Questions

Q1.

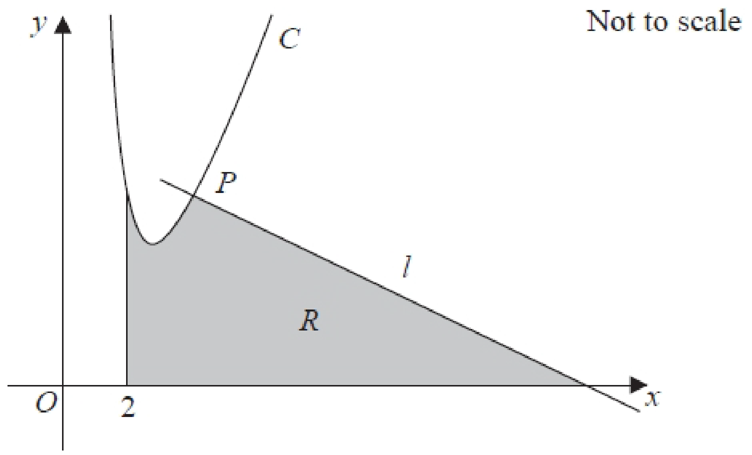


Figure 4

Figure 4 shows a sketch of part of the curve *C* with equation

$$y = \frac{32}{x^2} + 3x - 8, \qquad x > 0$$

The point *P* (4, 6) lies on *C*.
The line *l* is the normal to *C* at the point *P*.

The region *R*, shown shaded in Figure 4, is bounded by the line *l*, the curve *C*, the line with equation *x* = 2 and the *x*-axis.

Show that the area of *R* is 46

(*Solutions based entirely on graphical or numerical methods are not acceptable.*)

(10)

(Total for question = 10 marks)

Q2.

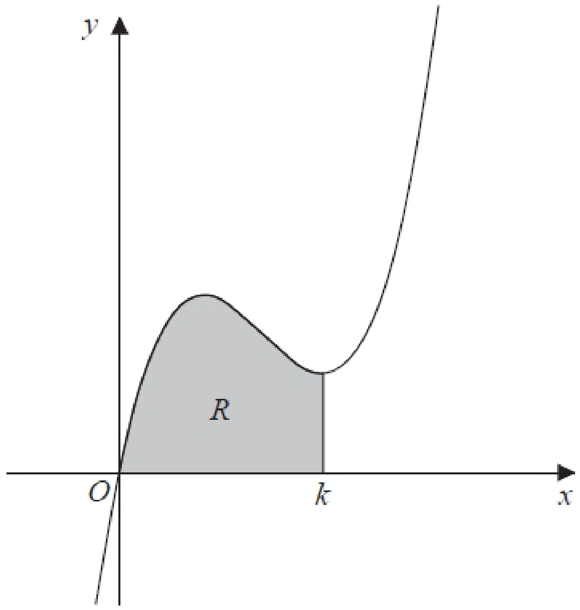


Figure 3

Figure 3 shows a sketch of part of the curve with equation

$$y = 2x^3 - 17x^2 + 40x$$

The curve has a minimum turning point at $x = k$.

The region R, shown shaded in Figure 3, is bounded by the curve, the x-axis and the line with equation $x = k$.

Show that the area of R is $\frac{256}{3}$

(*Solutions based entirely on graphical or numerical methods are not acceptable.*)

(7)

(Total for question = 7 marks)

Q3.

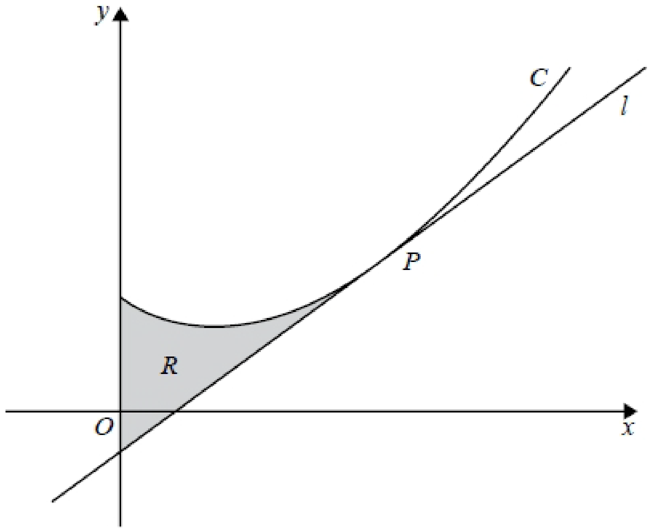


Figure 4

Figure 4 shows a sketch of the curve *C* with equation

$$y = 5x^{\frac{3}{2}} - 9x + 11, x \geqslant 0$$

The point *P* with coordinates (4, 15) lies on *C*.

