* $3x+1\leqslant-7$ (one sufficient) www	A1	
		$x\leqslant-8/3$ only www	A1 [4]	OR $x-2\geqslant$ *or* $3x+8\leqslant0$(one suffic)

9 (i)	At $x = 4$, $\frac{dy}{dx} = 2$	**B1**	
	$\frac{dy}{dt} = \frac{dy}{dx} \times \frac{dx}{dt} = 2 \times 3 = 6$	**M1A1** [3]	Use of Chain rule
(ii)	$(y) = x + 4x^{\frac{1}{2}} (+c)$	**B1**	
	Sub $x = 4$, $y = 6 \rightarrow 6 = 4 + (4 \times 4^{\frac{1}{2}}) + c$	**M1**	Must include c
	$c = -6 \rightarrow (y = x + 4x^{\frac{1}{2}} - 6$	**A1** [3]	
(iii)	Eqn of tangent is $y - 6 = 2(x - 4)$ or $(6 - 0)/(4 - x) = 2$	**M1**	Correct eqn thru (4, 6) & with m = *their* 2
		A1	
	$B = (1, 0)$ (Allow $x = 1$)	**M1**	[Expect eqn of normal: $y = -½x + 8$]
	Gradient of normal $= -1/2$	**A1**	
	$C = (16, 0)$ (Allow $x = 16$)	**A1**	
	Area of triangle $= \frac{1}{2} \times 15 \times 6 = 45$	[5]	Or $AB = \sqrt{45}$, $AC = \sqrt{180} \rightarrow$ Area = 45.0
10 (i)	$f'(x) = 2 - 2(x + 1)^{-3}$	**B1**	
	$f''(x) = 6(x + 1)^{-4}$	**B1**	
	$f'0 = 0$ hence stationary at $x = 0$	**B1**	**AG**
	$f''0 = 6 > 0$ hence minimum	**B1**	www. Dependent on correct $f''(x)$ except $-6(x+1)^{-4} \rightarrow < 0$ MAX scores SC1
		[4]	
(ii)	$AB^2 = (3/2)^2 + (3/4)^2$	**M1**	
	$AB = 1.68$ or $\sqrt{45/4}$ oe	**A1** [2]	
(iii)	Area under curve $= \int f(x) = x^2 - (x + 1)^{-1}$	**B1**	Ignore $+c$ even if evaluated Do not penalise reversed limits
	$= \left(1 - \frac{1}{2}\right) - \left(\frac{1}{4} - 2\right) = 9/4$ (Apply limits $-½ \rightarrow 1$)	**M1A1**	Allow reversed subtn if final ans positive
	Area trap. $= \frac{1}{2}(3 + \frac{9}{4}) \times \frac{3}{2}$	**M1**	
	$= 63/16$ or 3.94	**A1**	
	Shaded area $63/16 - 9/4 + 27/16$ or 1.69	**A1** [6]	
	ALT eqn AB is $y = -½x + 11/4$	**B1**	
	Area $= \int -½x + 11/4 - \int 2x + (x + 1)^{-2}$	**M1**	Attempt integration of at least one
	$= \left[-\frac{1}{4}x^2 + \frac{11}{4}x\right] - \left[x^2 - (x + 1)^{-1}\right]$	**A1A1**	Ignore $+c$ even if evaluated Dep. on integration having taken place
	Apply limits $-½ \rightarrow 1$ to both integrals	**M1**	Allow reversed subtn if final ans positive
	27/16 or 1.69	**A1**	