Question	Scheme	Marks	AOs
6 (a)	$3x^3 - 17x^2 - 6x = 0 \Rightarrow x\left(3x^2 - 17x - 6\right) = 0$	M1	1.1a
	$\Rightarrow x(3x+1)(x-6) = 0$	dM1	1.1b
	$\Rightarrow x = 0, -\frac{1}{3}, 6$	A1	1.1b
		(3)	
(b)	Attempts to solve $(y-2)^2 = n$ where n is any solution $\geqslant 0$ to (a)	M1	2.2a
	Two of $2, 2 \pm \sqrt{6}$	A1ft	1.1b
	All three of $2, 2 \pm \sqrt{6}$	A1	2.1
		(3)	
			(6 marks)

Notes

(a)

M1: Factorises out or cancels by x to form a quadratic equation.

dM1: Scored for an attempt to find x. May be awarded for factorisation of the quadratic or use of the quadratic formula.

A1: $x = 0, -\frac{1}{3}, 6$ and no extras

(b)

M1: Attempts to solve $(y-2)^2 = n$ where n is any solution $\geqslant 0$ to (a). At least one stage of working must be seen to award this mark. Eg $(y-2)^2 = 0 \Rightarrow y = 2$

A1ft: Two of $2, 2 \pm \sqrt{6}$ but follow through on $(y-2)^2 = n \Rightarrow y = 2 \pm \sqrt{n}$ where n is a positive solution to part (a). (Provided M1 has been scored)

A1: All three of $2, 2 \pm \sqrt{6}$ and no extra solutions. (Provided M1A1 has been scored)

Question	Scheme	Marks	AOs
9(a)	$(\mathrm{g}(-2)) = 4\times-8-12\times4-15\times-2+50$	M1	1.1b
	$\mathrm{g}(-2)=0 \Rightarrow (x+2)$ is a factor	A1	2.4
		(2)	
(b)	$4x^3-12x^2-15x+50=(x+2)(4x^2-20x+25)$	M1 A1	1.1b 1.1b
	$=(x+2)(2x-5)^2$	M1 A1	1.1b 1.1b
		(4)	
(c)	(i) $x \leqslant -2,\ x=2.5$	M1 A1ft	1.1b 1.1b
	(ii) $x=-1,\ x=1.25$	B1ft	2.2a
		(3)	
			(9 marks)

(a)

M1: Attempts $\mathrm{g}(-2)$ Some sight of (-2) embedded or calculation is required.

So expect to see $4\times(-2)^3-12\times(-2)^2-15\times(-2)+50$ embedded

Or $-32-48+30+50$ condoning slips for the M1

Any attempt to divide or factorise is M0. (See demand in question)

A1: $\mathrm{g}(-2)=0 \Rightarrow (x+2)$ is a factor.

Requires a correct statement and conclusion. Both "$\mathrm{g}(-2)=0$" and "$(x+2)$ is a factor" must be seen in the solution. This may be seen in a preamble before finding $\mathrm{g}(-2)=0$ but in these cases there must be a minimal statement ie QED, "proved", tick etc.

Also accept, in one coherent line/sentence, explanations such as, 'as g (x) =0 when $x=-2$, $(x+2)$ is a factor.'

(b)

M1: Attempts to divide $\mathrm{g}(x)$ by $(x+2)$ May be seen and awarded from part (a)

If inspection is used expect to see $4x^3-12x^2-15x+50=(x+2)(4x^2\ldots\ldots\ldots\ldots\pm25)$

If algebraic / long division is used expect to see
$$\begin{array}{r} 4x^2 \pm 20x \qquad\qquad\quad \\ x+2\overline{\smash{)}\,4x^3-12x^2-15x+50} \end{array}$$

A1: Correct quadratic factor is $(4x^2-20x+25)$ may be seen and awarded from part (a)

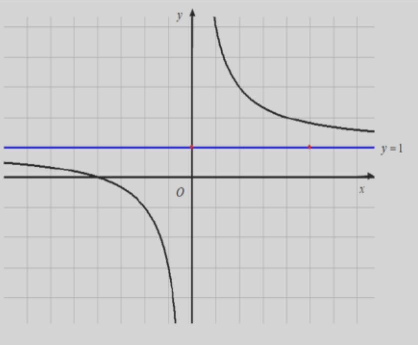
M1: Attempts to factorise their $(4x^2-20x+25)$ usual rule $(ax+b)(cx+d), ac=\pm4, bd=\pm25$

A1: $(x+2)(2x-5)^2$ oe seen on a single line. $(x+2)(-2x+5)^2$ is also correct.

