Question Number	Scheme	Marks	AOs
12 (a)	$\left\{\frac{dy}{dx}=\right\}\ 3x^{-\frac{1}{2}}-x$	M1 A1	1.1b 1.1b
	Substitutes $x=4$ into $\frac{dy}{dx}=\frac{3}{2}-4=\ldots\left\{-\frac{5}{2}\right\}$	dM1	1.1b
	$y-\frac{53}{2}=\text{"}-\frac{5}{2}\text{"}(x-4)$	ddM1	2.1
	$5x+2y=73$ *	A1*	1.1b
		(5)	
(b)	$x=9\Rightarrow y=6\sqrt{9}-\frac{1}{2}\times 9^2+\frac{45}{2}=0$ ✓	B1	2.4
		(1)	
(c)	$\left\{\int\left(6\sqrt{x}-\frac{1}{2}x^2+\frac{45}{2}\right)dx=\right\}\ 4x^{\frac{3}{2}}-\frac{1}{6}x^3+\frac{45}{2}x\ \{+c\}$	M1 A1	1.1b 1.1b
	Correct method for area under line e.g. $5x+2(0)=73\Rightarrow x=\ldots\left(\frac{73}{5}\right)$ $\Rightarrow$ Area $=\frac{1}{2}\times\left(\text{"}\frac{73}{5}\text{"}-4\right)\times\frac{53}{2}\ \left\{=\frac{2809}{20}\right\}$	M1 (B1 on EPEN)	1.1b
	Shaded Area $=\ \frac{1}{2}\times\left(\text{"}\frac{73}{5}\text{"}-4\right)\times\frac{53}{2}-\left[4x^{\frac{3}{2}}-\frac{1}{6}x^3+\frac{45}{2}x\ \{+c\}\right]_4^9$ $=\frac{2809}{20}-\left(189-\frac{334}{3}\right)$	ddM1	3.1a
	$=\frac{3767}{60}$ (allow awrt 62.8)	A1	1.1b
		(5)	
		(11 marks)	

Notes:

(a) **Throughout the question, be generous on the labelling of parts.**

M1: Attempts to differentiate the curve achieving at least one correct index which may be unprocessed for this mark or allow $\frac{45}{2}\to 0$

A1: Correct differentiation of the curve which may be unsimplified but indices must be processed.

dM1: Substitutes $x=4$ into their $\frac{dy}{dx}$ and proceeds as far as a value.
Dependent on the previous method mark.

ddM1: Full and complete method to find an equation for l.
Dependent on both previous method marks. If using $y = mx + c$ they must proceed as far as $c = \ldots$

A1*: Proceeds to $5x+2y=73$ from correct working and no errors seen.

ISW after the given answer is achieved. Not scored for just e.g. $5x+2y-73=0$

If they set e.g. $\frac{dy}{dx}=0$ or 4 but then ignore this and complete the question correctly then do not withhold the A1*. Condone e.g. l = on the LHS provided they have $5x+2y=73$

(b)

B1: Substitutes $x=9$ into the equation for y leading to an answer of 0 with some minimal conclusion (a ✓ or "shown" is sufficient). Underlining = 0 is not a sufficient conclusion.

Note that they may rearrange the equation first, but they must substitute $x = 9$ in and show that it satisfies the equation. Solving the equation on a calculator is B0.

(c) **Note: There are many ways to find the area of region *R*. The two main ways are listed below, but the general approach is:**

M1: Attempt to integrate either the curve or (line – curve).

If there is no algebraic integration seen, then the maximum score is M0A0M1ddM0A0.

A1: Correct algebraic integration of either the curve or (line – curve).

M1: Correct method to find the area of the remaining section of region *R* using any appropriate combination of triangles and/or trapezia.

If there **is** an attempt to integrate the curve or (line – curve), then to score this mark the area found **must** be able to be combined with their integration to find the area of region *R*.

If there is **no** attempt to integrate the curve or (line – curve), then this can be scored provided the area found **could** be combined with some integration to find the area of region *R*.

ddM1: Full and complete method that without errors would find the correct area.

