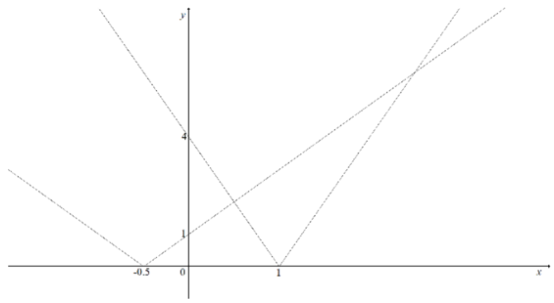
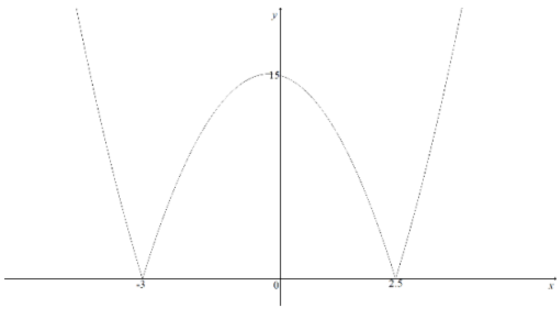
1.

Question	Answer	Marks	Guidance
4(a)	$[\text{f}(x)=]\pm 4(x+2)(x-1)(x-3)$	3	**B1** for $\pm$ **B1** for 4 **B1** for $(x+2)(x-1)(x-3)$
4(b)(i)		3	**B1** for 2 V shapes which intersect twice in the first quadrant, with vertices on the x-axis, must be straight lines, not curves. **B1** for –0.5 and 1 on the x-axis **B1** for 1 and 4 on the y-axis
4(b)(ii)	$2x + 1 = 4(x - 1)$	**M1**	For attempt to solve to get $x =$
	$x = 2.5$	**A1**	
	$2x + 1 = -4(x - 1)$ oe	**M1**	For attempt to solve to get $x =$
	$x = 0.5$	**A1**	
	Alternative $4x^2 + 4x + 1 = 16x^2 - 32x + 16$	**(M1)**	For attempt to square each equation and equate
	$12x^2 - 36x + 15 = 0$ oe	**(M1)**	Dep on previous M mark for attempt to simplify to a 3-term quadratic equation, equated to zero and attempt to solve
	$x = 2.5$ $x = 0.5$	**(A2)**	**A1** for each

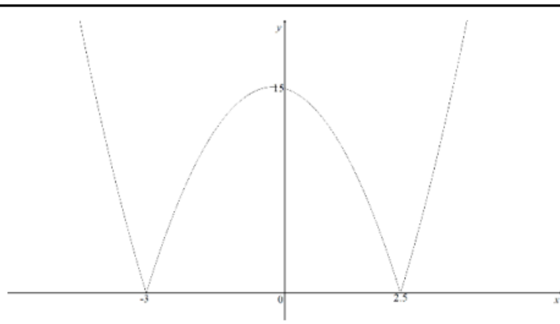
2.

$f(x)=-2x+5$ or $g(x)=x-1$ soi	**B1**	
Uses correct f(x) and g(x) to find the critical value 2 soi	**B1**	
Valid method to find other CV e.g. $2x-5*x-1$ oe seen, where * is = or any inequality sign	**M1**	**FT** *their* equations of form $y = mx + c$, for non-zero m and c; **dep** on first **B1**
Correct critical value 4 soi	**A1**	
$2 \leqslant x \leqslant 4$ mark final answer	**A1**	
Alternative method 1 $f(x)= 2x-5$ or $g(x)=x-1$ soi	**(B1)**	
Uses correct f(x) and g(x) to find the critical value 4 soi	**(B1)**	
Valid method to find other CV e.g. $-2x+5*x-1$ oe seen, where * is = or any inequality sign	**(M1)**	**FT** *their* equations of form $y = mx + c$, for non-zero m and c; **dep** on first **B1**
Correct critical value 2 soi	**(A1)**	
$2 \leqslant x \leqslant 4$ mark final answer	**(A1)**	
Alternative method 2 f(x) = $-2x + 5$ or $2x - 5$ OR g(x) = $x - 1$ soi	**(B1)**	
Squares, equates, simplifies correct f(x) and g(x): $3x^2-18x+24[*0]$	**(B1)**	where * is = or any inequality sign
Attempts to solve or factorise	**(M1)**	FT *their* 3-term quadratic from $(ax + b)^2 = (cx + d)^2$ for non-zero a, b, c and d; **dep** on first **B1**
Correct critical values 2, 4	**(A1)**	
$2 \leqslant x \leqslant 4$ mark final answer	**(A1)**	

3.

