1 Attempt use of quotient rule to find derivative M1 allow for numerator 'wrong way round'; or attempt use of product rule

Obtain $\frac{2(3x-1)-3(2x+1)}{(3x-1)^2}$ A1 or equiv

Obtain $-\frac{5}{4}$ for gradient A1 or equiv

Attempt eqn of straight line with numerical gradient M1 obtained from their $\frac{dy}{dx}$; tangent not normal

Obtain $5x+4y-11=0$ A1 **5** or similar equiv

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2 (i) Attempt complete method for finding $\cot\theta$ M1 rt-angled triangle, identities, calculator, ...

Obtain $\frac{5}{12}$ A1 **2** or exact equiv

(ii) Attempt relevant identity for $\cos 2\theta$ M1 $\pm 2\cos^2\theta \pm 1$ or $\pm 1 \pm 2\sin^2\theta$ or $\pm(\cos^2\theta - \sin^2\theta)$

State correct identity with correct value(s) substituted A1

Obtain $-\frac{119}{169}$ A1 **3** correct answer only earns 3/3

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3 (a) Sketch reasonable attempt at $y=x^5$ *B1 accept non-zero gradient at O but curvature to be correct in first and third quadrants

Sketch straight line with negative gradient *B1 existing at least in (part of) first quadrant

Indicate in some way single point of intersection B1 **3** dep *B1 *B1

(b) Obtain correct first iterate B1 allow if not part of subsequent iteration

Carry out process to find at least 3 iterates in all M1

Obtain at least 1 correct iterate after the first A1 allow for recovery after error; showing at least 3 d.p. in iterates

Conclude 2.175 A1 **4** answer required to precisely 3 d.p

[0 → 2.21236 → 2.17412 → 2.17480 → 2.17479;
1 → 2.19540 → 2.17442 → 2.17480 → 2.17479;
2 → 2.17791 → 2.17473 → 2.17479 → 2.17479;
3 → 2.15983 → 2.17506 → 2.17479 → 2.17479]

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4 (i) Obtain derivative of form $k(4t+9)^{-\frac{1}{2}}$ M1 any constant k

Obtain correct $2(4t+9)^{-\frac{1}{2}}$ A1 or (unsimplified) equiv

Obtain derivative of form ke^{3t+1} M1 any constant k different from 6

Obtain correct $3e^{3t+1}$ A1 **4** or equiv

(ii) Either: Form product of two derivatives M1 numerical or algebraic

Substitute for t and x in product M1 using $t=4$ and calculated value of x

Obtain 39.7 A1 **3** allow ±0.1; allow greater accuracy

Or: Obtain $k(4t+9)^n e^{\frac{1}{2}(4t+9)^{\frac{1}{2}}+1}$ M1 differentiating $y=6e^{\frac{1}{2}(4t+9)^{\frac{1}{2}}+1}$

Obtain correct $6(4t+9)^{-\frac{1}{2}}e^{\frac{1}{2}(4t+9)^{\frac{1}{2}}+1}$ A1 or equiv

Substitute $t=4$ to obtain 39.7 A1 **(3)** allow ±0.1; allow greater accuracy

5 (i) Obtain $R=\sqrt{17}$ or 4.12 or 4.1 B1 or greater accuracy

Attempt recognisable process for finding α M1 allow for sin/cos confusion

Obtain $\alpha=14$ A1 **3** or greater accuracy 14.036...

