Question	Scheme	Marks	AOs
10(a)	$y=\frac{1}{3}x^2-2\sqrt{x}+3 \Rightarrow \frac{\mathrm{d}y}{\mathrm{d}x}=\frac{2}{3}x-x^{-\frac{1}{2}}$	M1 A1	1.1b 1.1b
	$x=4 \Rightarrow y=\frac{13}{3}$	B1	1.1b
	$\left(\frac{\mathrm{d}y}{\mathrm{d}x}\right)_{x=4}=\frac{2}{3}\times 4-4^{-\frac{1}{2}}\left(=\frac{13}{6}\right) \quad \therefore y-\frac{13}{3}=\frac{13}{6}(x-4)$	M1	2.1
	$13x-6y-26=0*$	A1*	1.1b
		(5)	
(b)	$\int\left(\frac{x^2}{3}-2\sqrt{x}+3\right)\mathrm{d}x=\frac{x^3}{9}-\frac{4}{3}x^{\frac{3}{2}}+3x(+c)$	M1 A1	1.1b 1.1b
	$y=0 \Rightarrow x=2$	B1	2.2a
	Area of R is $\left[\frac{x^3}{9}-\frac{4}{3}x^{\frac{3}{2}}+3x\right]_0^4-\frac{1}{2}\times(4-\text{"}2\text{"})\times\text{"}\frac{13}{3}\text{"}=\frac{76}{9}-\frac{13}{3}$	M1	3.1a
	$=\frac{37}{9}$	A1	1.1b
		(5)	
			(10 marks)

Notes

(a) **Calculators: If no algebraic differentiation seen then maximum in a) is M0A0B1M1A0***

M1: $x^n \to x^{n-1}$ seen at least once $...x^2 \to ...x^1$, $...x^{\frac{1}{2}} \to ...x^{-\frac{1}{2}}$, $3 \to 0$.

Also accept on sight of eg $...x^{\frac{1}{2}} \to ...x^{\frac{1}{2}-1}$

A1: $\frac{2}{3}x-x^{-\frac{1}{2}}$ or any unsimplified equivalent (indices must be processed) accept the use of $0.\dot{6}x$ but not rounded or ambiguous values eg $0.6x$ or eg $0.66\ldots x$

B1: Correct y coordinate of P. May be seen embedded in an attempt of the equation of l

M1: Fully correct strategy for an equation for l. Look for $y-\text{"}\frac{13}{3}\text{"}=\text{"}\frac{13}{6}\text{"}(x-4)$ where their $\frac{13}{6}$ is from differentiating the equation of the curve and substituting in $x=4$ into their $\frac{\mathrm{d}y}{\mathrm{d}x}$ and the y coordinate is from substituting $x=4$ into the given equation.
If they use $y=mx+c$ they must proceed as far as $c=...$ to score this mark.
Do not allow this mark if they use a perpendicular gradient.

A1*: Obtains the printed answer with no errors.

(b) **Calculators: If no algebraic integration seen then maximum in b) is M0A0B1M1A0**

M1: $x^n \to x^{n+1}$ seen at least once. Eg $...x^2 \to ...x^3$, $...x^{\frac{1}{2}} \to ...x^{\frac{3}{2}}$, $3 \to 3x^1$. Allow eg $...x^2 \to ...x^{2+1}$ The $+c$ is not a valid term for this mark.

A1: $\quad \frac{x^3}{9} - \frac{4}{3}x^{\frac{3}{2}} + 3x$ or any unsimplified equivalent (indices must be processed) accept the use of exact decimals for $\frac{1}{9}$ $(0.\dot{1})$ and $-\frac{4}{3}$ $(-1.\dot{3})$ but not rounded or ambiguous values.

B1: Deduces the correct value for x for the intersection of l with the x-axis. May be seen indicated on Figure 2.

M1: Fully correct strategy for the area. This needs to include

- a correct attempt at the area of the triangle using their values (**could use integration**)
- a correct attempt at the area under the curve using 0 and 4 in their integrated expression
- the two values subtracted.

Be aware of those who mix up using the y-coordinate of P and the gradient at P which is M0. The values embedded in an expression is sufficient to score this mark.

A1: $\quad \frac{37}{9}$ or exact equivalent eg $4\frac{1}{9}$ or $4.\dot{1}$ but not $4.111\ldots$. isw after a correct answer

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Be aware of other strategies to find the area *R*

eg Finding the area under the curve between 0 and 2 and then the difference between the curve and the straight line between 2 and 4:

$$\int_0^2 \frac{x^2}{3} - 2\sqrt{x} + 3 \; dx + \int_2^4 \frac{x^2}{3} - 2\sqrt{x} - \frac{13}{6}x + \frac{22}{3} \; dx$$

M1 $\quad x^n \to x^{n+1}$ seen at least once on either integral (or on the equation of the line $y = \frac{1}{3}x + 3$)

A1 $\quad$ for correct integration of **either** integral $\frac{x^3}{9} - \frac{4}{3}x^{\frac{3}{2}} + 3x$ or $\frac{x^3}{9} - \frac{4}{3}x^{\frac{3}{2}} - \frac{13}{12}x^2 + \frac{22}{3}x$ (may be unsimplified/uncollected terms but the indices must be processed with/without the $+C$)

B1 $\quad$ Correct value for x can be seen from the top of the first integral (or bottom value of the second integral)

M1 $\quad$ Correct strategy for the area eg.

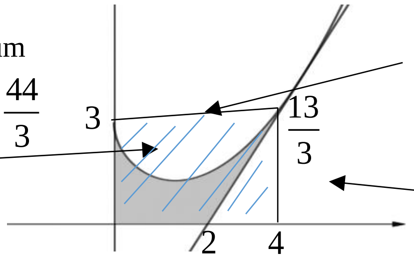
$$\left[\frac{x^3}{9} - \frac{4}{3}x^{\frac{3}{2}} + 3x\right]_0^2 + \left[\frac{x^3}{9} - \frac{4}{3}x^{\frac{3}{2}} - \frac{13}{12}x^2 + \frac{22}{3}x\right]_2^4 = \frac{62}{9} - \frac{4}{3}(2)^{\frac{3}{2}} + \frac{76}{9} - \frac{101}{9} + \frac{4}{3}(2)^{\frac{3}{2}}$$

A1: $\quad \frac{37}{9}$ or exact equivalent eg $4\frac{1}{9}$ or $4.\dot{1}$ but not 4.1 or $4.111\ldots$.

You could also see use of the area of a trapezium and/or the use of the line $y = \frac{1}{3}x + 3$ to find other areas which could be combined or used as part of the strategy to find *R*. Ignore areas which are not used. The marks should still be able to be applied as per the scheme

Area of large trapezium

$= \frac{1}{2} \times \left(3 + \frac{13}{3}\right) \times 4 = \frac{44}{3}$



$y = \frac{1}{3}x + 3$

Area of triangle and the y coordinate of point P are both $\frac{13}{3}$

Give BOD if in doubt of intention

Area of trapezium – (Area between $y = \frac{1}{3}x + 3$ and curve C + area of triangle)

$$= \frac{44}{3} - \frac{56}{9} - \frac{13}{3} = \frac{37}{9}$$