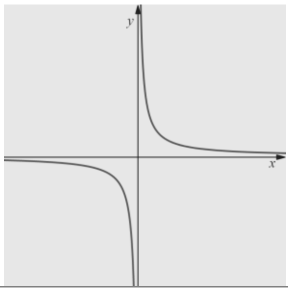
Question	Scheme	Marks	AOs
1(a)	 Shape in quadrant 1 **or** 3	M1	1.1b
	Shape and Position	A1	1.1b
		(2)	
(b)	Deduces that $x<0$	B1	2.2a
	Attempts $\frac{16}{x}...2 \Rightarrow x...\pm\frac{16}{2}$	M1	1.1b
	$x<0$ or $x \geq 8$	A1 cso	2.2a
		(3)	
			(5 marks)

Notes:

(a)

M1: For the correct shape in quadrant 1 **or** 3. Do not be concerned about position but it must not cross either axis. Ignore incorrect asymptotes for this mark.

A1: Correct shape and position. There should be no curve in either quadrant 2 or quadrant 4. The curve must not clearly bend back on itself but condone slips of the pen.

(b)

B1: Deduces that $x<0$ but condone $x \leq 0$ for this mark.

M1: Attempts $\frac{16}{x}...2 \Rightarrow x...\pm\frac{16}{2}$ where the … means any equality or inequality.

A1: cso $x<0$ or $x \geq 8$ (Both required)

Set notation may be seen $\{x: x<0\} \cup \{x: x \geq 8\}$ o.e. $x \in (-\infty, 0) \cup [8, \infty)$

Accept $x<0$, $x \geq 8$ but not $x<0$ and $x \geq 8$

Must not be combined incorrectly, e.g., $8 \leq x < 0$ **or** $\{x: x<0\} \cap \{x: x \geq 8\}$

Question	Scheme	Marks	AOs
2 (a)	$(-2,-3)$	B1	1.1b
		(1)	
(b)	$(-2, 5)$	B1	1.1b
		(1)	
(c)	Either $x=0$ or $y=-13$	M1	1.1b
	$(0,-13)$	A1	1.1b
		(2)	
			(4 marks)
Notes:			

Watch for answers in the body of the question and on sketch graphs. This is acceptable.
If coordinates are written by the question and in the main answer section the answer section takes precedence.

(a)
B1: Accept without brackets. May be written $x=-2, y=-3$
(b)
B1: Accept without brackets. May be written $x=-2, y=5$
(c)
M1: For either coordinate. E.g. $(0,...)$ or $(...,-13)$
If they are building up their solution in stages e.g. $(-2,-5) \rightarrow (0,-5) \rightarrow (0,-15) \rightarrow (0,-13)$ only mark their final coordinate pair
A1: Correct coordinates. See above for building up solution in stages
Accept without brackets. May be written $x=0, y=-13$
SC 10 for candidates who write $(-13, 0)$

Question	Scheme	Marks	AOs
3(a)	$2 < x < 6$	B1	1.1b
		(1)	
(b)	States either $k > 8$ or $k < 0$	M1	3.1a
	States e.g. $\{k : k > 8\} \cup \{k : k < 0\}$	A1	2.5
		(2)	
(c)	**Please see notes for alternatives**		
	States $y = ax(x-6)^2$ or $f(x) = ax(x-6)^2$	M1	1.1b
	Substitutes $(2,8)$ into $y = ax(x-6)^2$ and attempts to find a	dM1	3.1a
	$y = \frac{1}{4}x(x-6)^2$ or $f(x) = \frac{1}{4}x(x-6)^2$ o.e	A1	2.1
		(3)	
		(6 marks)	
Notes: Watch for answers written by the question. If they are beside the question and in the answer space, the one in the answer space takes precedence			

(a)

B1: Deduces $2 < x < 6$ o.e. such as $x > 2, x < 6$ $x > 2$ and $x < 6$ $\{x : x > 2\} \cap \{x : x < 6\}$ $x \in (2,6)$

