1	$\int\left(x+\frac{1}{x}\right)^2 \mathrm{d}x$ $= \frac{x^3}{3} - \frac{1}{x} + 2x + (c)$	B1 × 3	[3]	co. Omission of middle term of expansion can still get 2/3.
2	$(1 + ax)^6$ Term in $x = 6ax$ Equate with $-30 \rightarrow a = -5$ Term in $x^3 = \frac{6.5.4}{3!}a^3$ $\rightarrow$ coefficient of -2500	B1 B1√ B1 B1√	[4]	co √ from his answer for $6ax$ co For $20 \times a^3$
3	$\mathrm{f}: x \mapsto 2x + 3$, $\mathrm{g}: x \mapsto x^2 - 2x$, $\mathrm{gf}(x) = (2x + 3)^2 - 2(2x + 3)$ $= 4x^2 + 8x + 3$ $= 4(x + 1)^2 - 1$	M1 A1 3 × B1√	[5]	Must be f into g, not g into f. co Allow all these as √ for either fg or gf.
4	**(i)** $\frac{\sin x \tan x}{1-\cos x} = \frac{\sin^2 x}{\cos x(1-\cos x)}$ $= \frac{1-\cos^2 x}{\cos x(1-\cos x)}$ $= \frac{(1-\cos x)(1+\cos x)}{\cos x(1-\cos x)} = \frac{1}{\cos x}+1$	M1 M1 M1	[3]	Use of $\tan x = \sin x \div \cos x$ Use of $\sin^2 x = 1 - \cos^2 x$ Realising the need to use difference of 2 squares. Answer given.
	(ii) $\frac{1}{\cos x} + 1 + 2 = 0$ $\rightarrow \cos x = -⅓$ $\rightarrow x = 109.5°$ or $250.5°$	M1 A1 A1√	[3]	Uses part **(i)** with cos x as subject. co. √ for 360° – 1st answer.
5	$\overrightarrow{AC} = -6\mathbf{i} + 10\mathbf{k}$ $\overrightarrow{BC} = -8\mathbf{j} + 10\mathbf{k}$ $\overrightarrow{AC}.\overrightarrow{BC} = 100$ $\overrightarrow{AC}.\overrightarrow{BC} = \sqrt{136}\sqrt{164} \cos ACB$ Angle $ACB = 48.0°$	B1 B1 M1 M1 M1 A1	[6]	co (or $\overrightarrow{CA}$) co (or $\overrightarrow{CB}$) Must be scalar – available for any pair For modulus – available for any vector All linked correctly – for ACB only co

6	**(a)** $a + 4d = 18$	B1		co or $75 = 5/2(a + 18) \to a = 12$ etc
	$\frac{5}{2}(2a + 4d) = 75$	B1		co
	Solution $\to a = 12,\ d = 1\frac{1}{2}$	M1 A1	[4]	Solution of sim equations co for both
	(b) $a = 16$ and $ar^3 = \frac{27}{4}$ $r = \frac{3}{4}$	B1		Needs both of these
	Sum to infinity = 64	M1 A1	[3]	Correct formula and $\lvert r\rvert < 1$
7	$x \mapsto 3 - 2\tan(\frac{1}{2}x)$ **(i)** Range of f ≤ 3	B1	[1]	co. Allow <
	(ii) $f(\frac{2}{3}\pi) = 3 - 2\sqrt{3}$	B1	[1]	co
	(iii)	B2, 1, 0 Indep.	[2]	Starting at $y = 3$ Shape correct – no turning points. Tending tangentially towards $x = \pi$
	(iv) $y = 3 - 2\tan\left(\frac{x}{2}\right)$	M1 M1		Attempt at making x the subject. Order of operations all ok.
	$\to f^{-1}(x) = 2\tan^{-1}\left(\frac{3-x}{2}\right)$	A1	[3]	co – but with x, not y.
8	**(i)** $2x + 2y + \frac{\pi x}{2} = 60$	M1		Linking 60 with sum of at least 4 sides and use of radians
	$\to y = 30 - x - \frac{\pi x}{4}$	A1	[2]	co
	(ii) $A = xy + \frac{\pi x^2}{4}$ $= x\,(30 - x - \frac{\pi x}{4}) + \frac{\pi x^2}{4}$	M1		Subs "y" into area eqn and use $\frac{1}{2}r^2\theta$
	$= 30x - x^2$	A1	[2]	co.
	(iii) $\frac{dA}{dx} = 30 - 2x$			Knowing to differentiate
	$= 0$ when $x = 15$ cm	M1 A1	[2]	Sets differential to 0 + solution. co.
	(iv) Max.	M1 A1	[2]	Any valid method. co.

