Question	Scheme	Marks	AOs
1	Finds critical values $x^2 - x > 20 \Rightarrow x^2 - x - 20 > 0 \Rightarrow x = (5, -4)$	M1	1.1b
	Chooses outside region for their values Eg. $x > 5, x < -4$	M1	1.1b
	Presents solution in set notation $\{x : x < -4\} \cup \{x : x > 5\}$ oe	A1	2.5
		(3)	
			(3 marks)

Notes

M1: Attempts to find the critical values using an algebraic method. Condone slips but an allowable method should be used and two critical values should be found

M1: Chooses the outside region for their critical values. This may appear in incorrect inequalities such as $5 < x < -4$

A1: Presents in set notation as required $\{x : x < -4\} \cup \{x : x > 5\}$ Accept $\{x < -4 \cup x > 5\}$.

Do not accept $\{x < -4,\ x > 5\}$

Note: If there is a contradiction of their solution on different lines of working do not penalise intermediate working and mark what appears to be their final answer.

Question	Scheme	Marks	AOs
2	Complete method to find the RHS of an equation for l e.g., Attempts gradient = $\frac{80-60}{10}\{=2\}$ and uses intercept = 60	M1	1.1b
	$\{y=\}2x+60$	A1	1.1b
	Deduces the RHS of the equation for C is $\{y=\}ax(x-6)$ and attempts to use $(10,80)$ to find the value of a	M1	3.1a
	Equation of C is $\{y=\}2x(x-6)$	A1	1.1b
	$2x(x-6) \leqslant y \leqslant 2x+60$	B1ft	2.5
		(5)	
			(5 marks)

Notes:

M1: Complete attempt to use the given information to find an equation or inequality for l, which may be l = or have no LHS. $y - 80 = 2(x - 10)$ is acceptable for this mark.

A1: $\{y=\}2x+60$ This is not scored by $y - 80 = 2(x - 10)$

M1: Deduces the RHS of the equation of C is $\{y=\}ax(x-6)$, $a \neq 1$, and attempts to use $(10,80)$ to find the value of a which may be implied. Again, there may be no LHS.
Other possible and more lengthy alternatives include:
1) Setting the RHS to be $\{y=\}a(x-3)^2+b$ and using $(0,0)$ and $(10,80)$ to find a and b
2) Setting the RHS to be $\{y=\}px^2+qx$ and using $(6,0)$ and $(10,80)$ to find p and q

A1: $\{y=\}2x(x-6)$ or alternative such as $\{y=\}2(x-3)^2-18$ or $\{y=\}2x^2-12x$
This may be implied by an inequality $y \ldots 2x(x-6)$ and may be seen as, e.g., $C=2x(x-6)$

B1ft: $"2x(x-6)" \leq y \leq "2x+60"$ o.e. must follow from their l and C and apply isw
Follow through only on a quadratic for C and a straight line for l
Do not allow a mixture of inequalities, i.e., $<$ with $\leq$
Allow $2x^2-12x<y<2x+60$ or as separate inequalities $y>2x(x-6)$, $y<2x+60$
Do not allow $2x(x-6)<R<2x+60$ **or** $2x(x-6)<\mathrm{f}(x)<2x+60$ **or** $2x(x-6)<2x+60$
Ignore any reference to $-3<x<10$
Note: $y=2x+60$ and $y=2x(x-6)$ incorrectly expanded to $y=2x^2-12$ followed by $2x^2-12 \leq y \leq 2x+60$ would score 11110

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 $f(x) = k\left(...x^3 + ...x + ...\right)$ 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 (i)	For setting up the contradiction: There exists integers p and q such that pq is even and both p and q are odd	B1	2.5
	For example, sets $p = 2m+1$ and $q = 2n+1$ and then attempts $pq = (2m+1)(2n+1) = ...$	M1	1.1b
	Obtains $pq = (2m+1)(2n+1) = 4mn + 2m + 2n + 1$ $= 2(2mn + m + n) + 1$ States that this is odd, giving a contradiction so " if pq is even, then at least one of p and q is even" *	A1*	2.1
		(3)	
(ii)			
	$(x+y)^2 < 9x^2 + y^2 \Rightarrow 2xy < 8x^2$	M1	2.2a
	States that as $x < 0 \Rightarrow 2y > 8x$ $\Rightarrow y > 4x$ *	A1*	2.1
		(2)	
			(5 marks)
Notes:			

(i)

B1: For using the "correct"/ allowable language in setting up the contradiction.
Expect to see a minimum of

- "assume" or "let" or "there is " or other similar words
- "*pq* is even" and "*p* and *q* are (both) odd"

M1: Uses a correct algebraic form for *p* and *q* and attempting to multiply.
Allow any correct form so $p = 2n+1$ and $q = 2m+3$ would be fine to use
Different variables must be used for *p* and *q*, so $p = 2n+1$ and $q = 2n-1$ would be M0

A1*: Full argument .
This requires (1) a correct calculation for their *pq*
(2) a correct reason and conclusion that it is odd

E.g. $(2m+1)(2n+1) = 4mn + 2m + 2n + 1 = 2(2mn + m + n) + 1 = \text{odd}$

E.g. $(2m-1)(2n+1) = 4mn + 2m - 2n - 1 = \text{even + even} - \text{even} - 1 = \text{odd}$

and (3) a minimal statement implying that they have proven what was required which could be QED, proven etc

Note that B0 M1 A1 is possible

(ii)

M1: For multiplying out and cancelling terms before proceeding to a correct intermediate line such as $2xy < 8x^2$ o.e. such as $2x(4x - y) > 0$

A1*: Full and rigorous proof with reason shown as to why inequality reverses. The point at which it reverses must be correct and a correct reason given

See scheme

Alt: $2xy < 8x^2 \Rightarrow xy - 4x^2 < 0 \Rightarrow x(y - 4x) < 0$

as $x < 0$, $(y - 4x) > 0 \Rightarrow y > 4x$ scores M1 A1

So, the following should be scored M1 A0 as line 3 is incorrect

$2xy - 8x^2 < 0$

$\Rightarrow 2xy < 8x^2$

$\Rightarrow y < 4x$

$\Rightarrow y > 4x$ as $x < 0$

There should be no incorrect lines in their proof