Allow recovery for all marks for $\mathrm{g}(x)=(x+2)(x-2.5)^2=(x+2)(2x-5)^2$

(c)(i)

M1: For identifying that the solution will be where the curve is on or below the axis. Award for either $x \leqslant -2$ or $x=2.5$ Follow through on their $\mathrm{g}(x)=(x+2)(ax+b)^2$ only where $ab<0$ (that is a positive root). Condone $x<-2$ See SC below for $\mathrm{g}(x)=(x+2)(2x+5)^2$

Question	Scheme	Marks	AOs
7 (a)	 $\frac{1}{x}$ shape in 1st quadrant	M1	1.1b
	Correct	A1	1.1b
	Asymptote $y=1$	B1	1.2
		(3)	
(b)	Combines equations $\Rightarrow \frac{k^2}{x}+1=-2x+5$	M1	1.1b
	$(\times x)\Rightarrow k^2+1x=-2x^2+5x \Rightarrow 2x^2-4x+k^2=0$ *	A1*	2.1
		(2)	
(c)	Attempts to set $b^2-4ac=0$	M1	3.1a
	$8k^2=16$	A1	1.1b
	$k=\pm\sqrt{2}$	A1	1.1b
		(3)	
			(8 marks)

Notes

(a)

M1: For the shape of a $\frac{1}{x}$ type curve in Quadrant 1. It must not cross either axis and have acceptable curvature. Look for a negative gradient changing from $-\infty$ to 0 condoning "slips of the pencil". (See Practice and Qualification for clarification)

A1: Correct shape and position for both branches.
It must lie in Quadrants 1, 2 and 3 and have the correct curvature including asymptotic behaviour

B1: Asymptote given as $y=1$. This could appear on the diagram or within the text.
Note that the curve does not need to be asymptotic at $y=1$ but this must be the only horizontal asymptote offered by the candidate.

(b)

M1: Attempts to combine $y=\frac{k^2}{x}+1$ with $y=-2x+5$ to form an equation in just x

A1*: Multiplies by x (the processed line must be seen) and proceeds to given answer with no slips.
Condone if the order of the terms are different $2x^2+k^2-4x=0$

(c)

M1: Deduces that $b^2-4ac=0$ or equivalent for **the given equation.**
If a, b and c are stated only accept $a=2, b=\pm4, c=k^2$ so $4^2-4\times2\times k^2=0$
Alternatively completes the square $x^2-2x+\frac{1}{2}k^2=0 \Rightarrow (x-1)^2=1-\frac{1}{2}k^2 \Rightarrow "1-\frac{1}{2}k^2"=0$

A1: $8k^2=16$ or exact simplified equivalent. Eg $8k^2-16=0$

Question	Scheme	Marks	AOs
11 (a)	Attempts $\mathrm{f}(4)=2\times4^3-13\times4^2+8\times4+48$	M1	1.1b
	$\mathrm{f}(4)=0\Rightarrow(x-4)$ is a factor	A1	1.1b
		(2)	
(b)	$2x^3-13x^2+8x+48=(x-4)(2x^2...x-12)$	M1	2.1
	$=(x-4)(2x^2-5x-12)$	A1	1.1b
	Attempts to factorise quadratic factor or solve quadratic eqn	dM1	1.1b
	$\mathrm{f}(x)=(x-4)^2(2x+3)\Rightarrow\mathrm{f}(x)=0$ has only two roots, 4 and -1.5	A1	2.4
		(4)	
(c)	Deduces either three roots or deduces that $\mathrm{f}(x)$ is moved down two units	M1	2.2a
	States three roots, as when $\mathrm{f}(x)$ is moved down two units there will be three points of intersection (with the x - axis)	A1	2.4
		(2)	
(d)	For sight of $k=\pm4,\pm\frac{3}{2}$	M1	1.1b
	$k=4,-\frac{3}{2}$	A1ft	1.1b
		(2)	
			(10 marks)

Notes

(a)

M1: Attempts to calculate $\mathrm{f}(4)$.

Do not accept $\mathrm{f}(4)=0$ without sight of embedded values or calculations.