2(a)	$2\left(x+\frac{1}{4}\right)^2-\frac{121}{8}$	**2**	**B1** for $a=\frac{1}{4}$ **B1** for $b=-\frac{121}{8}$
2(b)	$\left(-\frac{1}{4},-\frac{121}{8}\right)$	**2**	**FTB1** for each, follow through on *their* a and b from **(a)** or **SC1** if differentiation is used ie $\frac{dy}{dx}=4x+1=0$ then $\left(-\frac{1}{4},-\frac{121}{8}\right)$
2(c)		**3**	**B1** for a correct shape. Must have the parabola part of the curve in the first and second quadrant with cusps and correct curvature and a max in the **2nd** quadrant. Ignore labelling of their maximum point if incorrect coordinates **B1** for a curve $\left(\frac{5}{2},0\right)$ and (–3, 0) **B1** for a curve (0, 15)
2(d)	$k=\frac{121}{8}$	**B1**	**FT** Follow through on *their* $-b$

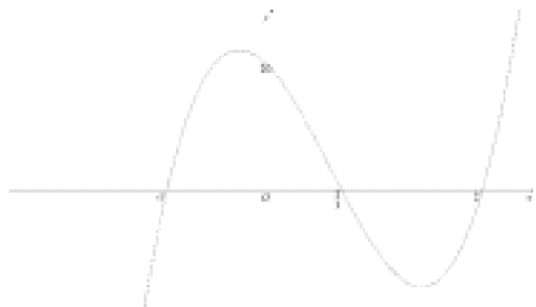
4.

2(a)	$2\left(x+\frac{1}{4}\right)^2-\frac{121}{8}$	**2**	**B1** for $a=\frac{1}{4}$ **B1** for $b=-\frac{121}{8}$
2(b)	$\left(-\frac{1}{4},-\frac{121}{8}\right)$	**2**	**FTB1** for each, follow through on *their* a and b from **(a)** or **SC1** if differentiation is used ie $\frac{dy}{dx}=4x+1=0$ then $\left(-\frac{1}{4},-\frac{121}{8}\right)$
2(c)		**3**	**B1** for a correct shape. Must have the parabola part of the curve in the first and second quadrant with cusps and correct curvature and a max in the **2nd** quadrant. Ignore labelling of their maximum point if incorrect coordinates **B1** for a curve $\left(\frac{5}{2},0\right)$ and (–3, 0) **B1** for a curve (0, 15)
2(d)	$k=\frac{121}{8}$	**B1**	**FT** Follow through on *their* $-b$

5.

$2x^2 - 8x + 3x - 12 * 3x^2 - 3x + 4x - 4$	**B1**	Correctly expands all brackets * is any inequality or equals sign
$[0*]\ x^2 + 6x + 8$	**B1**	Collects terms to correct 3-term quadratic in solvable form
$[0*](x+2)(x+4)$	**M1**	Factorises or solves *their* 3-term quadratic
–4 and –2	**A1**	Correct critical values
$-4 < x < -2$ mark final answer	**A1**	

6.

1(a)		3	**B1** for a well-drawn cubic graph in the correct orientation with both arms extending beyond x-axis **B1** for $x = -1$, $x = 2$ and $x = \frac{2}{3}$ either on the graph or stated with a cubic graph **B1** for $y = 20$ either on the graph or stated with a cubic graph
1(b)	$-1 < x < \frac{2}{3}$	**B1**	Must be found from a cubic graph
	$x > 2$	**B1**	

7.