9	**(i)** $RS^2 = 10^2 - 6^2$ $\rightarrow RS = 8$ cm.	M1 A1	[2]	Use of Pythagoras (or other) Answer given.
	(ii) $\sin\theta = 8/10$ oe $\rightarrow$ angle $RPQ = 0.9273$ radians	M1 A1	[2]	Use of trig – even if with degrees. co in radians. (Accept 0.927)
	(iii) Region = trapezium − 2 sectors Area of trapezium = 40 cm²	 B1		 co
	Large sector = $\frac{1}{2} \times 8^2 \times 0.9273$	M1		Use of $\frac{1}{2}r^2\theta$.
	Small sector angle = $(\pi - 0.9273)$ Small sector = $\frac{1}{2} \times 2^2 \times 2.214$	 M1		 Use of $\frac{1}{2}r^2\theta$ with angle = π − **(ii)**
	$\rightarrow 5.90$ cm^2	A1	[4]	co
10	$y = 4x - x^2 + 3$			
	(i) $\frac{dy}{dx} = 4 - 2x$ At $x = 3$, $m = -2$	B1		co
	Gradient of normal = $\frac{1}{2}$	M1		Use of $m_1m_2 = -1$
	Eqn of normal $y - 6 = \frac{1}{2}(x - 3)$ $\rightarrow 2y = x + 9$	M1 A1	[4]	Use of $y - k = m(x - h)$ or $y = mx + c$ (where m is gradient of normal)
	(ii) Meets axes at $(0, \frac{9}{2})$ and $(-9, 0)$	M1		Sets x and y to 0 + midpoint formula.
	Mid-point is $\left(\frac{-9}{2}, \frac{9}{4}\right)$	A1	[2]	co.
	(iii) $2y = x + 9$, $y = 4x - x^2 + 3$ $\rightarrow 2x^2 - 7x + 3 = 0$ oe $\rightarrow (\frac{1}{2}, 4\frac{3}{4})$	 M1 A1 M1 A1	[4]	 Eliminates x completely. Correct eqn. Solution of quadratic. co

11	$y = \dfrac{9}{2-x}$			
	(i) $\dfrac{dy}{dx} = -9(2-x)^{-2} \times -1$	B1 B1		Without the "× −1" Indep. With the "×−1". Indep.
	$\dfrac{9}{(2-x)^2} \neq 0$. No turning points.	B1√	[3]	√ provided of form $k \div (2-x)^2$.
	(ii) $V = \pi \int \dfrac{81}{(2-x)^2} dx$			
	$\int y^2 dx = -81(2-x)^{-1} \div (-1)$	B1 B1		Answer without the "÷ −1 including π For "÷ −1".
	Use of limits 0 to 1	M1		Uses both limits in an integral of y^2 – if "0" ignored, M0.
	$\rightarrow \dfrac{81\pi}{2}$ (or 127)	A1	[4]	co (If π omitted – max 3/4)
	(iii) $\dfrac{9}{2-x} = x + k$	M1		Elimination of y
	$\rightarrow x^2 - 2x + kx - 2k + 9 = 0$			
	Uses $b - 4ac$	M1		Uses discriminant
	$\rightarrow k^2 + 4k - 32$			
	$\rightarrow$ end-points of 4 and −8	A1		End-values correct.
	Range for 2 points of intersection			
	$\rightarrow k < -8$, $k > 4$.	A1	[4]	Accept ≤, ≥.