The line *l* is the tangent to *C* at the point *P*.

The region *R*, shown shaded in Figure 4, is bounded by the curve *C*, the line *l* and the *y*-axis.

Show that the area of *R* is 24, making your method clear.

(*Solutions based entirely on graphical or numerical methods are not acceptable.*)

(10)

(Total for question = 10 marks)

Q4.

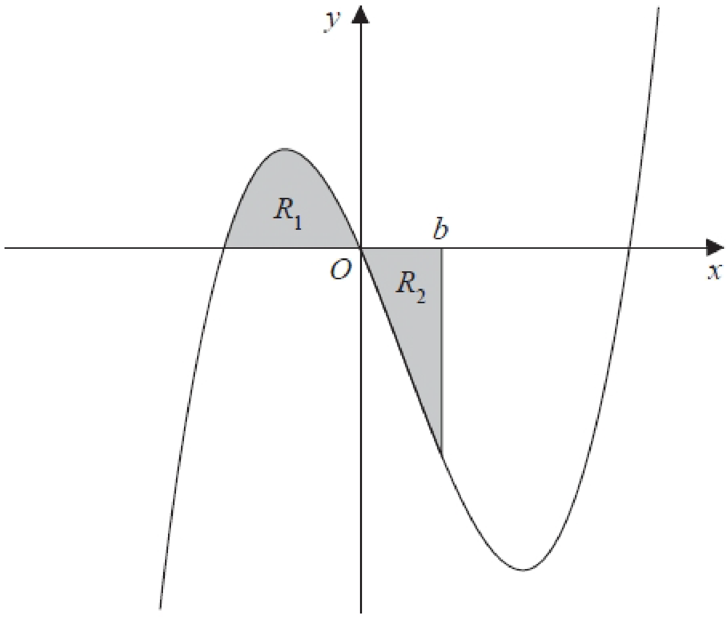


Figure 2

Figure 2 shows a sketch of part of the curve with equation $y = x(x + 2)(x - 4)$.

The region R_1 shown shaded in Figure 2 is bounded by the curve and the negative x-axis.

(a) Show that the exact area of R_1 is $\frac{20}{3}$

(4)

The region R_2 also shown shaded in Figure 2 is bounded by the curve, the positive x-axis and the line with equation $x = b$, where b is a positive constant and $0 < b < 4$

Given that the area of R_1 is equal to the area of R_2

(b) verify that b satisfies the equation

$$(b + 2)^2 (3b^2 - 20b + 20) = 0$$

(4)

The roots of the equation $3b^2 - 20b + 20 = 0$ are 1.225 and 5.442 to 3 decimal places. The value of b is therefore 1.225 to 3 decimal places.

(c) Explain, with the aid of a diagram, the significance of the root 5.442

(2)

(Total for question = 10 marks)

Q5.

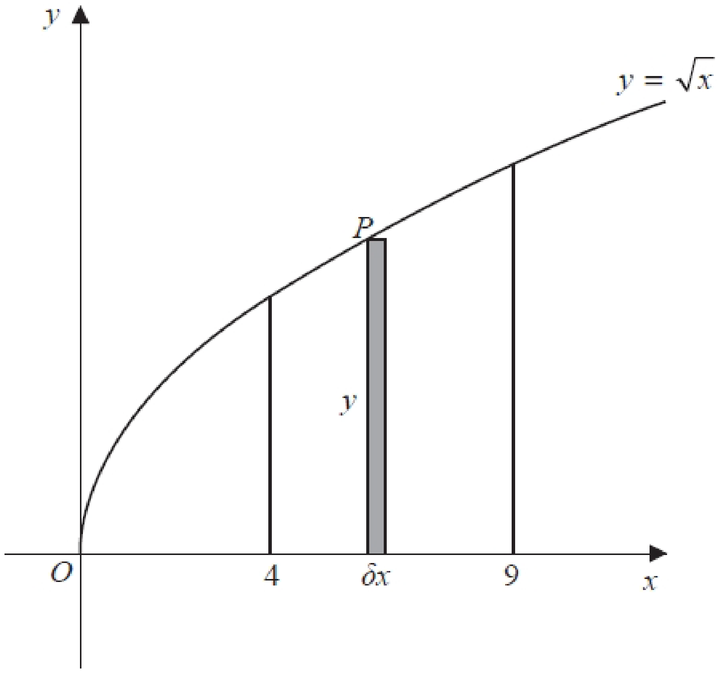


Figure 3

Figure 3 shows a sketch of the curve with equation $y = \sqrt{x}$

The point P(x, y) lies on the curve.

