1	${}^7C_1 \times 2^6 \times a$ (=) ${}^7C_2 \times 2^5 \times a^2$ soi $a = \left(\frac{7\times 2^6}{21\times 2^5}\right) = \frac{2}{3}$ oe	**B2, 1, 0** **B1** **[3]**	Treat the same error in each expression as a single error
2	$\tan^{-1}(3) = 1.249$ or $71.565°$ sin 1.25 or sin71.6 or 0.949 soi (x =) 1.95 cao, accept $1 + \frac{3}{\sqrt{10}}$ oe	**M1** **M1** **A1** **[3]**	Attempt at $\tan^{-1}3$ or right angle triangle with attempt at hypotenuse = √10 Attempt at sin $\tan^{-1}3$ Answer only **B3**
3	$13\sin^2\theta + 2\cos\theta + \cos^2\theta = 4 + 2\cos\theta$ $13\sin^2\theta + 1 - \sin^2\theta = 4 \to \sin^2\theta = \frac{1}{4}$ or $13 - 13\cos^2\theta + \cos^2\theta = 4 \to \cos^2\theta = \frac{3}{4}$ 30°, 150°	**M1** **M1** **A1A1**√ **[4]**	Attempt to multiply by $2 + \cos\theta$ Use of $s^2 + c^2$ appropriately **SC** both answers correct in radians, **A1** only Ft on 180 – their first value of θ
4 (i)	$32 - 4k = 20 \Rightarrow k = 3$ $4b + 3\times 2b = 20$ $b = 2$	**M1A1** **M1** **A1** **[4]**	Sub (8, –4) [alt: $(2b+4)/(b-8) = -4/k$ Sub (b, 2b), $4b + 2bk = 20$ **M1** both **M1** solving **A1**, **A1**]
(ii)	Mid-point = (5, 0)	**B1**√ **[1]**	Ft on *their b*
5	$x^2 + x(k-2) + (k-2)(=0)$ $(k-2)^2 - 4(k-2)(>0)$ soi $(k-2)(k-6)(>0)$ $k < 2$ or $k > 6$ (condone ⩽, ⩾) Allow {–∞, 2}U{6, ∞} etc.	**M1** **M1** **DM1** **A2** **[5]**	Equate and move terms to one side of equ. Apply $b^2 - 4ac$ (>0). Allow ⩾ at this stage. Attempt to factorise or solve or find 2 solns. **SCA1** for 2, 6 seen with wrong inequalities
6 (i)	***AB*** or ***BA*** = ±[(7**i** – 3**j** + **k**) – (3**i** + 2**j** – **k**)]= ±(**4i** – 5**j** + 2**k**) (***AO.AB***) = ±(12 – 10 – 2) [allow as column if total given] = 0 hence *OAB* = 90°	**M1A1** **DM1** **A1** **[4]**	May be seen in part **(ii)** **OR** $AB^2 = 45, AO^2 = 14, OB^2 = 59$ Hence $AB^2 + AO^2 = OB^2$ Hence *OAB* = 90°
(ii)	$\lvert \boldsymbol{OA} \rvert = \sqrt{9+4+1} = \sqrt{14}$, $\lvert \boldsymbol{AB} \rvert = \sqrt{16+25+4} = \sqrt{45}$ Area $\Delta = \frac{1}{2}\sqrt{14}\left(\sqrt{45}\right) = 12.5$	 **B1** **M1A1** **[3]**	 At least one magnitude correct in **(i)** or **(ii)** Accept 12.6, $\frac{\left(3\sqrt{70}\right)}{2}$ oe

7	(i)	$S=\frac{a}{1-r}$, $3S=\frac{a}{1-2r}$ $1-r=3-6r$ $r=\frac{2}{5}$	B1 M1 A1 [3]	At least $3S=\frac{a}{1-2r}$ Eliminate S
	(ii)	$7+(n-1)d=84$ and/or $7+(3n-1)d=245$ $[(n-1)d=77$, $(3n-1)d=238$, $2nd=161]$ $\frac{n-1}{3n-1}=\frac{77}{238}$ (must be from the correct u_n formula) $n=23$ $(d=\frac{77}{22}=3.5)$	B1 B1 M1 A1 [4]	At least one of these equations seen Two different seen – unsimplified ok Or other attempt to elim d. E.g. sub $d=\frac{161}{2n}$ (if n is eliminated d must be found)