Condone attempts in which set notation is incorrectly attempted but correct values can be seen or implied E.g. $\{x > 2\} \cap \{x < 6\}$ $\{x > 2, x < 6\}$. Allow just the open interval $(2,6)$

Do not allow for incorrect inequalities such as e.g. $x > 2$ or $x < 6$, $\{x : x > 2\} \cup \{x : x < 6\}$ $x \in [2,6]$

(b)

M1: Establishes a correct method by finding one of the (correct) inequalities

States either $k > 8$ (condone $k \geqslant 8$) or $k < 0$ (condone $k \leqslant 0$)

Condone for this mark $y \leftrightarrow k$ or $f(x) \leftrightarrow k$ and $8 < k < 0$

A1: Fully correct solution in the form $\{k : k > 8\} \cup \{k : k < 0\}$ or $\{k \mid k > 8\} \cup \{k \mid k < 0\}$ either way around but condone $\{k < 0\} \cup \{k > 8\}$, $\{k : k < 0 \cup k > 8\}$, $\{k < 0 \cup k > 8\}$. It is not necessary to mention $\mathbb{R}$, e.g. $\{k : k \in \mathbb{R}, k > 8\} \cup \{k : k \in \mathbb{R}, k < 0\}$ Look for $\{\ \}$ and $\cup$

Do not allow solutions not in set notation such as $k < 0$ or $k > 8$.

(c)

M1: Realises that the equation of C is of the form $y = ax(x-6)^2$. Condone with $a = 1$ for this mark.

So award for sight of $ax(x-6)^2$ even with $a = 1$

dM1: Substitutes $(2,8)$ into the form $y = ax(x-6)^2$ and attempts to find the value for a.

It is dependent upon having an equation, which the (y =..) may be implied, of the correct form.

A1: Uses all of the information to form a correct **equation** for C $y = \frac{1}{4}x(x-6)^2$ o.e.

ISW after a correct answer. Condone $f(x) = \frac{1}{4}x(x-6)^2$ but not $C = \frac{1}{4}x(x-6)^2$.

Allow this to be written down for all 3 marks

Examples of alternative methods

....

Alternative I part (c):
Using the form $y = ax^3 + bx^2 + cx$ and setting up then solving simultaneous equations.
There are various versions of this but can be marked similarly

M1: Realises that the equation of C is of the form $y = ax^3 + bx^2 + cx$ and forms two equations in a, b and c. Condone with a =1 for this mark.

Note that the form $y = ax^3 + bx^2 + cx + d$ is M0 until d is set equal to 0.

There are four equations that could be formed, only two are necessary for this mark.

Condone slips

Using $(6, 0)$ $\Rightarrow 216a+36b+6c=0$

Using $(2, 8)$ $\Rightarrow 8a+4b+2c=8$

Using $\frac{dy}{dx}=0$ at $x = 2$ $\Rightarrow 12a+4b+c=0$

Using $\frac{dy}{dx}=0$ at $x = 6 \Rightarrow 108a+12b+c=0$

dM1: Forms and solves three different equations, one of which must be using (2, 8) to find values for a, b and c. A calculator can be used to solve the equations

A1: Uses all of the information to form a correct equation for C $y = \frac{1}{4}x^3 - 3x^2 + 9x$ o.e.

ISW after a correct answer. Condone $f(x) = \frac{1}{4}x^3 - 3x^2 + 9x$

....

Alternative II part (c)
Using the gradient and integrating

M1: Realises that the gradient of C is zero at 2 and 6 so sets $f'(x) = k(x-2)(x-6)$ oe **and** attempts to integrate. Condone with $k = 1$

dM1: Substitutes $x = 2, y = 8$ into $f(x) = k(...x^3 + ...x + ...)$ and finds a value for k

A1: Uses all of the information to form a correct equation for C $y = \frac{3}{4}\left(\frac{1}{3}x^3 - 4x^2 + 12x\right)$ o.e.

ISW after a correct answer. Condone $f(x) = \frac{3}{4}\left(\frac{1}{3}x^3 - 4x^2 + 12x\right)$

....