A1: For a correct answer.

Main scheme: Triangle – area under curve

M1: Attempts to integrate the curve achieving at least one correct index for one term which may be unprocessed. Condone multiplying by 2 before integrating.

A1: Correct integration of the curve (may be unsimplified but the indices must be processed now).

M1: Correct method to find the area under the line between 4 and their attempt at $x=\frac{73}{5}$ $\{=14.6\}$

which may be implied by sight of $\frac{2809}{20}$ $\{=140.45\}$

Requires:

- setting y = 0 in the given equation for l (or their previous equation) and proceeding to $x = \ldots$
- either a **correct** attempt at the triangle using $\left(4, \frac{53}{2}\right)$ and their x **or** an attempt to integrate the equation of the line (with y the subject) between 4 and their x. Look for

  $$\frac{1}{2}\times\left(\text{"}\frac{73}{5}\text{"}-4\right)\times\frac{53}{2}=\ldots \quad \textbf{or} \quad \int_4^{\text{"}\frac{73}{5}\text{"}}\left(\text{"}\frac{73}{2}-\frac{5}{2}x\text{"}\right)\,dx=\left[\frac{73}{2}x-\frac{5}{4}x^2\,\{+c\}\right]_4^{\text{"}\frac{73}{5}\text{"}}=\ldots$$

  condoning slips in rearranging or in coefficients when integrating.

Condone attempts that find the area under the triangle using calculator integration, so if they have $\frac{2809}{20}$ they score this M1.

ddM1: Full and complete method of finding the area of region *R* (with correct limits) using triangle – area under curve.

If they substitute their limits in the wrong way round at any stage, then allow recovery if they make the area positive.

Dependent on both previous method marks.

A1: $\frac{3767}{60}$ but allow awrt 62.8 following award of all previous marks.

Alt: **Triangle + area under line – curve**

M1: Attempts to integrate ±(line – curve) achieving a correct index for one term which may be unprocessed. Condone multiplying by 2 before integrating.

A1: Correct integration of ±(line – curve) (may be unsimplified but the indices must be processed).

$$\left\{\int \left(\frac{73}{2}-\frac{5}{2}x-\left(6\sqrt{x}-\frac{1}{2}x^2+\frac{45}{2}\right)\right)\,\mathrm{d}x=\right\}\ \frac{73}{2}x-\frac{5}{4}x^2-4x^{\frac{3}{2}}+\frac{1}{6}x^3-\frac{45}{2}x\ \ \{+c\}$$

M1: Correct method to find the area under the line between 9 and their attempt at $x=\frac{73}{5}$ which may be implied by sight of $\frac{196}{5}$ $\{=39.2\}$

Requires:

- setting $y = 0$ in the given equation for l (or their previous equation) and proceeding to $x = \ldots$
- either a **correct** attempt at the triangle using their x and (9, "14") (coming from substituting $x = 9$ into l) **or** an attempt to integrate the equation of the line (with y the subject) between 9 and their x.

  Look for $\frac{1}{2}\times\left(\text{"}\frac{73}{5}\text{"}-9\right)\times\text{"}14\text{"}=\ldots$

  or $\int_9^{\text{"}\frac{73}{5}\text{"}}\left(\text{"}\frac{73}{2}-\frac{5}{2}x\text{"}\right)\,\mathrm{d}x=\left[\frac{73}{2}x-\frac{5}{4}x^2\ \{+c\}\right]_9^{\text{"}\frac{73}{5}\text{"}}=\ldots$

  condoning slips in rearranging or in coefficients when integrating.

Condone attempts that find the area under the triangle using calculator integration, so if they have $\frac{196}{5}$ they score this M1.

ddM1: Full and complete method of finding the area of region R (with correct limits) using triangle + area between line and curve.

If they substitute their limits in the wrong way round at any stage, then allow recovery if they make the area positive.

Dependent on both previous method marks.

A1: $\frac{3767}{60}$ but allow awrt 62.8 following award of all previous marks.