The rectangle, shown shaded on Figure 3, has height y and width δx.

Calculate

$$\lim_{\delta x \to 0} \sum_{x=4}^{9} \sqrt{x}\,\delta x$$

(Total for question = 3 marks)

Q6.

In this question you should show all stages of your working.

Solutions relying entirely on calculator technology are not acceptable.

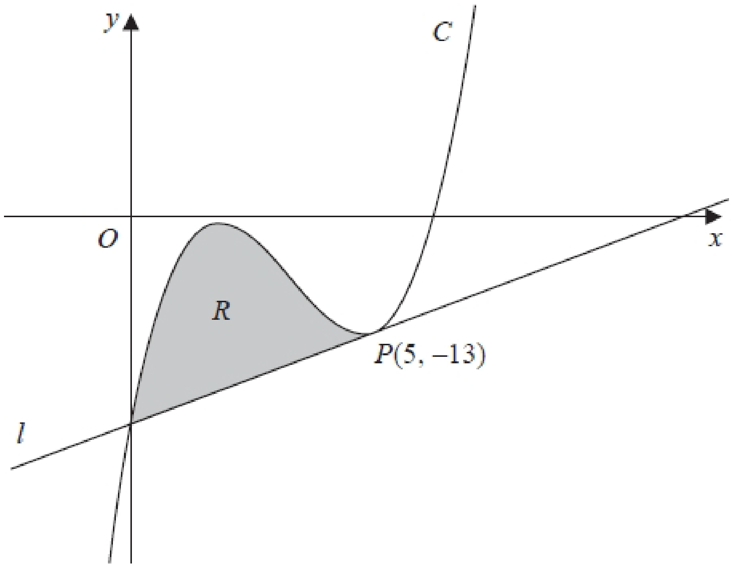


Figure 2

Figure 2 shows a sketch of part of the curve *C* with equation

$$y = x^3 - 10x^2 + 27x - 23$$

The point *P*(5, –13) lies on *C*

The line *l* is the tangent to *C* at *P*

(a) Use differentiation to find the equation of *l*, giving your answer in the form $y = mx + c$ where *m* and *c* are integers to be found.

(4)

(b) Hence verify that *l* meets *C* again on the *y*-axis.

(1)

The finite region *R*, shown shaded in Figure 2, is bounded by the curve *C* and the line *l*.

(c) Use algebraic integration to find the exact area of *R*.

(4)

(Total for question = 9 marks)

Q7.

$$g(x) = 2x^3 + x^2 - 41x - 70$$

(a) Use the factor theorem to show that $g(x)$ is divisible by $(x - 5)$.

(2)

(b) Hence, showing all your working, write $g(x)$ as a product of three linear factors.

(4)

The finite region R is bounded by the curve with equation $y = g(x)$ and the x-axis, and lies below the x-axis.

(c) Find, using algebraic integration, the exact value of the area of R.

(4)

(Total for question = 10 marks)

Q8.

A curve C has equation $y = f(x)$ where

$$f(x) = -3x^2 + 12x + 8$$

(a) Write f(x) in the form

$$a(x + b)^2 + c$$

where a, b and c are constants to be found.

(3)

The curve C has a maximum turning point at M.

(b) Find the coordinates of M.

(2)

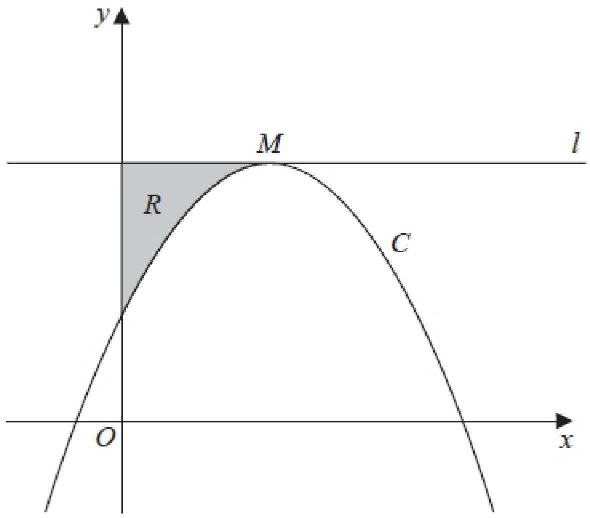


Figure 3

Figure 3 shows a sketch of the curve C.

