Question Number	Scheme	Marks
3 (i)	$\frac{\mathrm{d}}{\mathrm{d}x}\ln\left(\sin^2 3x\right)=\frac{1}{\sin^2 3x}\times 2\cancel{\sin 3x}\times 3\cos 3x=6\cot 3x$	M1 A1 **(2)**
(ii) (a)	$\frac{\mathrm{d}}{\mathrm{d}x}\left(3x^2-4\right)^6=36x\left(3x^2-4\right)^5$	M1 A1 **(2)**
(b)	$\int x\left(3x^2-4\right)^5\mathrm{d}x=\frac{1}{36}\left(3x^2-4\right)^6$	B1ft
	$\int_0^{\sqrt{2}} x\left(3x^2-4\right)^5\mathrm{d}x=\left[\frac{1}{36}\left(3x^2-4\right)^6\right]_0^{\sqrt{2}}=\frac{1}{36}(2)^6-\frac{1}{36}(-4)^6=-112$	M1 A1cso **(3)** **(7 marks)**

Notes

(i)

M1 Attempts to differentiate a ln function. Award for $\frac{\mathrm{d}}{\mathrm{d}x}\ln\left(\sin^2 3x\right)=\frac{1}{\sin^2 3x}\times\ldots$ where ... could be 1

An alternative could be $\frac{\mathrm{d}}{\mathrm{d}x}\ln\left(\sin^2 3x\right)=\frac{\mathrm{d}}{\mathrm{d}x}2\ln\left(\sin 3x\right)=(2\times)\frac{1}{\sin 3x}\times\ldots$ or

$\frac{\mathrm{d}}{\mathrm{d}x}\ln\left(\frac{1-\cos 6x}{2}\right)=\frac{2}{1-\cos 6x}\times\ldots$

A1 $6\cot 3x$ o.e. such as $\frac{6\cos 3x}{\sin 3x}$ or $\frac{6}{\tan 3x}$ or $6(\tan 3x)^{-1}$ but not $6\tan^{-1}3x$ Accept also $\frac{6\sin 6x}{1-\cos 6x}$ or $\frac{3\sin 6x}{\sin^2 3x}$ and isw after a suitably simplified answer.

Constant terms must be gathered and no uncancelled common factors in numerator and denominator.

(ii) (a)

M1 Achieves $\frac{\mathrm{d}}{\mathrm{d}x}\left(3x^2-4\right)^6=Ax\left(3x^2-4\right)^5$ where A is a constant which may be 1.

A1 $\frac{\mathrm{d}}{\mathrm{d}x}\left(3x^2-4\right)^6=36x\left(3x^2-4\right)^5$ oe. Need not be simplified. Isw after a correct answer.

(ii) (b)

B1ft $\int x\left(3x^2-4\right)^5\mathrm{d}x=\frac{1}{36}\left(3x^2-4\right)^6$ or $\frac{1}{A}\left(3x^2-4\right)^6$ following through on their (a) provided it is of the form $\frac{\mathrm{d}}{\mathrm{d}x}\left(3x^2-4\right)^6=Ax\left(3x^2-4\right)^5$ This may arise from attempts via substitution and can be scored from a restart if (ii)(a) was incorrect. Need not be simplified and isw if simplified incorrectly. Condone notation errors such as unneeded integral signs - mark the expression that is their attempt at the integration.

M1 Substitutes in both limits and subtracts (either way round) into an expression of the form $D\left(3x^2-4\right)^6$ where D is a constant but allow slips such as a missing power if the intention is clear.

Sight of the subtraction is sufficient. Implied by the correct answer for their integral if substitution not seen. If using integration by substitution they must be substituting the **correct** limits for their variable.

A1cso $(R=)\ -112$ and isw if they make the answer positive after a correct answer seen.
Note: Answer only with no working at all shown scores no marks. Correct integral must be seen.
Note: Attempts at integration by parts are unlikely to succeed, but if done correctly and achieve the correct form of the answer may score the relevant marks.

Note (ii) may be completed by expansion.
(a)

M1 Requires expansion to form $ax^{12}+bx^{10}+cx^{8}+dx^{6}+ex^{4}+fx^{2}+g$ followed by an attempt to integrate each term (power decreased by 1)

A1 Requires correct derivative. $8748x^{11}-58320x^{9}+155520x^{7}-207360x^{5}+138240x^{3}-36864x$

(b)

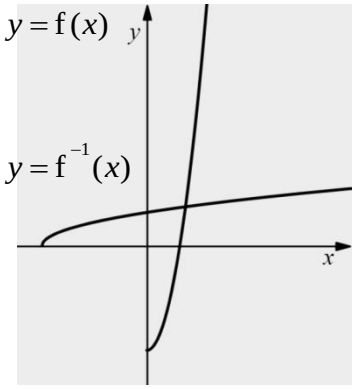
B1ft Correct answer from a restart, which may be via expansion

$$\frac{81x^{12}}{4}-162x^{10}+540x^{8}-960x^{6}+960x^{4}-512x^{2}$$

M1 Substitutes both limits and subtracts into an expression of the form

$$ax^{12}+bx^{10}+cx^{8}+dx^{6}+ex^{4}+fx^{2}$$

A1cso As main scheme.

Question Number	Scheme	Marks
4.(a)	$f \geqslant -5$	B1 **(1)**
(b)	 Curve starting on negative x-axis and passing through positive y-axis, in quadrants 1 and 2 only. Shape and position correct.	M1 A1 **(2)**
(c)	$2x^2 - 5 = x$ or $2x^2 - 5 = \sqrt{\frac{x+5}{2}}$ or $x = \sqrt{\frac{x+5}{2}}$ or $2\left(2x^2-5\right)^2 - 5 = x$	B1
	Full attempt to solve $2x^2 - x - 5 = 0 \Rightarrow x = ...$ exact	M1
	$x = \frac{1+\sqrt{41}}{4}$	A1
		(3) **6 marks**

Notes

(a) Mark the question as a whole - if (c) answered as (b) allow the marks.

B1 Correct range. Accept $y \geqslant -5$, $f(x) \geqslant -5$, $f \in [-5, \infty)$ or correct formal set notation but not just $x \geqslant -5$.

(b) Note: if a sketch is redrawn score for the sketch of the inverse only.

M1 For a curve starting on the negative x- axis and passing through the positive y - axis, in quadrants 1 and 2 only.

A1 Correct shape (curvature) and position. Must be increasing (not bending back on itself) with decreasing gradient, though be tolerant with pen slips at the end. Do not penalise incorrect intercepts.

(c)

B1 Sets up a correct equation for the solution, as shown in scheme or equivalents. Should be an equation but allow "=0" implied if there is an attempt to solve. Just $2x^2 - x - 5$ is B0 with no further working.

M1 Full attempt to solve a correct equation leading to exact answers.Attempts via $f(x) = f^{-1}(x)$ (oe) will lead a quartic $\left(8x^4 - 40x^2 - x + 45 = 0 \text{ if correct}\right)$ but will likely not lead to exact answers.
Note exact answers following a quadratic is fine, but method should be shown for a quartic.
Decimal answer only is M0.

A1 $x = \frac{1+\sqrt{41}}{4}$ ONLY.