1 $\left(x^2 - \frac{2}{x}\right)^5$		
Term in x is $10 \times (x^2)^2 \times \left(\frac{-2}{x}\right)^3$	B1 B1	B1 10 or ${}^5C_2$ or ${}^5C_3$, B1 $\left(\frac{-2}{x}\right)^3$
Coefficient $= -80(x)$	B1 [3]	co Must be identified
2 36, 32, **...**		
(i) $r = \frac{8}{9}$ $S_\infty = (their\ a) \div (1 - their\ r)$	M1	Method for r and S_∞ ok. ($\lvert r \rvert < 1$)
$S_\infty = 36 \div \frac{1}{9} = 324$	A1 [2]	co
(ii) $d = -4$	B1	co
$0 = \frac{n}{2}(72 + (n-1)(-4))$	M1	S_n formula ok and a value for d $\left(\neq \frac{8}{9}\right)$
$\rightarrow n = 19$	A1 [3]	Condone $n = 0$ but no other soln
3 **(i)** $s = r\theta$	M1	Used with major or minor arc
Angle of major arc $= 2\pi - 2.2 = (4.083)$	B1	Could be gained in **(ii)**.
Perimeter $= 12 + 24.5 = 36.5$ or $12\pi - 1.2$ (or full circle − minor arc B1)	A1 [3]	co
(ii) Area of major sector $= \frac{1}{2}r^2\theta = (73.49)$	M1	Used with major/minor sector.
Area of triangle $= \frac{1}{2}.6^2\sin 2.2 = (14.55)$	M1	Correct formula or method. $(2\pi - 2.2)/\sin 2.2$ gets M1M1
Ratio $= 5.05 : 1$ (Allow $5.03 \rightarrow 5.06$)	A1 [3]	co
4 $\frac{\tan x + 1}{\sin x \tan x + \cos x} \equiv \sin x + \cos x$		
(i) LHS $\frac{\left(\frac{s}{c}\right)+1}{\left(\frac{s^2}{c}+c\right)} = \frac{s+c}{s^2+c^2}$	M1 M1	Use of $t = s/c$ twice Correct algebra and use of $s^2 + c^2 = 1$
= RHS	A1 [3]	AG all ok
(ii) $s + c = 3s - 2c$		
$\rightarrow \tan x = \frac{3}{2}$ Allow $\cos^2 = \frac{4}{13}$, $\sin^2 = \frac{9}{13}$	M1	Uses (i) and $t = \frac{s}{c}$ $t = \frac{2}{3}$ or 0 is M0
$\rightarrow x = 0.983$ and 4.12 or 4.13	A1 A1√ [3]	co. √ 1st + π, providing no excess solns in range. Allow 0.313π, 1.31π

5 $f(x) = \dfrac{15}{2x+3}$		
(i) $f'(x) = \dfrac{-15}{(2x+3)^2} \times 2$	B1 B1	Without the "×2". For "×2" (indep of 1st B1).
$(\ )^2$ always +ve $\rightarrow$ $f'(x) < 0$ (No turning points) – therefore an inverse	B1√	√ providing $(\ )^2$ in $f'(x)$. 1–1 insuff.
	[3]	
(ii) $y = \dfrac{15}{2x+3}$ $\rightarrow 2x + 3 = \dfrac{15}{y}$	M1	Order of ops – allow sign error
$\rightarrow x = \dfrac{\frac{15}{y} - 3}{2}$ $\rightarrow$ $\dfrac{15-3x}{2x}$	A1	co as function of x. Allow $y = \ldots$
(Range) $0 \leqslant f^{-1}(x) \leqslant 6$. Allow $0 \leqslant y \leqslant 6$, [0,6]	B1	For range/domain ignore letters
(Domain) $1 \leqslant x \leqslant 5$. Allow [1, 5]	B1	unless range/domain not identified
	[4]	
6 $\dfrac{dy}{dx} = \dfrac{12}{\sqrt{4x+a}}$ P (2, 14) Normal $3y + x = 44$		
(i) m of normal $= -\dfrac{1}{3}$	B1	co
$\dfrac{dy}{dx} = 3 = \dfrac{12}{\sqrt{4x+a}}$ $\rightarrow$ $a = 8$	M1 A1	Use of $m_1 m_2 = -1$. AG.
	[3]	
(ii) $\int y = 12(4x + a)^{\frac{1}{2}} \div \dfrac{1}{2}$ $\div 4$ $(+c)$	B1 B1	Correct without "÷4". for "÷4".
Uses (2, 14)	M1	Uses in an integral only. Dep 'c'.
$c = -10$	A1	co All 4 marks can be given in (i)
	[4]	

