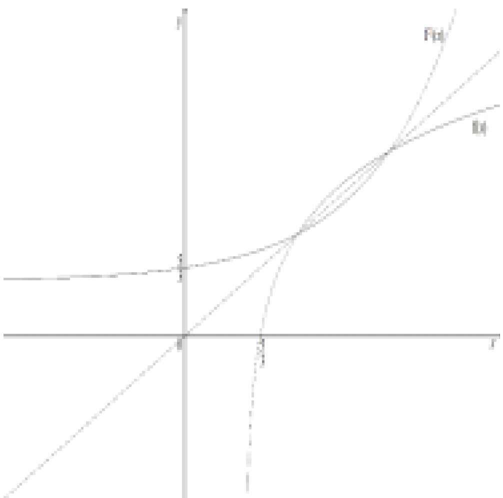
Question	Answer	Marks	Guidance
1	$a = 4$	**B1**	
	$b = \frac{3}{8}$ oe	**B1**	
	$c = -2$	**B1**	
2	$(x =)\ \frac{4 \pm \sqrt{16 + 12(2+\sqrt{5})(2-\sqrt{5})}}{2(2+\sqrt{5})}$ oe with simplification to $\frac{4 \pm \sqrt{16-k}}{2(2+\sqrt{5})}$	**M1**	For attempt to equate to zero and use quadratic formula, must see substitution and $\frac{4 \pm \sqrt{16-k}}{2(2+\sqrt{5})}$
	$\frac{4 \pm 2}{2(2+\sqrt{5})}$ or exact equivalent	**2**	**A1** for one exact solution
	$\frac{3}{2+\sqrt{5}} \times \frac{2-\sqrt{5}}{2-\sqrt{5}}$ or $\frac{1}{2+\sqrt{5}} \times \frac{2-\sqrt{5}}{2-\sqrt{5}}$	**M1**	For evidence of rationalisation and evaluation
	$-6 + 3\sqrt{5}$ and $-2 + \sqrt{5}$	**A1**	
	Alternative $\left((2+\sqrt{5})x - 3\right)\left(x + (2-\sqrt{5})\right)$	**(B2)**	
	$x = -2 + \sqrt{5}$	**(B1)**	**Dep** on previous **B2**
	$\frac{3}{2+\sqrt{5}} \times \frac{2-\sqrt{5}}{2-\sqrt{5}}$ leading to $x = -6 + 3\sqrt{5}$	**(2)**	**M1** for attempt at rationalisation and evaluation
3(a)	$\pm 3(x+2)(x-1)(x-4)$	**3**	**B1** for 3 soi **B1** for $\pm$ **B1** for $(x+2)(x-1)(x-4)$

Question	Answer	Marks	Guidance
3(b)	$5x-2*4x+1$ leading to critical value 3	**B1**	* can be ⩽, =, ⩾
	$5x-2*-4x-1$ oe	**M1**	* can be ⩽, =, ⩾
	leading to critical value $\frac{1}{9}$	**A1**	
	$\frac{1}{9}\leqslant x\leqslant 3$	**A1**	Mark final answer
	Alternative $9x^2-28x+3*0$	**(M1)**	Squaring both sides of the inequality and collecting terms, allow one sign error. * can be ⩽, =, ⩾
	$(9x-1)(x-3)*0$	**(M1)**	**Dep** for attempt to find two critical values * can be ⩽, =, ⩾
	Critical values $\frac{1}{9}$ and 3	**(A1)**	
	$\frac{1}{9}\leqslant x\leqslant 3$	**(A1)**	Mark final answer
4(a)	$r\theta=12$ soi	**B1**	
	$\frac{1}{2}r^2\theta=57.6$ soi	**B1**	
	$r=9.6$ oe nfww	**B1**	
	$\theta=1.25$ oe nfww	**B1**	
4(b)	$AC=28.89$	**B1**	
	Shaded area = $\left(\frac{1}{2}\times 28.89\times 9.6\right)-57.6$ soi	**M1**	Using *their AC*
	81.1	**A1**	
	Alternative $OC=30.45$	**(B1)**	
	Shaded area = $\left(\frac{1}{2}\times 30.45\times 9.6\times\sin 1.25\right)-57.6$ soi	**(M1)**	Using *their OC*
	81.1	**(A1)**	

Question	Answer	Marks	Guidance
5(a)	$6p^{\frac{2}{3}}-13p^{\frac{1}{3}}-5(=0)$ soi	**B1**	May introduce *their* own variable e.g. x