The line l passes through M and is parallel to the x-axis.

The region R, shown shaded in Figure 3, is bounded by C, l and the y-axis.

(c) Using algebraic integration, find the area of R.

(5)

(Total for question = 10 marks)

Mark Scheme

Q1.

Question	Scheme	Marks	AOs
	For the complete strategy of finding where the normal cuts the x-axis. Key points that must be seen are • Attempt at differentiation • Attempt at using a changed gradient to find equation of normal • Correct attempt to find where normal cuts the x - axis	M1	3.1a
	$y=\frac{32}{x^2}+3x-8 \Rightarrow \frac{dy}{dx}=-\frac{64}{x^3}+3$	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 $\int_4^{"16"} "\left(-\frac{1}{2}x+8\right)" \mathrm{d}x$	M1	3.1a
	$\int \frac{32}{x^2}+3x-8\,\mathrm{d}x = -\frac{32}{x}+\frac{3}{2}x^2-8x$	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: $\frac{\mathrm{d}y}{\mathrm{d}x} = -\frac{64}{x^3}+3$

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 $\int \frac{32}{x^2}+3x-8\,\mathrm{d}x$ raising the power of at least one index

A1: $\int \frac{32}{x^2}+3x-8\,\mathrm{d}x = -\frac{32}{x}+\frac{3}{2}x^2-8x$ 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

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 $\int_2^{16}\left("-\frac{1}{2}x+8"\right)\mathrm{d}x$

M1: Integrates $\int\left("-\frac{1}{2}x+8"\right)-\left(\frac{32}{x^2}+3x-8\right)\mathrm{d}x$ 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 $=\int_2^4\left("-\frac{1}{2}x+8"\right)-\left(\frac{32}{x^2}+3x-8\right)\mathrm{d}x=$ ......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.

Q2.

	Scheme	Marks	AOs
	The overall method of finding the x coordinate of A.	M1	3.1a
	$y=2x^3-17x^2+40x\Rightarrow\frac{\mathrm{d}y}{\mathrm{d}x}=6x^2-34x+40$	B1	1.1b
	$\frac{\mathrm{d}y}{\mathrm{d}x}=0\Rightarrow 6x^2-34x+40=0\Rightarrow 2(3x-5)(x-4)=0\Rightarrow x=...$	M1	1.1b
	Chooses $x=4$ $\cancel{x=\frac{5}{3}}$	A1	3.2a
	$\int 2x^3-17x^2+40x\,\mathrm{d}x=\left[\frac{1}{2}x^4-\frac{17}{3}x^3+20x^2\right]$	B1	1.1b
	Area $=\frac{1}{2}(4)^4-\frac{17}{3}(4)^3+20(4)^2$	M1	1.1b
	$=\frac{256}{3}$ *	A1*	2.1
		(7)	
			(7 marks)

Notes
M1: An overall problem -solving method mark to find the minimum point. To score this you need to see • an attempt to differentiate with at least **two correct terms** • an attempt to set their $\frac{dy}{dx}=0$ and then solve to find x. Don't be overly concerned by the mechanics of this solution **B1:** $\left(\frac{dy}{dx}=\right)6x^2-34x+40$ which may be unsimplified **M1:** Sets their $\frac{dy}{dx}=0$, which must be a 3TQ in x, and attempts to solve via factorisation, formula or calculator. If a calculator is used to find the roots, they must be correct for their quadratic. If $\frac{dy}{dx}$ is correct allow them to just choose the root 4 for M1 A1. Condone $(x-4)\left(x-\frac{5}{3}\right)$ **A1:** Chooses $x=4$ This may be awarded from the upper limit in their integral **B1:** $\int 2x^3-17x^2+40x\,dx=\left[\frac{1}{2}x^4-\frac{17}{3}x^3+20x^2\right]$ which may be unsimplified **M1:** Correct attempt at area. There may be slips on the integration but expect **two correct terms** The upper limit used must be their larger solution of $\frac{dy}{dx}=0$ and the lower limit used must be 0. So if their roots are 6 and 10, then they must use 10 and 0. If only one value is found then the limits must be 0 to that value. Expect to see embedded or calculated values. Don't accept $\int_0^4 2x^3-17x^2+40x\,dx=\frac{256}{3}$ without seeing the integration and the embedded or calculated values **A1*:** Area $=\frac{256}{3}$ **with** correct notation and no errors. Note that this is a given answer. For correct notation expect to see • $\frac{dy}{dx}$ or $\frac{d}{dx}$ used correctly at least once. If $f(x)$ is used accept $f'(x)$. Condone y' • $\int 2x^3-17x^2+40x\,dx$ used correctly at least once with or without the limits.

