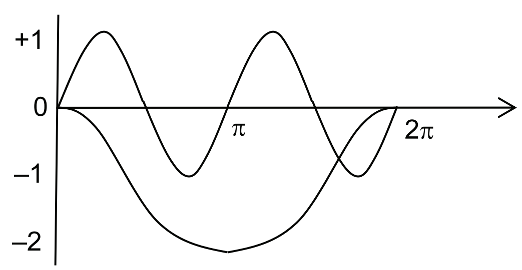
1	$\frac{dy}{dx} = \sqrt{2x+5}$			
	$\frac{(2x+5)^{\frac{3}{2}}}{\frac{3}{2}} \div 2 \quad (+c)$	B1 B1		B1 Everything without "÷2". B1 "÷2"
	Uses (2, 5) $\rightarrow$ $c = -4$	M1 A1	[4]	Uses point in an integral.
2 (i)	½.3²π = ½9²θ - ½3²θ $\rightarrow \theta = \frac{1}{4}\pi$	M1 A1 A1	[3]	M1 needs ½$r^2\theta$ once. A1 all correct. Answer given
(ii)	$P = 6+6+3\times\frac{1}{4}\pi + 9\times\frac{1}{4}\pi = 21.4$ cm. or $12 + 3\pi$	M1 A1	[2]	M1 is for use of $s=r\theta$ once.
3	2cos²θ = tan²θ			
(i)	$\rightarrow 2\cos^2\theta = \frac{\sin^2\theta}{\cos^2\theta}$ $\rightarrow$ Uses $c^2 + s^2 = 1 \rightarrow 2c^4 = 1 - c^2$	M1 A1	[2]	Use of $t^2 = s^2 \div c^2$ or alternative. Correct eqn.
(ii)	$(2c^2 - 1)(c^2 + 1) = 0 \quad \rightarrow c = \pm\frac{1}{\sqrt{2}}$ $\rightarrow \theta = \frac{1}{4}\pi$ or $\frac{3}{4}\pi$.	M1 A1 A1√	[3]	Method of solving for 3-term quadratic. (in terms of π). √ for $\pi - 1^{st}$ ans. Cannot gain A1√ if other answers given in the range.
4 (i)	$(2 + ax)^5 = 32 + 80ax + 80a^2x^2$	3 × B1	[3]	B1 for each term.
(ii)	$\times (1 + 2x)$ $240 = 80a^2 + 160a$ $\rightarrow a = 1$ or $a = -3$.	M1 DM1A1	[3]	Realises need to consider 2 terms. Solution of 3-term quadratic.
5 (i)		B1 DB1 B1 DB1	[4]	y =sin2x has 2 cycles, starts and finishes on the x-axis, max comes first. From +1 to −1. Smooth curves. y = cosx − 1 has one cycle, starts and finishes on x-axis, with a minimum pt. From 0 to −2, smooth curve, flattens.
(ii)	**(a)** $\sin 2x = -\frac{1}{2} \quad \rightarrow$ 4 solutions	B1√	[1]	√ for their curve.
	(b) $\sin 2x + \cos x + 1 = 0 \rightarrow$ 3 solutions.	B1√	[1]	√ for intersections of their curves.

