Question Number	Scheme	Marks
7 (a)	$\left(\frac{dy}{dx}\right) = 2x^2 - 16x + 43$	M1, A1
	$= 2x^2 - 16x + 43 \equiv 2\left(x^2 - 8x\right) + ... \equiv 2(x-4)^2 ...$	B1ft, dM1
	$\equiv 2(x-4)^2 + 11$	A1
		(5)
(b)(i)	States minimum value of $\frac{dy}{dx}$ is 11.	B1 ft
(ii)	States that the x coordinate is 4	B1 ft
		(2)
(c)	Attempts $\frac{2}{3}\times"4"^3 - 8\times"4"^2 + 43\times"4" - \frac{20}{3}\left(=80\right)$	M1
	Attempts equation of tangent $y - 80 = 11(x-4)$	dM1
	$y = 11x + 36$	A1
		(3)
		(10 marks)

(a)

M1: Reduces the index on any term including $\frac{20}{3} \to 0$. The index must be processed for this award

A1: $\left(\frac{dy}{dx}\right) = 2x^2 - 16x + 43$ or exact equivalent. There should not be any extra terms such as + c

B1ft: Takes out a correct factor of '2' from their $'2'x^2 - 16x + 43$

This will be implied by the correct value of p for their $2x^2 - 16x + 43$

dM1: Achieves a correct value for q for their $2x^2 - 16x + 43$. Look for $"\frac{-16}{2p}"$

It is dependent upon having differentiated (i.e scoring the first M1)

A1: CAO $2(x-4)^2 + 11$

(b) The question states hence so ideally, answers in (b) should follow their part (a).
A method must be seen so don't allow answers in (b) following no working in (a).

Condone solutions in (b) arising from the second derivative. E.g. $\frac{d^2y}{dx^2} = 4x - 16 = 0 \Rightarrow x = 4$

(b)(i) Do not award marks in (b) for just writing down (4, 11)

B1ft: States 11 but follow through on their r from part (a) as long as $\frac{dy}{dx} = p(x+q)^2 + r$

Also allow candidates to substitute $x =$ 4 in $\frac{dy}{dx}$ to reach 11. Ignore incorrect labelling such as y = 11

(b)(ii)

B1ft: States that the x coordinate is 4 but follow through on their $-q$ from part (a)

(c)

M1: Attempts to find the y coordinate of C using their $x = "4"$.

dM1: Correct attempt at equation of tangent using their 11 and a correctly found y coordinate

It is dependent upon the previous M1

A1: $y = 11x + 36$

Question Number	Scheme	Marks
	$f'(x) = 4x^2 + \frac{6}{x^2} - 4$	
8 (a)(i)	Substitutes $x = \sqrt{3}$ in $f'(x) = 4\times 3 + \frac{6}{3} - 4$	M1
	$= 10$ which is the same as the gradient of the tangent *	A1*
(a)(ii)	$4x^2 + \frac{6}{x^2} - 4 = 10 \Rightarrow 2x^4 - 7x^2 + 3 = 0$	M1, A1
	$\Rightarrow \left(2x^2 - 1\right)\left(x^2 - 3\right) = 0 \Rightarrow x^2 = \frac{1}{2} \Rightarrow x = \frac{\sqrt{2}}{2}$	dM1, A1
		(6)
(b)	States/implies that gradient of normal at P is $-\frac{1}{10}$ or y coordinate is $4\sqrt{3}$	M1
	Equation is $y - 4\sqrt{3} = -\frac{1}{10}\left(x - \sqrt{3}\right)$	A1
		(2)
(c)	$f'(x) = 4x^2 + \frac{6}{x^2} - 4 \Rightarrow \quad f(x) = \frac{4}{3}x^3 - \frac{6}{x} - 4x + c$	M1, A1
	Uses $\left(\sqrt{3}, 4\sqrt{3}\right) \Rightarrow 4\sqrt{3} = \frac{4}{3}\times 3\sqrt{3} - \frac{6}{\sqrt{3}} - 4\times\sqrt{3} + c \Rightarrow c = ...$	dM1
	$f(x) = \frac{4}{3}x^3 - \frac{6}{x} - 4x + 6\sqrt{3}$	A1
		(4)
		(12 marks)

(a)(i)

M1: Substitutes $x = \sqrt{3}$ in $f'(x)$. There must be evidence of this so award for sight of

$f'(x) = 4\times 3 + \frac{6}{3} - 4$, $f'(x) = 4\times\left(\sqrt{3}\right)^2 + \frac{6}{\left(\sqrt{3}\right)^2} - 4$ or $f'(x) = 12 + 2 - 4$

A1*: Achieves $f'(\sqrt{3}) = 10$ and alludes to the fact that this is equal to the gradient of the tangent. Condone a minimal response here.

……

Note that it is possible to combine both parts of (a) even if it is labelled (i) and find the two possible coordinates of P.

If this is attempted $x = \sqrt{3}$ could be substituted into any of the following equations

$$4x^2 + \frac{6}{x^2} - 4 = 10 \Rightarrow 4x^2 + \frac{6}{x^2} - 14 = 0 \Rightarrow 4x^4 - 14x^2 + 6 = 0 \Rightarrow 2x^4 - 7x^2 + 3 = 0$$

It is also possible to prove that $x = \sqrt{3}$ by solving $2x^4 - 7x^2 + 3 = 0$ via $\left(2x^2 - 1\right)\left(x^2 - 3\right) = 0$

The M1 is scored when they attempt to solve their quartic using a non- calculator method and the A1 when they solve correctly and proceed to $x = \sqrt{3}$