Q3.

Question	Scheme	Marks	AOs
	$\frac{dy}{dx}=\frac{15}{2}x^{\frac{1}{2}}-9$	M1 A1	3.1a 1.1b
	Substitutes $x=4\Rightarrow\frac{dy}{dx}=6$	M1	2.1
	Uses (4, 15) and gradient $\Rightarrow y-15=6(x-4)$	M1	2.1
	Equation of l is $y=6x-9$	A1	1.1b
	Area $R=\int_0^4\left(5x^{\frac{3}{2}}-9x+11\right)-(6x-9)\,dx$	M1	3.1a
	$=\left[2x^{\frac{5}{2}}-\frac{15}{2}x^2+20x(+c)\right]_0^4$	A1	1.1b
	Uses both limits of 4 and 0 $\left[2x^{\frac{5}{2}}-\frac{15}{2}x^2+20x\right]_0^4=2\times4^{\frac{5}{2}}-\frac{15}{2}\times4^2+20\times4-0$	M1	2.1
	Area of $R=24$ *	A1*	1.1b
	Correct notation with good explanations	A1	2.5
		(10)	
			(10 marks)

Notes:

M1: Differentiates $5x^{\frac{3}{2}} - 9x + 11$ to a form $Ax^{\frac{1}{2}} + B$

A1: $\frac{dy}{dx} = \frac{15}{2}x^{\frac{1}{2}} - 9$ but may not be simplified

M1: Substitutes $x = 4$ in their $\frac{dy}{dx}$ to find the gradient of the tangent

M1: Uses their gradient and the point (4, 15) to find the equation of the tangent

A1: Equation of l is $y = 6x - 9$

M1: Uses Area $R = \int_0^4 \left(5x^{\frac{3}{2}} - 9x + 11\right) - (6x - 9)\,dx$ following through on their $y = 6x - 9$

Look for a form $Ax^{\frac{5}{2}} + Bx^2 + Cx$

A1: $= \left[2x^{\frac{5}{2}} - \frac{15}{2}x^2 + 20x(+c)\right]_0^4$ This must be correct but may not be simplified

M1: Substitutes in both limits and subtracts

A1*: Correct area for $R = 24$

A1: Uses correct notation and produces a well explained and accurate solution. Look for

- Correct notation used consistently and accurately for both differentiation and integration
- Correct explanations in producing the equation of l. See scheme.
- Correct explanation in finding the area of R. In way 2 a diagram may be used.

Alternative method for the area using area under curve and triangles. (Way 2)

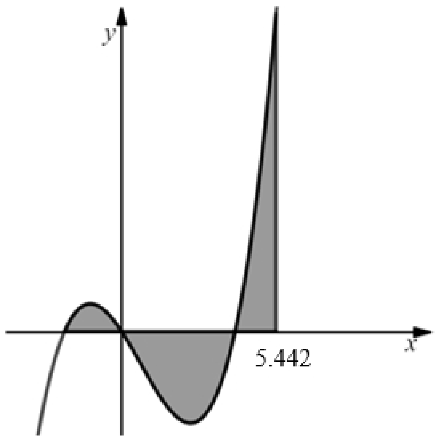
M1: Area under curve $= \int_0^4 \left(5x^{\frac{3}{2}} - 9x + 11\right) = \left[Ax^{\frac{5}{2}} + Bx^2 + Cx\right]_0^4$

A1: $= \left[2x^{\frac{5}{2}} - \frac{9}{2}x^2 + 11x\right]_0^4 = 36$

M1: This requires a full method with all triangles found using a correct method

Look for Area $R = \text{their } 36 - \frac{1}{2} \times 15 \times \left(4 - \text{their } \frac{3}{2}\right) + \frac{1}{2} \times \text{their } 9 \times \text{their } \frac{3}{2}$

Q4.