6	$u = x^2 y \quad y + 3x = 9$ $u = x^2(9 - 3x)$ or $\left(\frac{9-y}{3}\right)^2 y$	M1		Expressing u in terms of 1 variable
	$\frac{du}{dx} = 18x - 9x^2$ or $\frac{du}{dy} = 27 - 12y + y^2$	DM1A1		Knowing to differentiate.
	$= 0$ when $x = 2$ or $y = 3 \rightarrow u = 12$	DM1 A1		Setting differential to 0.
	$\frac{d^2u}{dx^2} = 18 - 18x \quad -$ve	DM1 A1	[7]	Any valid method
7	A (2, 14), B (14, 6) and C (7, 2).			
(i)	m of $AB = -⅔$	B1		
	m of perpendicular $= \frac{3}{2}$	M1		For use of $m_1 m_2 = -1$
	eqn of $AB \quad y - 14 = -\frac{2}{3}(x - 2)$	M1		Allow M1 for unsimplified eqn
	eqn of $CX \quad y - 2 = \frac{3}{2}(x - 7)$	M1		Allow M1 for unsimplified eqn
	Sim Eqns $\rightarrow X(11, 8)$	M1 A1	[6]	For solution of sim eqns.
(ii)	$AX : XB = 14-8 : 8-6 = 3 : 1$ Or $\sqrt{(9^2+6^2)} : \sqrt{(3^2+2^2)} = 3 : 1$	M1 A1	[2]	Vector steps or Pythagoras.
8	$\overrightarrow{OA} = \begin{pmatrix} 3 \\ 3 \\ -4 \end{pmatrix}$ and $\overrightarrow{OB} = \begin{pmatrix} 5 \\ 0 \\ 2 \end{pmatrix}$.			
	(i) **OC** = **AB** = **b** − **a** = $\begin{pmatrix} 2 \\ -3 \\ 6 \end{pmatrix}$	M1		Knowing how to find **OC**
	Uses **OC** and **OB**	B1		Using **OC.OB** or **CO.BO**
	OC.OB = 22 = 7 × √29 cos BOC	M1 M1		M1 Use of $x_1 x_2 + \ldots$ M1 for modulus
	→ Angle BOC = 54.3^0 (or 0.948 rad)	M1 A1	[6]	M1 everything linked. (nb uses **BO.OC** loses B1 A1) (nb uses other vectors – max M1M1)

(ii)	Modulus of **OC** = 7 Vector = 35 ÷ 7 × **OC** $\rightarrow \pm \mathbf{5}\begin{pmatrix}2\\-3\\6\end{pmatrix}$	M1 A1√	[2]	Knows to scale by factor of 35 ÷ Mod For their **OC.**
9 (a)	$S_n = 2n^2 + 8n$ $S_1 = 10 = a$ $S_2 = 24 = a + (a + d)$ $d = 4$	 B1 M1 A1	[3]	 correct use of S_n formula.
(b)	GP $a = 64$ $ar = 48 \rightarrow r = ¾$ →3rd term is $ar^2 = 36$ AP $a = 64$, $a + 8d = 48 \rightarrow d = -2$ $36 = 64 + (n - 1)(-2)$ $\rightarrow n = 15$.	B1 M1 B1 M1 A1	[5]	 ar^2 numerical – for their r correct use of $a+(n-1)d$
10	$\mathrm{f}: x \mapsto 2x + k$, $\mathrm{g}: x \mapsto x^2 - 6x + 8$,			
(i)	$2(2x + 3) + 3 = 25$ $\rightarrow x = 4$ or {f(11) = 25, f(4) = 11}	M1 A1	[2]	ff(x) needs to be correctly formed
(ii)	$x^2 - 6x + 8 = 2x + k$ $x^2 - 8x + 8 - k = 0$ Uses $b^2 - 4ac < 0$ $\rightarrow k < -8$	M1 M1 A1	[3]	Eliminates y to form eqn in x. Uses the discriminant – even if =0.>0
(iii)	$x^2 - 6x + 8 = (x - 3)^2 - 1$ $y = (x - 3)^2 - 1$ Makes x the subject $\rightarrow \pm\sqrt{(x + 1)} + 3$ Needs specifically to lose the "–".	B1 B1 M1 A1√	[4]	For "−3" and "−1" Makes x the subject, in terms of x and without − or ±.

11	$y = \frac{8}{\sqrt{x}} - x$			
(i)	$\frac{dy}{dx} = -4x^{-\frac{3}{2}} - 1$	B1		needs both
	$= -\frac{3}{2}$ when $x = 4$.	M1		Subs $x = 4$ into dy/dx
	Eqn of BC $y - 0 = -\frac{3}{2}(x - 4)$	M1		Must be using differential +
		A1		correct form of line at $B(4,0)$.
	$\rightarrow C(1, 4\frac{1}{2})$		[4]	
(ii)	area under curve = $\int(\frac{8}{\sqrt{x}} - x)$			
	$= \frac{8x^{\frac{1}{2}}}{\frac{1}{2}} - \frac{1}{2}x^2$	B1 B1		(both unsimplified)
	Limits 1 to 4 $\rightarrow$ $8\frac{1}{2}$	M1		Using correct limits.
	Area under tangent = $\frac{1}{2} \times 4\frac{1}{2} \times 3 = 6\frac{3}{4}$	M1		Or could use calculus)
	Shaded area = $1\frac{3}{4}$	A1	[5]	