2(a)		2	**B1** for symmetrical V shape in the correct quadrant, touching the x-axis. Must have straight lines. **B1** for $x = \frac{4}{3}$ and $y = 4$ only, either seen or stated on a modulus graph.
2(b)	$x \leqslant -1,\ x \geqslant \frac{11}{3}$ or 3.67 or better	3	**B1** for –1 from a correct method. **B1** for $\frac{11}{3}$ or 3.67 or better, from a correct method.

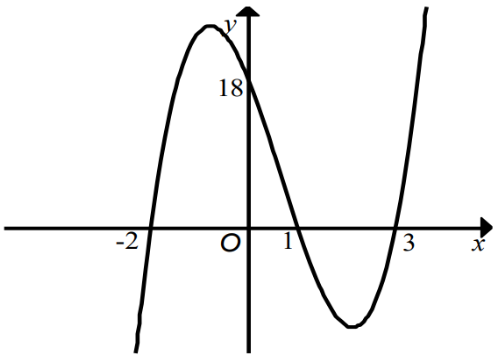
8.

2(a)		3	**B1** for the graph of either $y=\left\lvert\frac{2}{5}x\right\rvert$ or $y=\lvert x-3\rvert$, must be straight lines, not curves. **B1** for 2 correct graphs with 2 points of intersection only in the first quadrant soi. **B1** for $(0,\ 3)$ and $(3,\ 0)$, must have the correct graph of $y=\lvert x-3\rvert$.
2(b)	$\frac{2}{5}x=\pm(x-3)$ or $\left(\frac{2}{5}x\right)^2=(x-3)^2$ $x=5,\quad x=\frac{15}{7}$ or 2.14 or better	2	**B1** for each.

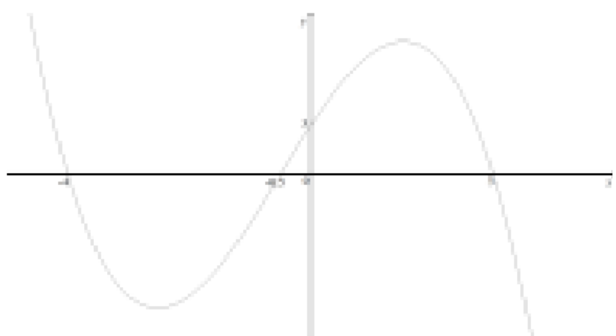
9.

3(a)	$4x-1*9$ oe and $4x-1*-9$ oe OR $16x^2-8x-80*0$ oe soi	**M1**	where * could be = or any inequality sign
	$x>\frac{5}{2},\ x<-2$ only; **mark final answer**	**A2**	not from wrong working **A1** for CV $\frac{5}{2}$, -2 oe If M0 then **SC1** for any correct inequality with at most one extra inequality
3(b)	$\left(2\sqrt{x}-3\right)\left(\sqrt{x}-4\right)$ or $x=u^2$ and $(2u-3)(u-4)$ oe soi	**M1**	
	$\sqrt{x}=\frac{3}{2},\ \sqrt{x}=4$ oe	**A1**	
	$x=\frac{9}{4}$, $x=16$	**B1**	**FT** their $\sqrt{x}$
	Alternative $(2x+12)^2=\left(11x^{\frac{1}{2}}\right)^2$ simplified to $4x^2-73x+144=0$	**(M1)**	
	solves 3 term quadratic in x	**(M1)**	
	$x=\frac{9}{4}$, $x=16$	**(A1)**	

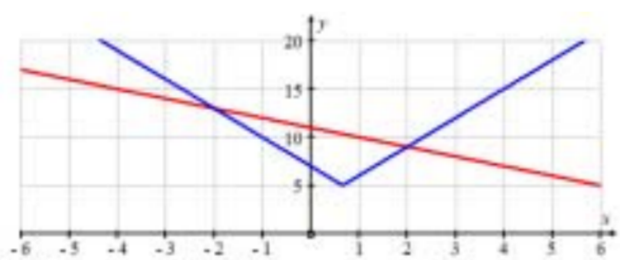
10.

