Question Number	Scheme	Marks
9 (a)	$y=\frac{2}{3}x^{2}-9\sqrt{x}+13$ $\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{4}{3}x-\frac{9}{2\sqrt{x}}$ Attempts to solve $\frac{\mathrm{d}y}{\mathrm{d}x}>0\Rightarrow x^{\frac{3}{2}}>\frac{27}{8}\Rightarrow x>\frac{9}{4}$	M1, A1 dM1, A1 **(4)**
(b)	$\int\frac{2}{3}x^{2}-9\sqrt{x}+13\,\mathrm{d}x=\frac{2}{9}x^{3}-6x^{\frac{3}{2}}+13x\quad(+c)$ Area $=\left[\frac{2}{9}x^{3}-6x^{\frac{3}{2}}+13x\right]_{0}^{9}=117$ Substitutes $x=9$ into $\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{4}{3}x-\frac{9}{2\sqrt{x}}\Rightarrow\frac{\mathrm{d}y}{\mathrm{d}x}=\left(\frac{21}{2}\right)$ Finds where tangent meets x-axis $0-40=\frac{21}{2}(x-9)\Rightarrow x=\frac{109}{21}$ Area of $R=\left[\frac{2}{9}x^{3}-6x^{\frac{3}{2}}+13x\right]_{0}^{9}-\frac{1}{2}\times40\times\left(9-\frac{109}{21}\right)$ $=117-\frac{1600}{21}=\frac{857}{21}$	M1 dM1, A1 M1 dM1 A1 ddM1 A1 **(8)** **(12 marks)**

There are no marks for integrating in part (a) or differentiating in (b). This is a problem-solving question and candidates should be awarded these marks only for work in the correct part.

(a)

M1: Attempts $\frac{\mathrm{d}y}{\mathrm{d}x}$ with one index correct. Allow for $x^{2}\rightarrow x^{1}$ or $\sqrt{x}\rightarrow x^{-\frac{1}{2}}$

A1: $\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{4}{3}x-\frac{9}{2\sqrt{x}}$ o.e which may be left un simplified. The LHS is not required

dM1: Attempts to find where $\frac{\mathrm{d}y}{\mathrm{d}x}>0$ and proceeds to $x^{\frac{3}{2}}>k$ or $x^{3}>k$ following correct squaring

Also allow $\frac{\mathrm{d}y}{\mathrm{d}x}\geqslant 0$ and proceeds to $x^{\frac{3}{2}}\geqslant k$ but also condone $\frac{\mathrm{d}y}{\mathrm{d}x}=0$ leading to $x^{\frac{3}{2}}=k$

If a candidate has a correct derivative, then condone $\frac{4}{3}x-\frac{9}{2\sqrt{x}}...0\Rightarrow x...\frac{9}{4}$ where ... is =, > or $\geqslant$

A1: States $x>\frac{9}{4}$ or $x\geqslant\frac{9}{4}$ o.e. following the award of both M's. Do not accept other ranges such as $x<0$

(b)

M1: Attempts to integrate $\frac{2}{3}x^{2}-9\sqrt{x}+13$ scored for increasing a correct index by 1 which could include $13\rightarrow 13x$

dM1: Uses limits of 9 (and 0) either way around and finds area under curve between 0 and 9.
It is dependent upon the previous M mark. Award when values are embedded

A1: Achieves 117 as the area under the curve between 0 and 9.
Be careful when awarding this mark as sight of 117 does not necessarily merit this award
You must see M1 and dM1 and have correct integration. Allow for $\left[\frac{2}{9}x^{3}-6x^{\frac{3}{2}}+13x\right]_{0}^{9}=117$
The use of a calculator to integrate is not allowed

M1: Attempts the gradient of the tangent.
Substitutes $x=9$ into their $\frac{\mathrm{d}y}{\mathrm{d}x}$ (from part a or restarted) which must have one index correct.
A correct value (or follow through value) can imply this method only if there is a $\frac{\mathrm{d}y}{\mathrm{d}x}$. It cannot be awarded if there is not a calculation for $\frac{\mathrm{d}y}{\mathrm{d}x}$ in the question

dM1: Correct method of finding where tangent meets the *x*-axis. Dependent upon previous M
For this to be awarded you must see all elements or their equivalent. E.g.

- Substitution of $x=9$ into their $\frac{\mathrm{d}y}{\mathrm{d}x}$ (from part a or restarted) which must have one index correct
- use of (9, 40) with their $\frac{\mathrm{d}y}{\mathrm{d}x}$ to form the equation of the tangent at *P*
- substitution of $y=0$ into their correctly found tangent to find where tangent crosses *x*-axis

A1: Correct value $x=\frac{109}{21}$

ddM1: Complete method of finding the area of *R*. This is dependent upon all previous M's
It is usually scored for the area under the curve between 0 and 9 − the area of the triangle.
The area of the triangle may be attempted by integration. Look for a correct attempt at the method for the equation of a tangent, integrated to a form $\alpha x^{2}+\beta x$ with limits of the *x* intercept of their tangent and 9

A1: Area *R* = $\frac{857}{21}$

.....

Note that there are other ways in which the area could be attempted. Look carefully at their attempt please.

