Question	Scheme	Marks	AOs
15.	For the complete strategy of finding where the normal cuts the x-axis. Key points that must be seen are • Attempt at differentiation	M1	3.1a

	• Attempt at using a changed gradient to find equation of normal • Correct attempt to find where normal cuts the x - axis		
	$y=\frac{32}{x^2}+3x-8 \Rightarrow \frac{dy}{dx}=-\frac{64}{x^3}+3$	M1 A1	1.1b 1.1b
	For a correct method of attempting to find Either the equation of the normal: this requires substituting $x=4$ in their $\frac{dy}{dx}=-\frac{64}{x^3}+3=(2)$, then using the perpendicular gradient rule to find the equation of normal $y-6="-\frac{1}{2}"(x-4)$ Or where the equation of the normal at (4,6) cuts the x - axis. As above but may not see equation of normal. Eg $0-6="-\frac{1}{2}"(x-4) \Rightarrow x=...$ or an attempt using just gradients $"-\frac{1}{2}"=\frac{6}{a-4} \Rightarrow a=...$	dM1	2.1
	Normal cuts the x-axis at $x=16$	A1	1.1b
	For the complete strategy of finding the values of the two key areas. Points that must be seen are • There must be an attempt to find the area under the curve by integrating between 2 and 4 • There must be an attempt to find the area of a triangle using $\frac{1}{2}\times('16'-4)\times 6$ or $\int_4^{"16"} "\left(-\frac{1}{2}x+8\right)" dx$	M1	3.1a
	$\int \frac{32}{x^2}+3x-8 \, dx=-\frac{32}{x}+\frac{3}{2}x^2-8x$	M1 A1	1.1b 1.1b
	Area under curve = $=\left[-\frac{32}{x}+\frac{3}{2}x^2-8x\right]_2^4=(-16)-(-26)=(10)$	dM1	1.1b
	Total area =10 + 36 =46 *	A1*	2.1
		(10)	

(10 marks)

(a)
The first 5 marks are for finding the normal to the curve cuts the x - axis
M1: For the complete strategy of finding where the normal cuts the x- axis. See scheme
M1: Differentiates with at least one index reduced by one
A1: $\frac{dy}{dx}=-\frac{64}{x^3}+3$
dM1: Method of finding
either the equation of the normal at (4, 6) .
or where the equation of the normal at (4, 6) cuts the x - axis
See scheme. It is dependent upon having gained the M mark for differentiation.

A1: Normal cuts the x-axis at $x = 16$

The next 5 marks are for finding the area *R*

M1: For the complete strategy of finding the values of two key areas. See scheme

M1: Integrates $\int \frac{32}{x^2} + 3x - 8 \, dx$ raising the power of at least one index

A1: $\int \frac{32}{x^2} + 3x - 8 \, dx = -\frac{32}{x} + \frac{3}{2}x^2 - 8x$ which may be unsimplified

dM1: Area $= \left[-\frac{32}{x} + \frac{3}{2}x^2 - 8x \right]_2^4 = (-16) - (-26) = (10)$

It is dependent upon having scored the M mark for integration, for substituting in both 4 and 2 and subtracting either way around. The above line shows the minimum allowed working for a correct answer.

A1*: Shows that the area under curve = 46. No errors or omissions are allowed

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A number of candidates are equating the line and the curve (or subtracting the line from the curve)
The last 5 marks are scored as follows.

M1: For the complete strategy of finding the values of the two key areas. Points that must be seen are

- There must be an attempt to find the area BETWEEN the line and the curve either way around by integrating between 2 and 4
- There must be an attempt to find the area of a triangle using $\frac{1}{2} \times ('16' - 2) \times \left(-\frac{1}{2} \times 2 + 8 \right)$ or via integration $\int_2^{16} \left("-\frac{1}{2}x + 8" \right) dx$

M1: Integrates $\int \left("-\frac{1}{2}x + 8" \right) - \left(\frac{32}{x^2} + 3x - 8 \right) dx$ either way around and raises the power of at least one index by one

A1: $\pm\left(-\frac{32}{x} + \frac{7}{4}x^2 - 16x \right)$ must be correct

dM1: Area = $\int_2^4 \left("-\frac{1}{2}x + 8" \right) - \left(\frac{32}{x^2} + 3x - 8 \right) dx =$ ......either way around

A1: Area = $49 - 3 = 46$

NB: Watch for candidates who calculate the area under the curve between 2 and 4 = 10 and subtract this from the large triangle = 56. They will lose both the strategy mark and the answer mark.