B1: For the coordinates of the maximum and minimum points in correct positions. E.g. *P*' must be on the *x*-axis although *P* and *Q* don't need to be seen, just their coordinates. Coordinates may be given in the body of the script but must match with maximum and minimum points marked in some way on the graph.

Question	Scheme	Marks
5(a)	E.g. $12-a(x+2)^2$ or $a(x-1)(x+5)$ or $y=ax^2+bx+c \Rightarrow 4a-2b+c=12$ and $25a-5b+c=0$	**M1A1**
	E.g. $0=12-a(-5+2)^2 \Rightarrow a=...$ or $12=a(-2-1)(-2+5) \Rightarrow a=...$ or $2a(-2)+b=0, 25a-5b+c=0, 4a-2b+c=12 \Rightarrow a=..., b=..., c=...$	**dM1**
	$12-\frac{4}{3}(x+2)^2$ or $-\frac{4}{3}(x-1)(x+5)$ or $-\frac{4}{3}x^2-\frac{16}{3}x+\frac{20}{3}$ oe	**A1**
		(4)
(b)	Gradient of l_2 is $\frac{-5}{4}$ o.e.	**M1**
	Equation of l_2 is $y="-\frac{5}{4}"(x+5)$	**M1**
	$y=-\frac{5}{4}x-\frac{25}{4}$	**A1**
		(3)
(c)	For two of $y \geqslant "-\frac{5}{4}x-\frac{25}{4}"$; $y \geqslant \frac{4}{5}x$; $y \leqslant "-\frac{4}{3}x^2-\frac{16}{3}x+\frac{20}{3}"$ Or with strict inequalities	**M1**
	For all three of $y \geqslant "-\frac{5}{4}x-\frac{25}{4}"$; $y \geqslant \frac{4}{5}x$; $y \leqslant "-\frac{4}{3}x^2-\frac{16}{3}x+\frac{20}{3}"$ Or with strict inequalities	**A1ft**
		(2)
		(9 marks)
Notes:		

(a) Just the expression for f (*x*) is required but you may see *y* = ... or f(*x*) =.. . which is fine

M1: For knowing a quadratic form and using two correct pieces of information. This can be scored by

- using the maximum value occurs at (−2,12) to state the form $12 \pm a(x \pm 2)^2$
- use symmetry, usually with roots of -5 and 1 to state the form $a(x \pm 1)(x \pm 5)$
- using the general form $y=ax^2+bx+c$ and substituting in two points, usually $\left(-2,12\right)$ and $\left(-5,0\right)$. An alternative is using just one point and setting $\frac{\mathrm{d}y}{\mathrm{d}x}=0$ at $x=-2 \Rightarrow -4a+b=0$

Condone for each of these: (1) slips (e.g incorrect squaring) or (2) the use of $a = \pm 1$

A1: For a **correct equation/expression set up** with the correct unknown constants included. It is for getting in a position where only one more equation or constant, usually the value of *a*, needs to be found. If *a* is set = ± 1 then this mark cannot be awarded

Usually scored for one of

- using the maximum of (−2,12) to state the form $(y) = 12 \pm a(x+2)^2$
- using the symmetry to deduce roots, usually -5 and 1 to state the form $(y) = a(x-1)(x+5)$
- using the general form $(y) = ax^2 + bx + c$ and substituting in two points, usually $(-2,12)$ and $(-5,0)$ to form two different equations in *a*, *b* and *c*. Award for example for $4a - 2b + c = 12$ and $25a - 5b + c = 0$

dM1: For a full method of finding $\mathrm{f}(x)$ in any allowable form.

- using the form $y = 12 \pm a(x+2)^2$ with usually $(-5,0)$ to find *a*
- using the form $y = a(x-1)(x+5)$ with usually $(-2,12)$ to find *a*
- using the general form $y = ax^2 + bx + c$ scored for forming three equations and solving to find values for *a*, *b* and *c*. E.g Uses $(-2,12)$ and $(-5,0)$ in *y* = f(x) and then uses $2ax + b = 0$ at $x = -2$

A1: Correct equation or expression for $\mathrm{f}(x)$ or *y*. Accept in any equivalent form

- $(\mathrm{f}(x) =) 12 - \frac{4}{3}(x+2)^2$
- $(y =) -\frac{4}{3}(x-1)(x+5)$
- $(y =) -\frac{4}{3}x^2 - \frac{16}{3}x + \frac{20}{3}$

(b)

M1: Applies perpendicular condition to find gradient of l_2

Look for $\frac{-5}{4}$, -1.25 or it may be implied by an equation for l_2 of $y = \frac{-5}{4}x + ...$

M1: Uses their changed gradient with (−5,0) to find the equation of the line. Look for $y = "m_n"(x+5)$

If they use the form $y = mx + c$ with (−5,0) they must proceed as far as *c* = ...