Part	Working or answer an examiner might expect to see	Mark	Notes
(a)	$y = x(x+2)(x-4) = x^3 - 2x^2 - 8x$	B1	This mark is given for expanding brackets as a first step to a solution
	$\int_{-2}^{0} x^3 - 2x^2 - 8x \; dx$	M1	This mark is given for a method to find the exact are of R_1
	$= \left[\frac{1}{4}x^4 - \frac{2}{3}x^3 - 4x^2\right]_{-2}^{0}$	M1	This mark is given for a method to evaluate the integral
	$= 0 - (4 - \frac{-16}{3} - 16) = \frac{20}{3}$	A1	This mark is given for a full method to show the exact value of R_1
(b)	$\frac{1}{4}b^4 - \frac{2}{3}b^3 - 4b^2 = -\frac{20}{3}$	M1	This mark is given for deducing the area of $R_2 = -\frac{20}{3}$
	$3b^4 - 8b^3 - 48b^2 + 80 = 0$	A1	This mark is given for rearranging the equation to a quartic
	$(b+2)^2(3b^2 - 20b + 20)$ $= (b^2 + 4b + 4)(3b^2 - 20b + 20)$	M1	This mark is given for expanding the equation given
	$= 3b^4 - 8b^3 - 48b^2 + 80 = 0$ The two equations are the same, so verified	A1	This mark is for showing, and stating, that the equations are the same
(c)		B1	This mark is given for a sketch of the curve with $b = 5.442$ shown
	Between $x = -2$ and $b = 5.442$, the area above the x-axis is the same as the area below the x-axis	B1	This mark is given for a valid explanation of the significance of the root 5.442

Q5.

Part	Working or answer an examiner might expect to see	Mark	Notes
	$\lim_{\delta x \to 0} \sum_{x=4}^{9} \sqrt{x}\,\delta x = \int_4^9 \sqrt{x}\ dx$	B1	This mark is given for writing the expression for a sum as an integral
	$\left[\frac{2}{3}x^{\frac{3}{2}}\right]_4^9 = \frac{2}{3} \times 9^{\frac{3}{2}} - \frac{2}{3} \times 4^{\frac{3}{2}}$	M1	This mark is given for a method to evaluate the integral
	$= \frac{38}{3}$	A1	This mark is given for a correct evaluation of the integral
			(Total 3 marks)

Q6.

Question	Scheme	Marks	AOs
(a)	$y = x^3 - 10x^2 + 27x - 23 \Rightarrow \frac{dy}{dx} = 3x^2 - 20x + 27$	B1	1.1b
	$\left(\frac{dy}{dx}\right)_{x=5} = 3\times5^2 - 20\times5 + 27 (= 2)$	M1	1.1b
	$y + 13 = 2(x - 5)$	M1	2.1
	$y = 2x - 23$	A1	1.1b
		(4)	
(b)	Both C and l pass through $(0, -23)$ and so C meets l again on the y-axis	B1	2.2a
		(1)	

(c)	$\pm\int\left(x^3-10x^2+27x-23-(2x-23)\right)\mathrm{d}x$ $=\pm\left(\frac{x^4}{4}-\frac{10}{3}x^3+\frac{25}{2}x^2\right)$	M1 A1ft	1.1b 1.1b
	$\left[\frac{x^4}{4}-\frac{10}{3}x^3+\frac{25}{2}x^2\right]_0^5$ $=\left(\frac{625}{4}-\frac{1250}{3}+\frac{625}{2}\right)(-0)$	dM1	2.1
	$=\frac{625}{12}$	A1	1.1b
		(4)	
	(c) Alternative 1:		
	$\pm\int\left(x^3-10x^2+27x-23\right)\mathrm{d}x$ $=\pm\left(\frac{x^4}{4}-\frac{10}{3}x^3+\frac{27}{2}x^2-23x\right)$	M1 A1	1.1b 1.1b
	$\left[\frac{x^4}{4}-\frac{10}{3}x^3+\frac{27}{2}x^2-23x\right]_0^5+\frac{1}{2}\times5(23+13)$ $=-\frac{455}{12}+90$	dM1	2.1
	$=\frac{625}{12}$	A1	1.1b
	(c) Alternative 2:		
	$\int\left(x^3-10x^2+27x\right)\mathrm{d}x=\left(\frac{x^4}{4}-\frac{10}{3}x^3+\frac{27}{2}x^2\right)$	M1 A1	1.1b 1.1b
	$\left[\frac{x^4}{4}-\frac{10}{3}x^3+\frac{27}{2}x^2\right]_0^5-\frac{1}{2}\times5\times10$	dM1	2.1
	$=\frac{625}{12}$	A1	1.1b
			(9 marks)

Notes

(a)
B1: Correct derivative

M1: Substitutes $x = 5$ into their derivative. This may be implied by their value for $\frac{\mathrm{d}y}{\mathrm{d}x}$

M1: Fully correct straight line method using $(5, -13)$ and their $\frac{\mathrm{d}y}{\mathrm{d}x}$ at $x = 5$

A1: cao. Must see the full equation in the required form.