If values are not embedded look for two correct terms from $\mathrm{f}(4)=128-208+32+48$

Alternatively attempts to divide by $(x-4)$. Accept via long division or inspection.

See below for awarding these marks.

A1: Correct reason with conclusion. Accept $\mathrm{f}(4)=0,$ hence factor as long as M1 has been scored.

This should really be stated on one line after having performed a correct calculation. It could appear as a preamble if the candidate states "If $\mathrm{f}(4)=0,$ then $(x-4)$ is a factor before doing the calculation and then writing hence proven or ✓ oe.

If division/inspection is attempted it must be correct and there must be some attempt to explain why they have shown that $(x-4)$ is a factor. Eg Via division they must state that there is no remainder, hence factor

(b)

M1: Attempts to find the quadratic factor by inspection (correct first and last terms) or by division (correct first two terms)

Question	Scheme	Marks	AOs
4(a)	States or uses $f(+3) = 0$	M1	1.1b
	$4(3)^3 - 12(3)^2 + 2(3) - 6 = 108 - 108 + 6 - 6 = 0$ and so $(x - 3)$ is a factor	A1	1.1b
		(2)	
(b)	Begins division or factorisation so x $4x^3 - 12x^2 + 2x - 6 = (x - 3)(4x^2 + \ldots)$	M1	2.1
	$4x^3 - 12x^2 + 2x - 6 = (x - 3)(4x^2 + 2)$	A1	1.1b
	Considers the roots of their quadratic function using completion of square or discriminant	M1	2.1
	$(4x^2 + 2) = 0$ has no real roots with a reason (e.g. negative number does not have a real square root, or $4x^2 + 2 > 0$ for all x So $x = 3$ is the only real root of $f(x) = 0$ *	A1*	2.4
		(4)	
		(6 marks)	

Notes:

(a)

M1: States or uses $f(+3) = 0$

A1: See correct work evaluating and achieving zero, together with correct conclusion

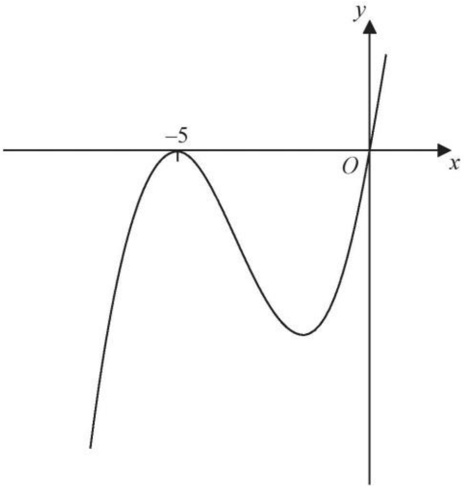
(b)

M1: Needs to have $(x - 3)$ and first term of quadratic correct

A1: Must be correct – may further factorise to $2(x - 3)(2x^2 + 1)$

M1: Considers their quadratic for no real roots by use of completion of the square or consideration of discriminant then

A1*: A correct explanation

Question	Scheme	Marks	AOs
13(a)	$x^3+10x^2+25x=x(x^2+10x+25)$	M1	1.1b
	$=x(x+5)^2$	A1	1.1b
		(2)	
(b)	 A cubic with correct orientation	M1	1.1b
	Curve passes through the origin (0, 0) and touches at (− 5, 0) (see note below for ft)	A1ft	1.1b
		(2)	
(c)	Curve has been translated a to the left	M1	3.1a
	$a = -2$	A1ft	3.2a
	$a = 3$	A1ft	1.1b
		(3)	
		(7 marks)	

Notes:

(a)

M1: Takes out factor x

A1: Correct factorisation – allow $x(x + 5)(x + 5)$

(b)

M1: Correct shape

A1ft: Curve passes through the origin (0, 0) and touches at (− 5, 0) – allow follow through from incorrect factorisation

(c)