Question	Scheme	Marks	AOs
4 (a)	Substitutes $x=\frac{1}{2}$ into $y=2x^3+10$ **and** $y=42x-15x^2-7$ and finds the y values for both	M1	1.1b
	Achieves $\frac{41}{4}$ o.e. for both and makes a valid conclusion. *	A1*	2.4
		(2)	
(b)	Sets $42x-15x^2-7=2x^3+10 \Rightarrow 2x^3+15x^2-42x+17=0$	M1	1.1b
	Deduces that $(2x-1)$ is a factor and attempts to divide	dM1	2.1
	$2x^3+15x^2-42x+17=(2x-1)(x^2+8x-17)$	A1	1.1b
	Solves their $x^2+8x-17=0$ using suitable method	M1	1.1b
	Deduces $x=-4+\sqrt{33}$ (see note)	A1	2.2a
		(5)	
			(7 marks)
Notes:			

(a)

M1: Substitutes $x=\frac{1}{2}$ into both $y=2x^3+10$ and $y=42x-15x^2-7$ and finds y values

Sight of just the y values at each is sufficient for this mark only.

Alternative: Sets $42x-15x^2-7=2x^3+10 \Rightarrow$ cubic and substitutes $x=\frac{1}{2}$ into the expression, attempts $f\left(\frac{1}{2}\right)$ or else attempts to divide the cubic = 0 by $(2x-1)$ or $\left(x-\frac{1}{2}\right)$. Condone $f\left(\frac{1}{2}\right)=0$ without calculations for this mark only.

A1*: Correct calculations must be seen with a minimal conclusion that curves intersect (at $x=\frac{1}{2}$).

E.g. $2\left(\frac{1}{2}\right)^3+10=10.25$ and $42\left(\frac{1}{2}\right)-15\left(\frac{1}{2}\right)^2-7=10.25$ so curves intersect.

Acceptable alternatives are:

$f(x)=42x-15x^2-7-2x^3-10, f\left(\frac{1}{2}\right)=42\left(\frac{1}{2}\right)-15\left(\frac{1}{2}\right)^2-7-2\left(\frac{1}{2}\right)^3-10=0 \Rightarrow$ so curves intersect

$f(x)=2x^3+15x^2-42x+17 \Rightarrow \left(x-\frac{1}{2}\right)(2x^2+16x-34)$ so $x=\frac{1}{2}$ is a root so curves intersect

$f(x)=2x^3+15x^2-42x+17 \Rightarrow (2x-1)(x^2+8x-17)$ so $(2x-1)$ is a factor hence curves intersect

Only accept verified, QED etc if there is a preamble mentioning intersection about how it will be shown.

Special case: Scores M1 A0 with or without a conclusion

This is presumably done using a calculator and requires all three roots exact or correct to 3sf

$f(x)=2x^3+15x^2-42x+17=0$

$\Rightarrow x=0.5, 1.74, -9.74$

(b) **This part requires candidates to show all stages of their working.**
Answers without working will not score any marks
A method must be seen which could be from part (a) which must then be continued in (b)

M1: Sets $42x-15x^2-7=2x^3+10$ and proceeds to 4 term cubic equation.
Condone slips, e.g. signs. Terms do not have to be on one side of the equation.

dM1: For the key step in attempting to "divide" the cubic by $(2x-1)$
If attempted via inspection look for correct first and last terms
E.g. $2x^3+15x^2-42x+17=(2x-1)(x^2+...\pm17)$ if cubic expression is correct
If attempted via division look for correct first and second terms

$$\begin{array}{r|l} & x^2+8x \\ \hline 2x-1 & 2x^3+15x^2-42x+17 \end{array}$$ if cubic expression is correct