(b)
B1: Makes a suitable deduction.

Alternative via equating l and C and factorising e.g.

$$x^3-10x^2+27x-23=2x-23$$
$$x^3-10x^2+25x=0$$
$$x\left(x^2-10x+25\right)=0\Rightarrow x=0$$

So they meet on the y-axis

(c)
M1: For an attempt to integrate $x^n \to x^{n+1}$ for $\pm$" $C - l$"
A1ft: Correct integration in any form which may be simplified or unsimplified. (follow through their equation from (a))

If they attempt as 2 separate integrals e.g. $\int (x^3 - 10x^2 + 27x - 23)\,dx - \int (2x - 23)\,dx$ then award this mark for the correct integration of the curve as in the alternative.
If they combine the curve with the line first then the subsequent integration must be correct or a correct ft for their line and allow for $\pm$" $C - l$"

dM1: Fully correct strategy for the area. Award for use of 5 as the limit and condone the omission of the "– 0". **Depends on the first method mark.**
A1: Correct exact value

Alternative 1:
M1: For an attempt to integrate $x^n \to x^{n+1}$ for $\pm C$
A1: Correct integration for $\pm C$
dM1: Fully correct strategy for the area e.g. correctly attempts the area of the trapezium and subtracts the area enclosed between the curve and the x-axis. Need to see the use of 5 as the limit condoning the omission of the "– 0" **and** a correct attempt at the trapezium **and** the subtraction.

May see the trapezium area attempted as $\int (2x - 23)\,dx$ in which case the integration and use of the limits needs to be correct or correct follow through for their straight line equation.
Depends on the first method mark.
A1: Correct exact value

Note if they do $l - C$ rather than $C - l$ and the working is otherwise correct allow full marks if their final answer is given as a positive value. E.g. correct work with $l - C$ leading to $-\frac{625}{12}$ and then e.g. hence area is $\frac{625}{12}$ is acceptable for full marks.
If the answer is left as $-\frac{625}{12}$ then score A0

Alternative 2:
M1: For an attempt to integrate $x^n \to x^{n+1}$ for $(C + 23)$
A1: Correct integration for $(C + 23)$
dM1: Fully correct strategy for the area e.g. correctly attempts the area of the triangle and subtracts from the area under the curve
Need to see the use of 5 as the limit condoning the omission of the "– 0" **and** a correct attempt at the triangle **and** the subtraction.
Depends on the first method mark.

Q7.

Question	Scheme	Marks	AOs
(a)	$g(5) = 2\times5^3 + 5^2 - 41\times5 - 70 = ...$	M1	1.1a
	$g(5) = 0 \Rightarrow (x-5)$ is a factor, hence $g(x)$ is divisible by $(x-5)$.	A1	2.4
		(2)	
(b)	$2x^3 + x^2 - 41x - 70 = (x-5)(2x^2 ... x \pm 14)$	M1	1.1b
	$= (x-5)(2x^2 + 11x + 14)$	A1	1.1b
	Attempts to factorise quadratic factor	dM1	1.1b
	$(g(x)) = (x-5)(2x+7)(x+2)$	A1	1.1b
		(4)	
(c)	$\int 2x^3 + x^2 - 41x - 70 \,dx = \frac{1}{2}x^4 + \frac{1}{3}x^3 - \frac{41}{2}x^2 - 70x$	M1 A1	1.1b 1.1b
	Deduces the need to use $\int_{-2}^{5} g(x)dx$ $-\frac{1525}{3} - \frac{190}{3}$	M1	2.2a
	Area $= 571\frac{2}{3}$	A1	2.1
		(4)	
			(10 marks)

Notes

(a)

M1: Attempts to calculate $g(5)$ Attempted division by $(x-5)$ is M0

Look for evidence of embedded values or two correct terms of $g(5) = 250 + 25 - 205 - 70 = ...$

A1: Correct calculation, reason and conclusion. It must follow M1. Accept, for example,

$g(5) = 0 \Rightarrow (x-5)$ is a factor, hence divisible by $(x-5)$

$g(5) = 0 \Rightarrow (x-5)$ is a factor ✓

Do not allow if candidate states

$f(5) = 0 \Rightarrow (x-5)$ is a factor, hence divisible by $(x-5)$ **(It is not f)**

$g(x) = 0 \Rightarrow (x-5)$ is a factor **(It is not g(x) and there is no conclusion)**

This may be seen in a preamble before finding $g(5) = 0$ but in these cases there must be a minimal statement ie QED, "proved", tick etc.