	$\left(\left(2p^{\frac{1}{3}}-5\right)\left(3p^{\frac{1}{3}}+1\right)=0 \text{ oe}\right)$ $p^{\frac{1}{3}}=\frac{5}{2}$ $p^{\frac{1}{3}}=-\frac{1}{3}$	**M1**	For attempt to solve quadratic equation to obtain $p^{\frac{1}{3}}=..$ or e.g. $x=\ldots$
	$\frac{125}{8}$ or 15.625 or $15\frac{5}{8}$	**A1**	Must be simplified and exact
	$-\frac{1}{27}$	**A1**	Must be simplified and exact
5(b)	$\lg(2x+5)^2$	**B1**	
	$\lg\frac{(2x+5)^2}{x+2}$	**B1**	**Dep** on first **B1**, must be a correct statement
	$1=\lg 10$ soi	**B1**	
	$\frac{(2x+5)^2}{(x+2)}=k$ oe	**M1**	Dep on second **B** mark For correct attempt to obtain a quadratic equation with no log terms, where k = 1 or 10
	$4x^2+10x+5=0$ $x=\frac{-5\pm\sqrt{5}}{4}$ or exact equivalent	**2**	**M1** for attempt to solve *their* quadratic to obtain $x=\ldots$, implied by decimals of -1.8 or -0.69 or better **A1** for both, **A0** if one is discarded
6(a)	A correct equation in terms of x and y only	**B1**	No inverse trig functions
	$y=(x-4)^2-3$ or $y=x^2-8x+13$	**B1**	
6(b)	$\sin\left(2\phi+\frac{3\pi}{4}\right)=\frac{\sqrt{3}}{2}$ soi	**B1**	May be implied by one correct solution
	$-\frac{5\pi}{24}, -\frac{\pi}{24}, \frac{19\pi}{24}, \frac{23\pi}{24}$ with no extra solutions within the range	**4**	**M1** for explicitly correct order of operations from *their* $\left(2\phi+\frac{3\pi}{4}\right)=k$, or may be implied by one correct solution **A1** for two correct solutions **A1** for a third correct solution **A1** for a further solution with no extra solutions in the range

Question	Answer	Marks	Guidance
7(a)	${}^{14}C_2 \times {}^{12}C_3 \times {}^{9}C_4$ oe, soi 2 522 520	3	**B1** for a product of 3 combinations (ignore combinations that are equal to 1), one of which must be in the form ${}^{14}C_k$ where $k = 2, 3, 4, 5, 9, 10, 11, 12$ **B2** for a correct product of combinations
7(b)(i)	136 080	**B1**	
7(b)(ii)	15 120	**B1**	
7(b)(iii)	38 640	3	**B1** for ${}^{8}P_4$ or 1680 or $(8 \times 7 \times 6 \times 5)$ **B2** for $8 \times {}^{8}P_4$ (13 440) oe or $15 \times {}^{8}P_4$ (25 200) oe
8(a)	$(a =)\ \frac{4}{3}$ or $1.\dot{3}$	**B1**	Allow a recurring decimal Must not be an inequality in terms of *a* Allow $x > \frac{4}{3}$
8(b)	$f \in \mathbb{R}$ or $-\infty < f < \infty$ or $\mathbb{R}$	**B1**	Allow *y* or $f(x)$ but not *x*.