A1: Correct equation $y = -\frac{5}{4}x - \frac{25}{4}$ o.e. Allow exact equivalents but must be in the form $y = mx + c$

(c)

M1: For identifying any two of the three restrictions given in the scheme. FT on their answers to (a) and (b) where (a) is a quadratic and (b) is linear. Allow for this mark only the inequality for the quadratic to be $y \leqslant ax^2 + bx + c$ or $y \leqslant \mathrm{f}(x)$ if that is what they identify as the curve. They may combine two of these as one statement, e.g. $\frac{4}{5}x \leqslant y \leqslant -\frac{4}{3}x^2 - \frac{16}{3}x + \frac{20}{3}$, which is fine (and scores the M1). Use of *R* instead of *y* is M0 A0

A1ft: For all three of the restrictions given in the scheme, follow through their answers to (a) and (b) Accept with strict inequalities, but should be consistent in all inequalities.

The use of set notation is fine $\left\{(x,y):\frac{4}{5}x\leqslant y\leqslant -\frac{4}{3}x^2-\frac{16}{3}x+\frac{20}{3}\right\}\cap\left\{(x,y):y\geqslant -\frac{5}{4}x-\frac{25}{4}\right\}$

Spurious additional restrictions such as $x\geqslant -5$ may be seen and should not be marked as incorrect unless the additional restriction gives further restrictions on the region *R*, e.g. $y\geqslant 0$

Do not ISW here. Mark their final answer.

Question	Scheme	Marks
6(a)	$2xy-3x^2=50;\ y-x^3+6x=0$	
	$\Rightarrow 2x\left(x^3-6x\right)-3x^2=50$	**M1**
	$\Rightarrow 2x^4-12x^2-3x^2-50=0\Rightarrow 2x^4-15x^2-50=0$* CSO	**A1***
		(2)
(b)	$\Rightarrow\left(2x^2+5\right)\left(x^2-10\right)=0\Rightarrow x^2=...$	**M1**
	So $x^2=10$	**A1**
	$\Rightarrow y=\left(\sqrt{10}\right)^3-6\sqrt{10}=...$	**M1**
	one solution pair is $x=\sqrt{10}, y=4\sqrt{10}$	**A1**
	Solutions are $x=\sqrt{10}, y=4\sqrt{10}$ and $x=-\sqrt{10}, y=-4\sqrt{10}$ CSO	**A1**
		(5)
		(7 marks)

(a)

M1: Attempts to substitute their expression for *y* from rearranging the second equation into the first equation. More difficult approaches are possible, but all should lead to an equation in just *x*

E.g 1 substituting their expression for *y* from rearranging the first equation into the second equation

E.g. 2 multiplying the second equation by 2*x* and subtracting

A1*: Correct work leading to the given answer. Expect to see correct bracketing etc and at least one intermediate line with the two x^2 terms initially uncollected. See scheme

(b) This is a non calculator question so look for evidence of calculations

M1: Uses a non calculator method to solve the given quadratic in x^2.

Allow factorisation, the quadratic formula or completing the square.

You may see a substitution, say $u=x^2$. In this case it is for solving to find *u*

Condone substitutions $y=x^2$ or $x=x^2$ if it is clear what is meant.

E.g. $2x^4-15x^2-50=0\Rightarrow x=\frac{-(-15)\pm\sqrt{(-15)^2-4\times 2\times -50}}{4}=10,-\frac{5}{2}$ scores 0 unless recovered to $x^2=10$ or $x=\sqrt{10}$

A1: A correct solution for *x* or x^2 e.g. $x^2=10$, $u=10$ $x=\pm\sqrt{10}$, $x=\sqrt{10}$ etc but not *x* = 10

Candidates cannot just write down $2x^4-15x^2-50=0\Rightarrow x=\pm\sqrt{10}$