8	(i)	Arc $AB=4\alpha$ Arc $DC=(4\cos\alpha)\alpha$ AC (or DB) $=4-4\cos\alpha$ Perimeter $=4\alpha\cos\alpha+4\alpha+8-8\cos\alpha$	B1 B1 B1 B1 [4]	
	(ii)	$OD=4\cos\frac{\pi}{6}\left(=2\sqrt{3}\right)$ Shaded area = $\left[\frac{1}{2}\times4^2\times\frac{\pi}{6}\right]\left[-\frac{1}{2}\left(2\sqrt{3}\right)^2\times\frac{\pi}{6}\right]$ $\frac{\pi}{3}$	B1 B1B1 B1 [4]	Or $k=\frac{1}{3}$
9	(i)	$f'(2)=4-\frac{1}{2}=\frac{7}{2}\to$ gradient of normal $=-\frac{2}{7}$ $y-6=-\frac{2}{7}(x-2)$ AEF	B1M1 A1√ [3]	Ft from their $f'(2)$
	(ii)	$f(x)=x^2+\frac{2}{x}(+c)$ $6=4+1+c\Rightarrow c=1$	B1B1 M1A1 [4]	Sub (2, 6) – dependent on c being present
	(iii)	$2x-\frac{2}{x^2}=0\Rightarrow 2x^3-2=0$ $x=1$ $f''(x)=2+\frac{4}{x^3}$ or any valid method $f''(1)=6$ OR >0 hence minimum	M1 A1 M1 A1 [4]	Put $f'(x)=0$ and attempt to solve Not necessary for last A mark as $x>0$ given Dependent on everything correct

10 (i)	$(x-1)^2-16$	**B1B1** **[2]**	
(ii)	-16	**B1√** **[1]**	Ft from **(i)**
(iii)	$9 \leqslant (x-1)^2 - 16 \leqslant 65$ **OR** $x^2-2x-15=9 \to 6,-4$ $25 \leqslant (x-1)^2 \leqslant 81$ $\quad x^2-2x-15=65 \to 10,-8$ $5 \leqslant x-1 \leqslant 9$ $\quad p=6$ $6 \leqslant x \leqslant 10$ $\quad q=10$	**M1** **M1** **A1** **A1** **[4]**	**OR** $x^2-2x-24 \geqslant 0$, $x^2-2x-80 \leqslant 0$, $(x-6)(x+4) \geqslant 0$ $(x-10)(x+8) \leqslant 0$ $x \geqslant 6$ $x \leqslant 10$ **SC B2, B2** for trial/improvement
(iv)	$x=(y-1)^2-16$ [interchange x/y] $y-1=(\pm)\sqrt{x+16}$ $f^{-1}(x)=1+\sqrt{x+16}$	**M1** **M1** **A1** **[3]**	**OR** $(x-1)^2=y+16$ $x=1+(\pm)\sqrt{y+16}$ $f^{-1}(x)=1+\sqrt{x+16}$
11 (i)	For $y=(4x+1)^{\frac{1}{2}}$, $\frac{dy}{dx}=\left[\frac{1}{2}(4x+1)^{-\frac{1}{2}}\right]\times[4]$ When $x=2$, gradient $m_1=\frac{2}{3}$ For $y=\frac{1}{2}x^2+1$, $\frac{dy}{dx}=x \to$ gradient $m_2=2$ $\alpha=\tan^{-1}m_2-\tan^{-1}m_1$ $\alpha=63.43-33.69=29.7$ cao	**B1B1** **B1√** **B1** **M1** **A1** **[6]**	 Ft from *their* derivative above
(ii)	$\int(4x+1)^{\frac{1}{2}}dx=\left[\frac{(4x+1)^{\frac{3}{2}}}{2/3}\right]\div[4]$ $\int\left(\frac{1}{2}x^2+1\right)dx=\frac{1}{6}x^3+x$ $\int_0^2(4x+1)^{\frac{1}{2}}dx=\frac{1}{6}[27-1]$, $\int_0^2\left(\frac{1}{2}x^2+1\right)dx=\left[\frac{8}{6}+2\right]$ $\frac{13}{3}-\frac{10}{3}$ 1	**B1B1** **B1** **M1** **M1** **A1** **[6]**	 Apply limits $0 \to 2$ to at least the 1st integral Subtract the integrals (at some stage)