(b)

M1: Attempts to find the quadratic factor by inspection (correct coefficients of first term and ± last term) or by division (correct coefficients of first term and ± second term). Allow this to be scored from division in part (a)

A1: $(2x^2 + 11x + 14)$ You may not see the $(x-5)$ which can be condoned

dM1: Correct attempt to factorise their $(2x^2 + 11x + 14)$

A1: $(g(x)=)\ (x-5)(2x+7)(x+2)$ or $(g(x)=)\ (x-5)(x+3.5)(2x+4)$
It is for the product of factors and not just a statement of the three factors
Attempts with calculators via the three roots are likely to score 0 marks. The question was "Hence" so the two M's must be awarded.

(c)

M1: For $x^n \to x^{n+1}$ for any of the terms in x for $g(x)$ so
$2x^3 \to ...x^4,\ x^2 \to ...x^3,\ -41x \to ...x^2,\ -70 \to ...x$

A1: $\int 2x^3 + x^2 - 41x - 70\, dx = \frac{1}{2}x^4 + \frac{1}{3}x^3 - \frac{41}{2}x^2 - 70x$ which may be left unsimplified (ignore any reference to $+C$)

M1: Deduces the need to use $\int_{-2}^{5} g(x)dx$.
This may be awarded from the limits on their integral (either way round) or from embedded values which can be subtracted either way round.

A1: For clear work showing all algebraic steps leading to area = $571\frac{2}{3}$ oe

So allow $\int_{-2}^{5} 2x^3 + x^2 - 41x - 70\, dx = \left[\frac{1}{2}x^4 + \frac{1}{3}x^3 - \frac{41}{2}x^2 - 70x\right]_{-2}^{5} = -\frac{1715}{3} \Rightarrow$ area $= \frac{1715}{3}$ for 4 marks

Condone spurious notation, as long as the algebraic steps are correct. If they find $\int_{-2}^{5} g(x)dx$ then withhold the final mark if they just write a positive value to this integral since $\int_{-2}^{5} g(x)dx = -\frac{1715}{3}$

Note $\int_{-2}^{5} 2x^3 + x^2 - 41x - 70\, dx \Rightarrow \frac{1715}{3}$ with no algebraic integration seen scores M0A0M1A0

Q8.

Question	Scheme	Marks	AOs
(a)	$f(x) = -3x^2 + 12x + 8 = -3(x \pm 2)^2 + \ldots$	M1	1.1b
	$= -3(x-2)^2 + \ldots$	A1	1.1b
	$= -3(x-2)^2 + 20$	A1	1.1b
		(3)	
(b)	Coordinates of $M = (2, 20)$	B1ft B1ft	1.1b 2.2a
		(2)	
(c)	$\int -3x^2 + 12x + 8 \, dx = -x^3 + 6x^2 + 8x$	M1 A1	1.1b 1.1b
	Method to find $R =$ their $2 \times 20 - \int_0^2 \left(-3x^2 + 12x + 8\right) dx$	M1	3.1a
	$R = 40 - \left[-2^3 + 24 + 16\right]$	dM1	1.1b
	$= 8$	A1	1.1b
		(5)	
		(10 marks)	
Alt(c)	$\int 3x^2 - 12x + 12 \, dx = x^3 - 6x^2 + 12x$	M1 A1	1.1b 1.1b
	Method to find $R = \int_0^2 3x^2 - 12x + 12 \, dx$	M1	3.1a
	$R = 2^3 - 6 \times 2^2 + 12 \times 2$	dM1	1.1b
	$= 8$	A1	1.1b

Notes:

(a)

M1: Attempts to take out a common factor and complete the square. Award for $-3(x \pm 2)^2 + ...$
Alternatively attempt to compare $-3x^2 + 12x + 8$ to $ax^2 + 2abx + ab^2 + c$ to find values of a and b

A1: Proceeds to a form $-3(x-2)^2 + ...$ or via comparison finds $a = -3, b = -2$

A1: $-3(x-2)^2 + 20$

(b)

B1ft: One correct coordinate

B1ft: Correct coordinates. Allow as $x = ..., y = ...$
Follow through on their $(-b, c)$

(c)

M1: Attempts to integrate. Award for any correct index

A1: $\int -3x^2 + 12x + 8 \, dx = -x^3 + 6x^2 + 8x$ $(+ c)$ (which may be unsimplified)

M1: Method to find area of R. Look for their $2 \times "20" - \int_0^{"2"} f(x) \, dx$

dM1: Correct application of limits on their integrated function. Their 2 must be used

A1: Shows that area of $R = 8$