(ii)	Attempt to find at least one value of $\theta + \alpha$	M1		
	Obtain or imply value 61	A1√		following R value; or value rounding to 61
	Obtain 46.9	A1		allow ±0.1; allow greater accuracy
	Show correct process for obtaining second angle	M1		
	Obtain −75	A1	5	allow ±0.1; allow greater accuracy; max of 4/5 if extra angles between −180 and 180

6 (i)	Obtain integral of form $k(3x+2)^{\frac{3}{2}}$	M1		any constant k
	Obtain correct $\frac{2}{3}(3x+2)^{\frac{3}{2}}$	A1		or equiv
	Substitute limits 0 and 2 and attempt evaluation	M1		for integral of form $k(3x+2)^n$
	Obtain $\frac{2}{3}(8^{\frac{3}{2}} - 2^{\frac{3}{2}})$	A1	4	or exact equiv suitably simplified
(ii)	State or imply $\pi\int\frac{1}{3x+2}\,dx$ or unsimplified version	B1		allow if dx absent or wrong
	Obtain integral of form $k\ln(3x+2)$	M1		any constant k involving π or not
	Obtain $\frac{1}{3}\pi\ln(3x+2)$ or $\frac{1}{3}\ln(3x+2)$	A1		
	Show correct use of $\ln a - \ln b$ property	M1		
	Obtain $\frac{1}{3}\pi\ln 4$	A1	5	or (similarly simplified) equiv

7 (i)	State a in x-direction	B1		or clear equiv
	State factor 2 in x-direction	B1	2	or clear equiv
(ii)	Show (largely) increasing function crossing x-axis	M1		with correct curvature
	Show curve in first and fourth quadrants only	A1	2	not touching y-axis and with no maximum point; ignore intercept
(iii)	Show attempt at reflecting negative part in x-axis	M1		
	Show (more or less) correct graph	A1√	2	following their graph in (ii) and showing correct curvatures
(iv)	Identify $2a$ as asymptote or $2a+2$ as intercept	B1		allow anywhere in question
	State $2a < x \leq 2a+2$	B1	2	allow < or ≤ for each inequality

8 (i)	Obtain $-2xe^{1-x^2}$ as derivative of e^{1-x^2}	B1		
	Attempt product rule	*M1		allow if sign errors or no chain rule
	Obtain $8x^7e^{1-x^2} - 2x^9e^{1-x^2}$	A1		or (unsimplified) equiv
	Either Equate first derivative to zero and attempt solution	M1		dep *M; taking at least one step of solution
	Confirm 2	A1	5	AG
	Or Substitute 2 into derivative and show attempt at evaluation M1			
	Obtain 0	A1	(5)	AG; necessary correct detail required

(ii) Attempt calculation involving attempts at y values — M1 with each of 1, 4, 2 present at least once as coefficients

Attempt $k(y_0 + 4y_1 + 2y_2 + 4y_3 + y_4)$ — M1 with attempts at five y values corresponding to correct x values

Obtain $\frac{1}{6}(0 + 4 \times 0.00304 + 2 \times 0.36788 + 4 \times 2.70127 + 4.68880)$ — A1 or equiv with at least 3 d.p. or exact values

Obtain 2.707 — A1 **4** or greater accuracy; allow ±0.001

(iii) Attempt 4(*y* value) − 2(part **(ii)**) — M1 or equiv

Obtain 13.3 — A1 **2** or greater accuracy; allow ±0.1

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9 (i) State $-2 \leq y \leq 2$ — B1 allow $<$; any notation

State $y \leq 4$ — B1 **2** allow $<$; any notation

(ii) Show correct process for composition — M1 right way round

Obtain or imply 0.959 and hence 2.16 — A1 AG; necessary detail required

Obtain $g(0.5) = 3.5$ — B1 or (unsimplified) equiv

Observe that 3.5 not in domain of f — B1 **4** or equiv

(iii) Relate quadratic expression to at least one end of range of f — M1 or equiv

Obtain both of $4 - 2x^2 < -2$ and $4 - 2x^2 > 2$ — A1 or equiv; allow any sign in each ($<$ or $\leq$ or $>$ or $\geq$ or $=$)

Obtain at least two of the x values $-\sqrt{3}, -1, 1, \sqrt{3}$ — A1

Obtain all four of the x values — A1

Attempt solution involving four x values — M1 to produce at least two sets of values

Obtain $x < -\sqrt{3}$, $-1 < x < 1$, $x > \sqrt{3}$ — A1 **6** allow $\leq$ instead of $<$ and/or $\geq$ instead of $>$