8(c)		4	**B1** for a correct shape for $y = f(x)$ in quadrants 1 and 4 **B1** for $\left(\frac{5}{3}, 0\right)$, must have a correct shape in either quadrant 1 or quadrant 4 **B1** for $y = f^{-1}(x)$, must be a correct shape in quadrants 1 and 2 and intersect twice. **B1** for $\left(0, \frac{5}{3}\right)$, must have a reasonable shape for $y = f^{-1}(x)$ in either the first quadrant or the second quadrant
8(d)(i)	$g(g(x)) = 4x - 9$	**B1**	Must be simplified
8(d)(ii)	$fg(g(x)) = 2\ln(12x - 31)$	**M1**	allow unsimplified, using *their* answer to **(i)**
	$2\ln(12x - 31) = 4$ $x = \frac{e^2 + 31}{12}$	2	**Dep M1** for correct order of operations to solve *their* equation, to get as far as *x* = … Implied by decimal answer of awrt 3.2 **A1** Must be exact form.

Question	Answer	Marks	Guidance
9	$\frac{(2x+6)}{3}=3+\frac{4}{2x+1}$ $4x^2-4x-15(=0)$	2	**M1** for equating the line and curve and obtaining a 3 term quadratic expression in terms of *x*.
	$x=\frac{5}{2}$	A1	For *x*-coordinate of the point of intersection.
	Either $\int\left(3+\frac{4}{2x+1}\right)\mathrm{d}x=3x+2\ln(2x+1)$	2	**M1** for attempt to integrate with one term correct
	$\left[3x+2\ln(2x+1)\right]_0^{\frac{5}{2}}=\frac{15}{2}+2\ln 6$	2	**Dep M1** for using *their* *x*-coordinate of *C* in *their* integral. Must have a term in $\ln(2x+1)$ Allow for awrt 11.1. **A1** Must be exact but allow unsimplified
	Area of trapezium $\frac{1}{2}\left(2+\frac{11}{3}\right)\times\frac{5}{2}$ or $\left[\frac{x^2}{3}+2x\right]_0^{their\ \frac{5}{2}}$ or $\left[\frac{(2x+6)^2}{12}\right]_0^{their\ \frac{5}{2}}=\frac{85}{12}$	2	**M1** for attempt at the trapezium, must have at least one side correct. If using integration, the integral must be correct using *their* $\frac{5}{2}$
	Shaded area = $2\ln 6+\frac{5}{12}$ or $\ln 36+\frac{5}{12}$ or $\ln 6^2+\frac{5}{12}$	A1	
	Or $\int\left\|1+\frac{4}{2x+1}-\frac{2}{3}x\right\|\mathrm{d}x$ $x+2\ln(2x+1)-\frac{x^2}{3}$ or $-x-2\ln(2x+1)+\frac{x^2}{3}$	(5)	**M2** for attempt to subtract and integrate with at least one term correct, allow *x* terms considered separately. If subtraction is reversed allow accuracy marks. Separate *x* terms should be considered as one term for A marks. **A1** for one term only correct **A2** for two terms only correct
	$\left[x+2\ln(2x+1)-\frac{x^2}{3}\right]_0^{\frac{5}{2}}=\frac{5}{2}+2\ln 6-\frac{25}{12}$ or $\left[\frac{x^2}{3}-x-2\ln(2x+1)\right]_0^{\frac{5}{2}}=\frac{25}{12}-\frac{5}{2}-2\ln 6$	(M1)	**Dep M1** for using *their* *x*-coordinate of the point of intersection in *their* integral, must have a term in $\ln(2x+1)$ Allow for awrt ± 4 as appropriate

Question	Answer	Marks	Guidance
9	Shaded area = $2\ln 6+\frac{5}{12}$ or $\ln 36+\frac{5}{12}$ or $\ln 6^2+\frac{5}{12}$	(A1)	
	Or $\int\left\|3+\frac{4}{2x+1}-\frac{11}{3}\right\|\,\mathrm{d}x$ $2\ln(2x+1)-\frac{2x}{3}$	(3)	**M1** for attempt to subtract and integrate with at least one term correct, allow x terms considered separately. Separate x terms should be considered as one term for A marks. **A1** for one term only correct
	$\left[2\ln(2x+1)-\frac{2x}{3}\right]_0^{\frac{5}{2}}=2\ln 6-\frac{5}{3}$	(M1)	**Dep M1** for using *their* x-coordinate of the point of intersection in *their* integral, must have a term in $\ln(2x+1)$
	Area of triangle = $\frac{1}{2}\times\left(\frac{11}{3}-2\right)\times\frac{5}{2}$ $=\frac{25}{12}$	(2)	**M1** for attempt at the area of the triangle
	Shaded area = $2\ln 6+\frac{5}{12}$ or $\ln 36+\frac{5}{12}$ or $\ln 6^2+\frac{5}{12}$	(A1)	
	Alternative $3y^2-14y+11(=0)$	(2)	**M1** for a correct attempt to equate the line and curve and obtain a 3 term quadratic expression in terms of y.