ALT I: (Area under curve between 0 and *x* intercept) +(Area between curve and line between *x* intercept and 9)

E.g. $\int_0^{\frac{109}{21}} \frac{2}{3}x^2 - 9\sqrt{x} + 13 \, \mathrm{d}x + \int_{\frac{109}{21}}^{9} \left(\frac{2}{3}x^2 - 9\sqrt{x} + 13\right) - \left(\frac{21}{2}x - \frac{109}{2}\right) \mathrm{d}x$

M1: As the main method. Attempts to integrate $\frac{2}{3}x^2 - 9\sqrt{x} + 13$, scored for increasing a correct index by 1

dM1: As main method with same dependency. In this case it would be for applying the limits 0 to *k* and *k* to 9 to the integrated $\frac{2}{3}x^2 - 9\sqrt{x} + 13$

A1: Implied by correct final answer

M1, dM1, A1: As main method

ddM1: $\int_0^{"\frac{109}{21}"} \frac{2}{3}x^2 - 9\sqrt{x} + 13 \, \mathrm{d}x + \int_{"\frac{109}{21}"}^{9} \left(\frac{2}{3}x^2 - 9\sqrt{x} + 13\right) - "\left(\frac{21}{2}x - \frac{109}{2}\right)" \mathrm{d}x$

Complete method of finding the area of *R*. This is dependent upon all previous M's. See main scheme for general principles for awarding this mark.

A1: Area *R* = $\frac{857}{21}$

ALT II: (Area between curve and line between 0 and 9) - (Area of triangle under axis)

E.g. $\int_0^{9} \left(\frac{2}{3}x^2 - 9\sqrt{x} + 13\right) - \left(\frac{21}{2}x - \frac{109}{2}\right) \mathrm{d}x - \frac{1}{2} \times \frac{109}{2} \times \frac{109}{21}$

M1: As the main method. Attempts to integrate $\frac{2}{3}x^2 - 9\sqrt{x} + 13$, scored for increasing a correct index by 1

dM1: As main method with same dependency. Look for applying the limits 0 and 9 to the integrated $\frac{2}{3}x^2 - 9\sqrt{x} + 13$

A1: Area between curve and line, between 0 and 9, is $\frac{729}{4}$

M1, dM1, A1: As main method

ddM1: $\int_0^{9} \left(\frac{2}{3}x^2 - 9\sqrt{x} + 13\right) - "\left(\frac{21}{2}x - \frac{109}{2}\right)" \mathrm{d}x - \frac{1}{2} \times "\frac{109}{2}" \times "\frac{109}{21}"$

Complete method of finding the area of *R*. This is dependent upon all previous M's. See main scheme for general principles for awarding this mark.

A1: Area *R* = $\frac{857}{21}$

Question Number	Scheme	Marks
10.(i)(a)	$(3+2x)^6$	
	Any correct form for any term of ${}^6C_1 3^5 (2x)^1$ or ${}^6C_2 3^4 (2x)^2$ or ${}^6C_4 3^2 (2x)^4$	M1
	Any two correct: t(2) = $6\times 3^5\times(2x)^1$, t(3) =$15\times 3^4\times(2x)^2$ t(5) = $15\times 3^2\times(2x)^4$	A1
	All 3 terms correct 2nd term = 2916x, 3rd term= 4860x^2 , 5th term=2160x^4	A1 **(3)**
(b)	Method using consecutive terms of a GP e.g $\dfrac{2160x^4}{4860x^2}=\dfrac{4860x^2}{2916x}$	M1
	$\Rightarrow ...x=...$	dM1
	$\Rightarrow x=\dfrac{15}{4}$	A1 **(3)**
(ii) (a)	Attempts to use $S_\infty=\dfrac{a}{1-r}\Rightarrow\dfrac{8}{5}=\dfrac{\sin^2\theta}{1-2\cos\theta}$	M1
	$\Rightarrow\dfrac{8}{5}=\dfrac{1-\cos^2\theta}{1-2\cos\theta}$	dM1
	$\Rightarrow 8-16\cos\theta=5-5\cos^2\theta$	
	$\Rightarrow 5\cos^2\theta-16\cos\theta+3=0$	A1* **(3)**
(b)	Solves $5\cos^2\theta-16\cos\theta+3=0\Rightarrow\cos\theta=\dfrac{1}{5}$	B1
	Attempts $ar=\sin^2\theta\times 2\cos\theta=\left(1-\left(\dfrac{1}{5}\right)^2\right)\times 2\times\dfrac{1}{5}$	M1
	$=\dfrac{48}{125}$	A1 **(3)** **(12 marks)**

(i) (a)

M1: For an attempt at using the binomial expansion to find **one** of the required terms.
Condone the omission of the brackets on the 2x terms. Allow using combination notation.
Don't be concerned over any labelling (2nd term). May be awarded from a full expansion

A1: Any **two** correct terms, simplified or not. The ${}^6C_2$ must now be numerical.
Don't be concerned by labelling and accept as part of a large list or expansion

A1: All three terms correct and simplified.
They may be part of a larger or complete expansion, which is fine. Look for the 2nd , 3rd and 5th terms
Accept the 3 terms with +'s between. So accept for example $2916x+4860x^2+2160x^4$

Note that the expansion can be done by $(3+2x)^6=3^6\left(1+\dfrac{2}{3}x\right)^6$ The unsimplified versions of the terms are:

t (2) = $3^6\times 6\left(\dfrac{2}{3}x\right)$ t(3) = $3^6\times\dfrac{6\times 5}{2}\left(\dfrac{2}{3}x\right)^2$ and t(5) = $3^6\times\dfrac{6\times5\times4\times3}{4\times3\times2\times1}\left(\dfrac{2}{3}x\right)^4$