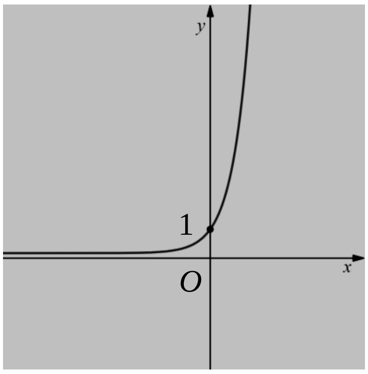
It is acceptable for an attempt to divide by $\left(x-\frac{1}{2}\right)$. It is easily marked using the same guidelines, e.g. $2x^3+15x^2-42x+17=\left(x-\frac{1}{2}\right)(2x^2+16x...)$

A1: $2x^3+15x^2-42x+17=(2x-1)(x^2+8x-17)$ o.e. $\left(x-\frac{1}{2}\right)(2x^2+16x-34)$
This may be implied by sight of $(x^2+8x-17)$ or $(2x^2+16x-34)$ in a "division" sum.

M1: Solves their quadratic $x^2+8x-17=0$ using a suitable method including calculator. You may need to check this. It is not completely dependent upon the previous M's but an attempt at a full method must have been seen. So look for

- the two equations being set equal to each other and some attempt made to combine
- some attempt to "divide" the result by $(2x-1)$ o.e. allowing for flaws in the method

A1: Gives $x=-4+\sqrt{33}$ o.e. only. The $x=-4-\sqrt{33}$ must not be included in the final answer.
Allow exact unsimplified equivalents such as $x=\frac{-8+\sqrt{132}}{2}$. ISW for instance if they then put this in decimal form.

Question	Scheme		Marks	AOs
5(a)		Correct shape or correct intercept – see notes	B1	1.2
		Fully correct – see notes	B1	1.1b
			(2)	
(b)	$4^x = 100 \Rightarrow x = \log_4 100$ or e.g. $x\log 4 = \log 100 \Rightarrow x = \dfrac{\log 100}{\log 4}$		M1	1.1b
	$\Rightarrow (x =)$ awrt 3.32		A1	1.1b
			(2)	
				(4 marks)

Notes:

Note that B0B1 is not possible in part (a)

(a) **Axes do not need to be labelled. No sketch is no marks.**

B1: Correct shape or correct intercept.

Shape: A positive exponential curve in quadrants 1 and 2 only, passing through a point on the positive y-axis. Must "level out" in quadrant 2 but not necessarily asymptotic to the x-axis and allow if the curve bends up slightly for $x < 0$ but do not allow a clear "U" shape. It must not clearly "stop" on the x-axis to the left of the y-axis.

OR

Intercept: The intercept can be marked as 1 or (0, 1) or $y = 1$ or (1, 0) as long as it is in the correct place. May also be seen away from the sketch but must be seen as (0, 1) or possibly these coordinates in a table but it must correspond to the sketch. If there is any ambiguity, the sketch takes precedence.

B1: Fully correct.

Shape: A positive exponential curve in quadrants 1 and 2 only, passing through a point on the positive y-axis. The curve must appear to be asymptotic to the x-axis **and it must level out at least half way below the intercept**. Allow if the curve bends up slightly for $x < 0$ but do not allow a clear "U" shape. The curve must not bend back on itself on the rhs of the y-axis. There must be no suggestion that the curve approaches another horizontal asymptote other than the x-axis e.g. a horizontal dotted line that the curve approaches.

AND

Intercept: As above

See practice items and below for some examples:

(b)

M1: Uses logs in an attempt to solve the equation. E.g. takes log base 4 and obtains $x = \log_4 100$

Alternatively takes logs (any base) to obtain $x\log 4 = \log 100$ and proceeds to $x = \frac{\log 100}{\log 4}$

Allow if this subsequently becomes e.g. log 25 as long as $\frac{\log 100}{\log 4}$ is seen **but**

$x\log 4 = \log 100 \Rightarrow x = \log 25$ or $x\log 4 = \log 100 \Rightarrow x = \log 100 - \log 4$ scores M0

A1: awrt 3.32 . A correct answer only of awrt 3.32 scores M1A1

Note that a common incorrect answer is x = 3.218875… and comes from ln 25 or ln 100 – ln4 and unless $x = \frac{\ln 100}{\ln 4}$ is seen previously, this scores M0A0