	$y=\frac{11}{3}$	(A1)	
	$\int\left(\frac{2}{y-3}-\frac{1}{2}\right)\mathrm{d}y=2\ln(y-3)-\frac{1}{2}y$	(2)	**M1** for attempt to integrate with one term correct
	$\left[2\ln(y-3)-\frac{1}{2}y\right]_{\frac{11}{3}}^{7}=2\ln 6-\frac{5}{3}$	(2)	**Dep M1** for using *their* y-coordinate of C in *their* integral. Allow for awrt 1.92 **A1** Must be exact
	Area of triangle $\frac{1}{2}\left(\frac{11}{3}-2\right)\times\frac{5}{2}$ or $\left[\frac{3y^2}{4}-3y\right]_2^{their\ \frac{11}{3}}$ $=\frac{25}{12}$	(2)	**M1** for attempt at the triangle, must have at least one side correct. If using integration, the integral must be correct using *their* $\frac{11}{3}$
	Shaded area = $2\ln 6+\frac{5}{12}$ or $\ln 36+\frac{5}{12}$ or $\ln 6^2+\frac{5}{12}$	(A1)	

Question	Answer	Marks	Guidance
10(a)(i)	$\frac{n}{2}(2x+1)(3n-1)$	2	**B1** for $\frac{n}{2}(2(2x+1)+3(n-1)(2x+1))$ or $\frac{n}{2}(2(2x+1)+(6x+3)(n-1))$ oe
10(a)(ii)	$\frac{n}{2}(2x+1)(3n-1)=(54n+37)(2x+1)$ $3n^2-109n-74=0$	M1	For equating *their* answer to **(a)** to $(54n+37)(2x+1)$ and attempt to solve a 3-term quadratic equation in n to obtain $n = ...$
	37 only	A1	
10(a)(iii)	$1017.5=(54(\textit{their } n)+37)(2x+1)$	M1	For attempt to solve to obtain a value for x. n must be a positive integer
	$x=-\frac{1}{4}$	A1	
10(b)	$(2y+1)(3(2y+1))^{n-1}=$ $4(2y+1)(3(2y+1))^{n+1}$ Or $(3(2y+1))^{n-1}=4(3(2y+1))^{n+1}$ Or $(2y+1)r^{n-1}=4(2y+1)r^{n+1}$ Or $ar^{n-1}=4ar^{n+1}$	B1	Award when a correct statement is first seen
	Either $(2y+1)^2=\frac{1}{36}$ oe or $(6y+3)^2=\frac{1}{4}$ oe or $r^2=\frac{1}{4}$ oe	M1	**Either M1** for an equation of the form $(2y+1)^2=k$ or $(6y+3)^2=m$ where k and m are numerical and not zero (may be expanded) with no terms in n **Or M1** for $r^2=p$, where p is numerical and not zero
	$2y+1=\pm\frac{1}{6}$ or $6y+3=\pm\frac{1}{2}$	A1	
	$-\frac{5}{12}$, $-\frac{7}{12}$ and no others	A1	For both
10(c)	$-1<2\sin^2\theta<1$ oe soi or $0<2\sin^2\theta<1$ soi	B1	Allow $2\sin^2\theta<1$ May be implied by $\theta<\frac{\pi}{4}$
	$\theta<\frac{\pi}{4}$ or $\theta<0.785$	B1	
	$0<\theta<\frac{\pi}{4}$ Or $0<\theta<0.785$ or better	B1	