7 **(i)** Angle BAC needs sides AB,AC or BA,CA $\mathbf{AB.AC} = (\mathbf{b}-\mathbf{a}).(\mathbf{c}-\mathbf{a})$		Ignore *their* labels:
$= \begin{pmatrix}4\\-2\\4\end{pmatrix}.\begin{pmatrix}0\\3\\4\end{pmatrix} = 10$	B1 M1	One of **AB, BA, AC, CA** correct Use of $x_1x_2 + y_1y_2$, etc.
$= \sqrt{36} \times \sqrt{25}\cos BAC$	M1M1	M1 prod of moduli. M1 all linked
$\rightarrow \quad BAC = \cos^{-1}\frac{1}{3}$ AG	A1	If e.g. **BA.OC** max B1M1M1. If both vectors wrong 0/5. If e.g. **BA.AC** used $\rightarrow \cos^{-1}\left(-\frac{1}{3}\right)$ final mark A0
	[5]	
(ii) $\sin BAC = \sqrt{1-\frac{1}{9}}$	B1	Use of $s^2 + c^2 = 1$ – not decimals
Area $= \frac{1}{2} \times 6 \times 5 \times \sqrt{\frac{8}{9}} = 5\sqrt{8}$ oe	M1 A1	Correct formula for area. Decimals seen A0
	[3]	
8 $2x^2 - 10x + 8 \rightarrow a(x+b)^2 + c$		
(i) $a = 2,\ b = -2\frac{1}{2},\ c = -4\frac{1}{2}$	3 × B1	Or $2\left(x-2\frac{1}{2}\right)^2 - 4\frac{1}{2}$
$\rightarrow$ min value is $-4\frac{1}{2}$ Allow $(2\frac{1}{2}, -4\frac{1}{2})$	B1√	Can score by sub $x = 2\frac{1}{2}$ into original but not by differentiation
	[4]	
(ii) $2x^2 - 10x + 8 - kx = 0$ Use of "$b^2 - 4ac$" $(-10-k)^2 - 64 < 0$ or $k^2 + 20k + 36 < 0$ $\rightarrow\ k = -18$ or -2 $-18 < k < -2$	M1 M1 A1 A1	Sets equation to 0 and uses discriminant correctly Realises discriminant < 0. Allow ⩽ co Dep on 1st M1 only co
	[4]	
9 **(i)** $3x^2y = 288$ y is the height	B1	co
$A = 2(3x^2 + xy + 3xy)$	M1	Considers at least 5 faces $(y \neq x)$
Sub for $y \rightarrow A = 6x^2 + \frac{768}{x}$	A1	co answer given
	[3]	
(ii) $\frac{dA}{dx} = 12x - \frac{768}{x^2}$	B1	co
$= 0$ when $x = 4 \rightarrow A = 288$. Allow $(4, 288)$	M1 A1	Sets differential to 0 + solution. co
$\frac{d^2A}{dx^2} = 12 + \frac{1536}{x^3}$	M1	Any valid method
$(= 36) > 0$ Minimum	A1	co www dep on correct f″ and $x = 4$
	[5]	

10 pts of intersection $2x + 1 = -x^2 + 12x - 20$ $\rightarrow$ $x = 3, 7$	M1A1	Attempt at soln of sim eqns. co
Area of trapezium = $\frac{1}{2}(4)(7 + 15) = 44$ (or $\int (2x+1)\,dx$ from 3 to 7 = 44)	M1A1	Either method ok. co
Area under curve = $-\frac{1}{3}x^3 + 6x^2 - 20x$	B2,1	−1 each term incorrect
Uses 3 to 7 $\rightarrow$ $(54\frac{2}{3})$	DM1	Correct use of limits (Dep 1st M1)
Shaded area = $10\frac{2}{3}$	A1 [8]	co
OR		
$\int_3^7 \left(-x^2 + 10x - 21\right) = \left(-\frac{x^3}{3} + 5x^2 - 21x\right)$		Functions subtracted before integration
M1 subtraction, A1A1A1 for integrated terms, DM1 correct use of limits, A1		Subtraction reversed allow A3A0. Limits reversed allow DM1A0
11 Sim eqns $\rightarrow$ $A(1, 3)$	M1 A1	co Allow answer only B2
Vectors or mid-point $\rightarrow$ $C(12, 14)$	M1 A1$\surd$	Allow answer only B2$\surd$
Eqn of BC $4y = x + 44$ or CD $y = 3x - 22$	M1	equation ok – unsimplified
Sim eqns $\rightarrow$ $B(4, 12)$ or $D(9, 5)$	DM1A1	Sim eqns. co
Vectors or mid-point $\rightarrow$ $B(4, 12)$ or $D(9, 5)$	DM1A1 [9]	Valid method (or sim eqns) co