2	Correct graph and intercepts 	**B3**	**B1** for correct shape; the ends must extend above and below the x-axis **B1** for correct roots indicated; must have attempted a cubic shape **B1** for correct y-intercept indicated; must have attempted a cubic shape

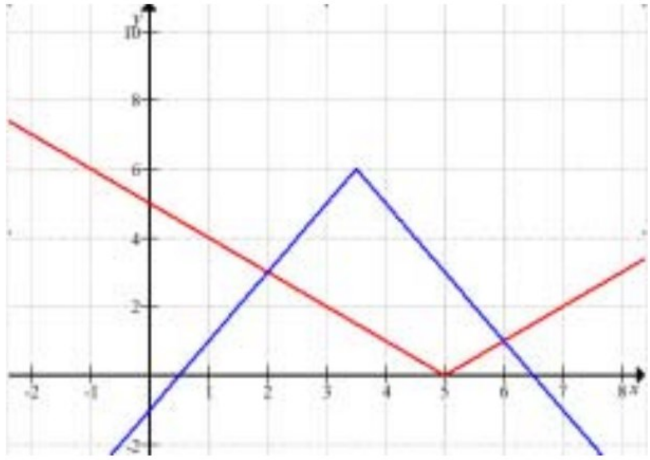
11.

	**3**	**B1** for a cubic shape with a maximum in the first quadrant, a minimum in the third quadrant, extending into the second and 4th quadrants. The extensions must not curve incorrectly and not lead to a complete stationary point. **B1** for x-intercepts $-4,-\frac{1}{2},3$ either on diagram or stated but must be with a cubic graph. **B1** for y-intercept 3 either on diagram or stated but must be with a cubic graph.

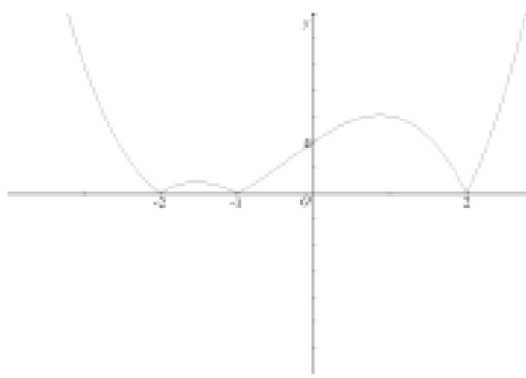
12.

1(a)		**4**	**M1** for $\vee$ shape of $y=5+\lvert 3x-2\rvert$ with vertex at $\left(\frac{2}{3},5\right)$ **A1** for correct graph with y-intercept $(0,7)$ **M1** for correct straight line for $y=11-x$ **A1** for correct straight line with y-intercept $(0,11)$
1(b)	$x>2$ or $x<-2$	**B2**	Mark final answer for **B2** **B1 FT** for exactly two correct critical values or correct FT critical values soi, FT dependent on at least M1 in **(a)**

13.

1(a)		**4**	**M1** for $y = \lvert x-5 \rvert$: ∨ shape with vertex at (5, 0) **A1** Correct graph with y-intercept at (0, 5) **M1** for $y = 6 - \lvert 2x-7 \rvert$: ∧ shape with vertex at (3.5, 6) **A1** Correct graph with y-intercept at (0, –1)
1(b)	$x < 2$ or $x > 6$ final answer	**B2**	**B1** for exactly two correct critical values or **B1 FT** for exactly two correct FT critical values soi, FT dependent on at least M1 in **(a)** If the CVs are decimal allow BOD for reasonable values

14.

1		**B1**	Shape
		B1	Correct x-coordinates
		B1	Correct y-coordinate and max in first quadrant

15.

1	$x^2 - 18x + 45$ (= 0)	**B1**	Expand and simplify to three terms.
	$(x-15)(x-3)(= 0)$ or $x = \dfrac{18 \pm \sqrt{18^2 - 4\times 45}}{2}$ or $(x-9)^2 = -45 + 81$	**M1**	Factorise or use formula on *their* 3 term quadratic or complete the square
	$x = 15$ and $x = 3$	**A1**	
	$x < 3$ or $x > 15$ or $(-\infty, 3) \cup (15, \infty)$	**A1**	oe Do not accept 'and'. Do not accept $3 > x > 15$. Mark final answer.

