1	$\left(x^2 - \frac{a}{x}\right)^7$ Term in x^5 is ${}_7C_3 \times (x^2)^4 \times (-a/x)^3$ This term isolated Equated to $-280 \rightarrow a = 2$.	 B1 M1 A1 [3]	 Allow on own or in an expansion. Correct term in x^5 selected. Equated to -280
2	**(i)** $f(x) = \sqrt{\frac{x+3}{2}} + 1$, for $x \geq -3$ Make x the subject or interchanges x,y $\rightarrow 2(x-1)^2 - 3$ $\rightarrow 2x^2 - 4x - 1$ **(ii)** domain of f^{-1} is ≥ 1.	 M1 M1 A1 [3] B1 [1]	 Attempt at x as subject and removes +1 Squares both sides and deals with "+3" and "÷2". co co. condone >1
3	**(i)** $A = 2400 - 20(60 - 2x) - x(40 - x) - 30x$ $\rightarrow A = x^2 - 30x + 1200$. (could be trapezium − triangle) **(ii)** $\frac{dA}{dx} = 2x - 30$ or $(x - 15)^2 + 975$ $= 0$ when $x = 15$ or Min at $x = 15$ $\rightarrow A = 975$.	 M1 A1 [2] B1 M1 A1 [3]	 Needs attempts at all areas co answer given co - either method okay Sets differential to 0 + solution. co co.
4	$y = \frac{x}{k} + k \quad 4y = x^2$ **(i)** $\frac{x^2}{4} = \frac{x}{k} + k \rightarrow kx^2 - 4x - 4k^2 = 0$ Uses $b^2 - 4ac \rightarrow k = -1$ (calculus $\frac{1}{k} = \frac{2x}{4}$ B1 $\rightarrow x = \frac{2}{k}$, $y = \frac{1}{k^2}$ M1 $\rightarrow k = -1$ A1) **(ii)** $y = -x - 1$, $4y = x^2$ $\rightarrow x^2 + 4x + 4 = 0$ $\rightarrow P(-2, 1)$	 M1 M1 A1 [3] M1 M1 A1 [3]	 Eliminates x or y completely. Uses $b^2 - 4ac$ for a quadratic = 0 co nb a,b,c must not be $f(x)$ Elimination of x or y Soln of eqn. co.

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5	$A\ (1, 3), B\ (5, 11)\ , X\ (4, 4)$ **(i)** Gradient of $AB = 2$ Gradient of $BC = -½$ → Eqn of BC is $y - 11 = -\frac{1}{2}(x - 5)$ **(ii)** gradient of AC (or AX) is ⅓ → eqn of AC is $y - 3 = \frac{1}{3}(x - 1)$ or $y - 4 = \frac{1}{3}(x - 4)$ Sim equations → $C\ (13,7)$	B1 M1 A1 [3] B1 M1 A1 [3]	co For use of $m_1m_2 = -1$ co – unsimplified is fine co Correct form of line equation + sim eqns co answer only -0/3- assumed $AB = BC$. Uses graph or table and gets exactly (13,7) allow the 3 marks for **(ii)**.
6	$2\cos x = 3\tan x$ **(i)** Replaces tan x by sin$x$ ÷ cos x → $2c^2 = 3s$ → $2s^2 + 3s - 2 = 0$ **(ii)** Soln of quadratic → $y = 15°$ $2y$ can also be $180 - 30$ → $y = 75°$.	M1 M1 A1 [3] M1 A1 DM1 A1√ [4]	Uses $t = s \div c$ Uses $s^2 + c^2 = 1$. Correct eqn . Method for quadratic = 0 and ÷2 co Works with $2y$ first before ÷ 2 for $90° - 1^{st}$ answer. (loses √ mark if extra soln in range)
7	$\overrightarrow{OA} = \begin{pmatrix}1\\0\\2\end{pmatrix}$ $\overrightarrow{OB} = \begin{pmatrix}k\\-k\\2k\end{pmatrix}$ **(i)** $\begin{pmatrix}1\\0\\2\end{pmatrix}.\begin{pmatrix}2\\-2\\4\end{pmatrix} = 10$ $= \sqrt{5} \times \sqrt{24}\cos\theta$ → $\theta = 24.1°$ **(ii)** $\overrightarrow{AB} = \begin{pmatrix}k-1\\-k\\2k-2\end{pmatrix}$ allow each cpt ± $(k-1)^2 + k^2 + (2k-2)^2$ → $6k^2 - 10k + 4 = 0$ → $k = 1$ or ⅔	M1 M1 M1 A1 [4] M1 M1 A1 A1 [4]	Use of $x_1x_2 + y_1y_2 + z_1z_2$ Product of 2 moduli All connected correctly. co Correct for either **AB** or **BA**. Sum of 3 squares (doesn't need =1) Correct quadratic co