16.

1	$x = 3$	**B1**	
	$2 - 3x = 4 + x$ oe	**M1**	
	$x = -0.5$ oe	**A1**	

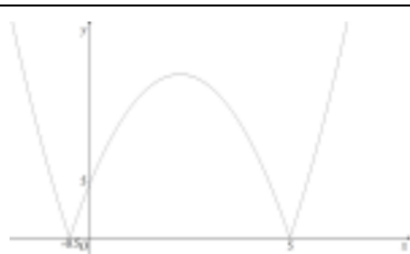
17.

1	$6x^2 + 7x - 20\,[*0]$	**M1**	where * may be any inequality sign or =
	Critical values $\frac{4}{3}$, $-\frac{5}{2}$	**A1**	
	$x \leqslant -\frac{5}{2}$ or $x \geqslant \frac{4}{3}$ final answer	**A1**	**FT** *their* critical values using outside regions

18.

3(i)	Correct shape 0.6 oe indicated on x-axis 3 indicated on y-axis	**3**	**B1** correct shape must have cusp on x-axis **B1** for each correct point There must be a sketch to award the marks for the intercepts and sketch should be continuous with one intersection only on each axis
3(ii)	Solves $5x - 3 = x - 2$ oe or $(5x-3)^2 = (2-x)^2$	**M1**	
	$[x =]\,\frac{1}{4}$ oe	**A1**	
	$[x =]\,\frac{5}{6}$ oe	**B1**	

19.

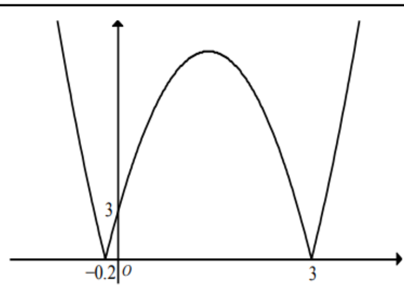
4(i)		**B4**	**B1** for shape, with max in first quadrant **B1** for $(-0.5, 0)$ and $(5, 0)$ **B1** for $(0, 5)$ **B1** all correct, with cusps and correct curvature for $x < 0.5$ and $x > 5$

4(ii)	$k = 0$	**B1**	Not from incorrect work
	Stationary point when $y = \pm\frac{121}{8}$ or ± 15.125	**M1**	For attempt to find y-coordinate of stationary point, must be a complete method i.e. Use of calculus Use of discriminant, Use of completing the square Use of symmetry Allow if seen in part (i), but must be used in (ii)
	$k > \frac{121}{8}$	**A1**	cao

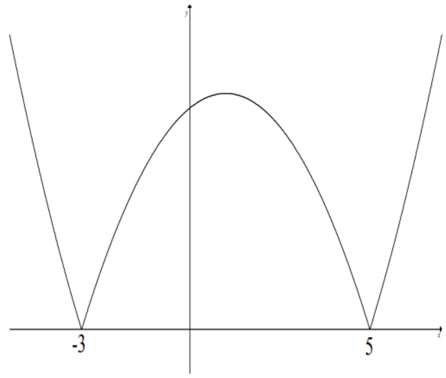
20.

1	$x = 1$	**B1**	
	$-3x - 2 = x + 4$ oe	**M1**	
	$x = -1.5$ oe	**A1**	

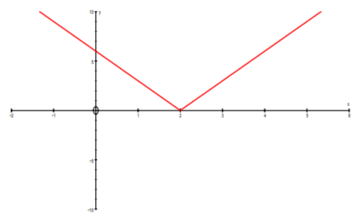
21.