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8	**(a)** **(i)** $ar = 24$, $ar^3 = 13\frac{1}{2}$ Eliminates a (or r) $\rightarrow$ $r = \frac{3}{4}$ $\rightarrow$ $a = 32$	B1 M1 A1 [3]	Both needed Method of Solution. co
	(ii) sum to infinity $= 32 \div \frac{1}{4} = 128$	M1A1√ [2]	Correct formula used. √ on value of r
	(b) $a = 3$, $d = 2$ $\frac{n}{2}(6 + (n-1)2)$ $(= 360)$ $\rightarrow$ $2n^2 + 4n - 720 = 0$ $\rightarrow$ $n = 18$	B1 M1 A1 A1 [4]	Correct value for d Correct S_n used. no need for 360 here. Correct quadratic co
9	$y = \frac{9}{2x+3}$ $A\ (3, 1)$ $B\ (0, 3)$ **(i)** $\frac{dy}{dx} = \frac{-9}{(2x+3)^2} \times 2$ $\rightarrow m = -\frac{2}{9}$ $\rightarrow$ $y - 1 = -\frac{2}{9}(x-3)$	B1 B1 M1 A1√ [4]	Correct without the ×2. For × 2, independent of first part. Correct form of tan - numerical dy/dx For his m following use of dy/dx. (normal →max 2/4, no calculus 0/4)
	(ii) Meets the y-axis when $x = 0$, $y = 1\frac{2}{3}$ This is nearer to B than to O.	B1 [1]	Sets x to 0 in his tangent. The $1\frac{2}{3}$ and part **(i)** must be correct.
	(iii) Integral of $\frac{81}{(2x+3)^2} = \frac{-81}{2x+3} \div 2$ Uses limits 0 to 3 $\rightarrow$ $\frac{-9}{2} - \frac{-81}{6} = 9\pi$	B1 B1 M1 A1 [4]	Correct without the ÷ 2. For ÷ 2, Use of limits with integral of y^2 only no π – max ¾. Use of area - 0/4,

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10	$\frac{dy}{dx} = x + \frac{4}{x^2}$ and P (4, 8)		
	(i) $y = \frac{x^2}{2} - \frac{4}{x}$ + (c)	B1 B1	co.co (ignore +c at this stage)
	Uses (4, 8) → $c = 1$	M1 A1 [4]	Uses the point after integration for c
	(ii) $\frac{d^2y}{dx^2} = 1 - \frac{8}{x^3}$	B1	Co
	$= 0$ when $x = 2$	B1	Sets to 0 + solution or verifies and states a conclusion (stationary or min)
	→ gradient of 3	B1	Allow for $x = 2$ into dy/dx.
	d/d$x$$(1 - \frac{8}{x^3}) = \frac{24}{x^4}$ → +ve → Min.	B1 [4]	Any valid method - 3rd differential +ve 2nd diff goes −0+, or 1st goes >3,3,>3
11	**(i)** $OQ = x + OC = 20$	B1	Used somewhere – needs "20".
	$\sin 0.6 = \frac{x}{OC}$ → $OC = \frac{x}{\sin 0.6}$	M1	Use of trig in 90º triangle
	$x + \frac{x}{\sin 0.6} = 20$ → $x = 7.218$	M1 A1 [4]	Soln of linear equation. (answer given, ensure there is a correct method)
	(ii) Area = ½. 20² × 1.2 – π × 7.218² = 76.3	M1 A1 [2]	Use of ½$r^2\theta$ - needs r=20 and θ = 1.2 co
	(iii) Angle $PCR = \pi - 1.2$	B1	co
	Arc $PR = 7.218 \times (\pi - 1.2) = (14.01)$	M1	Use of $s = r\theta$ with r = 7.218 -any θ -even $2\pi/3$
	$OP = OR = \frac{x}{\tan 0.6}$	M1 A1 [4]	Correct use of trig or Pythagoras co
	→ Perimeter of 35.1 cm		

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