9(i)	$5\left(x - \frac{7}{5}\right)^2 - \frac{64}{5}$	**B3**	**B1** for each of p, q, r correct in correct format; allow correct equivalent values. If **B0**, then **SC2** for $5\left(x - \frac{7}{5}\right) - \frac{64}{5}$ or **SC1** for correct values but incorrect format
9(ii)		**B4**	**B2** for fully correct shape in correct position or **B1** for fully correct shape translated parallel to the x-axis **B1** for y-intercept at (0, 3) marked on graph **B1** for roots marked on graph at –0.2 and 3
9(iii)	$0 < k < \left\| their\left(-\frac{64}{5}\right)\right\|$	**B2**	**FT** *their* **(i)** **B1** for any inequality using *their* $\frac{64}{5}$ or max y value is *their* 12.8soi

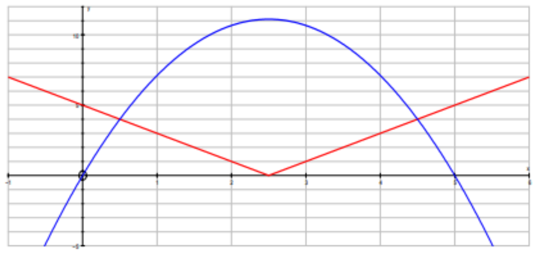
22.

10(a)(i)		**B2**	**B1** for correct shape **B1** for roots marked on the graph or seen nearby provided graph drawn and one root is negative and one is positive

23.

3(i)		**B2**	**B1** for correct shape with vertex at $(2,0)$ **Dep B1** for passing through or starting at $(0,6)$
3(ii)	**Either** $6-3x=2$ $x=\frac{4}{3}$	**B1**	For $x=\frac{4}{3}$
	$6-3x=-2$	**M1**	For considering – 2
	$x=\frac{8}{3}$	**A1**	
	Or $9x^2-36x+32=0$	**M1**	For squaring each side and attempt to solve a 3 term quadratic = 0
	$x=\frac{4}{3}$	**A1**	
	$x=\frac{8}{3}$	**A1**	
3(iii)	$x<\frac{4}{3}$, $x>\frac{8}{3}$	**B1**	**FT** on *their* solutions in part **(ii)**, must both be positive and written as 2 separate statements

24.

8(i)		**B5**	**B1** for shape of modulus function **B1** for y intercept = 5 (for modulus graph only) **B1** for x intercept = 2.5 at the V of a modulus graph **B1** for shape of quadratic function for $-1 \leqslant x \leqslant 6$ **B1** for intercepts at $x = 0$ and $x = 5$ for a quadratic graph
8(ii)	$2x-5=\pm 4$	**B1**	one correct answer
	$x=\frac{9}{2}$	**M1**	solution of two different correct linear equations or solution of an equation obtained from squaring both sides or use of symmetry from first solution.
	$x=\frac{1}{2}$	**A1**	second correct solution
8(iii)	$16\left(\frac{1}{2}\right)^2-80\left(\frac{1}{2}\right)+36=4$ and $16\left(\frac{9}{2}\right)^2-80\left(\frac{9}{2}\right)+36=4$	**B1**	verification using both x values or for forming and solving $16x^2-80x+36=0$
8(iv)	using *their* values from (ii) in an equality of the form $a \leqslant x \leqslant b$ or $a < x < b$	**M1**	
	$\frac{1}{2} \leqslant x \leqslant \frac{9}{2}$ cao	**A1**	

25.

$5x + 3 = 3x - 1$ oe or $5x + 3 = 1 - 3x$ oe	**M1**	
$x = -2$ and $x = -0.25$ only mark final answer	**A2**	nfww **A1** for $x = -2$ ignoring extras implies M1 if no extras seen If M0 then **SC1** for any correct value with at most one extra value
Alternative method $(5x+3)^2=(1-3x)^2$ oe soi	**M1**	
$16x^2+36x+8=0$ oe	**A1**	
$x=-0.25$, $x=-2$ only; mark final answer	**A1**	

26.

Correctly obtain a value of $x = 2$	**B1**	Inequality not required
Correctly obtain a value of $x = -\frac{1}{2}$	**B1**	Inequality not required
$x > 2$ and $x < -\frac{1}{2}$	**B1**	**B1dep** mark final answer(s). Allow $2 < x < -\frac{1}{2}$

27.

$3x - 1 = 5 + x$ $\quad\quad x = 3$	**B1**	
$3x - 1 = -5 - x$ oe	**M1**	M1 not earned if incorrect equation(s) present
$x = -1$	**A1**	