M1: May be implied by one of the correct answers for a or by a statement

A1ft: ft from their cubic as long as it meets the x-axis only twice

A1ft: ft from their cubic as long as it meets the x-axis only twice

Question Number	Scheme	Marks
6. (a)	Attempt $\mathrm{f}(3)$ or $\mathrm{f}(-3)$ Use of long division is M0A0 as factor theorem was required. $\mathrm{f}(-3)=162-63-120+21=0$ so $(x+3)$ is a factor	M1 A1 **(2)**
(b)	Either (Way 1): $\mathrm{f}(x)=(x+3)(-6x^2+11x+7)$ $=(x+3)(-3x+7)(2x+1)$ or $-(x+3)(3x-7)(2x+1)$	M1A1 M1A1 **(4)**
	Or (Way 2) Uses trial or factor theorem to obtain $x=-1/2$ **or** $x=7/3$ Uses trial or factor theorem to obtain both $x=-1/2$ **and** $x=7/3$ Puts three factors together (see notes below) Correct factorisation : $(x+3)(7-3x)(2x+1)$ or $-(x+3)(3x-7)(2x+1)$ oe	M1 A1 M1 A1 **(4)**
	Or (Way 3) No working three factors $(x+3)(-3x+7)(2x+1)$ otherwise need working	M1A1M1A1 **(4)**
(c)	$2^y=\frac{7}{3}$, $\rightarrow$ $\log\left(2^y\right)=\log\left(\frac{7}{3}\right)$ or $y=\log_2\left(\frac{7}{3}\right)$ or $\dfrac{\log(7/3)}{\log 2}$ $\{y=1.222392421...\}$ $\Rightarrow$ $y=$ awrt 1.22	B1, M1 A1 **(3)** **[9]**
	Notes	
(a)	M1 for attempting either $\mathrm{f}(3)$ or $\mathrm{f}(-3)$ – with **numbers substituted into expression** A1 for calculating $\mathrm{f}(-3)$ **correctly to 0**, and they must state $(x+3)$ **is a factor** for A1 (or equivalent ie. QED, □ or a tick). A conclusion may be implied by a preamble, “if f(−3) = 0, (x+3) is a factor”. $-6(-3)^3-7(-3)^2+40(-3)+21=0$ so $(x+3)$ is a factor of f(x) is M1A1 providing bracketing is correct.	
(b)	1st M1: attempting to divide by $(x+3)$ leading to a 3TQ beginning with the correct term, usually $-6x^2$. This may be done by a variety of methods including long division, comparison of coefficients, inspection etc. Allow for work in part (a) if the result is used in (b). 1st A1: usually for $(-6x^2+11x+7)$ … Credit when seen and use isw if miscopied 2nd M1: for a ***valid**** attempt to factorise their quadratic (* see notes on page 6 - General Principles for Core Mathematics Marking section 1) 2nd A1 is cao and needs all three factors together fully factorised. Accept e.g. $-3(x+3)(x-\frac{7}{3})(2x+1)$ but $(x+3)(x-\frac{7}{3})(-6x-3)$ and $(x+3)(3x-7)(-2x-1)$ are A0 as not fully factorised. Ignore subsequent work (such as a solution to a quadratic equation.) Way 2: The second M mark needs three roots together so $\pm 6(x-\alpha)(x-\beta)(x+3)$ or equivalent where they obtained α and β by trial, so if correct roots identified, then $(x+3)(3x-7)(2x+1)$ can gain M1A1M1A0. N.B. Replacing $(-6x^2+11x+7)$ (already awarded M1A1) by $(6x^2-11x-7)$ giving $(x+3)(3x-7)(2x+1)$ can have M1A0 for factorization so M1A1M1A0	
(c)	B1: $2^y=\frac{7}{3}$ M1: Attempt to take logs to solve $2^y=\alpha$ or $2^y=1/\alpha$, where $\alpha>0$ and α was a root of their factorization. A1: for an answer that rounds to 1.22. If other answers are included (and not “rejected”) such as ln(− 3) or − 1 lose final A mark **Special case:** Those who deal **throughout** with $\mathrm{f}(x)=6x^3+7x^2-40x-21$ They may have full credit in part (a). In part (b) they can achieve a maximum of M1A0M1A0 unless they return the negative sign to give the correct answer. This is then full marks. Part (c) is fine. So they could lose 2 marks on the factorisation. (Like a misread)	

Question Number	Scheme	Marks
1.	The line l_1 has equation $8x+2y-15=0$	
(a)	Gradient is -4	B1 **[1]**
(b)	Gradient of parallel line is equal to their previous gradient	M1
	Equation is $y-16="-4"\left(x-\left(-\frac{3}{4}\right)\right)$	M1
	So $y=-4x+13$	A1 **[3]** **(4 marks)**

(a)

B1 Gradient, m, $\frac{dy}{dx}$ given as -4 FINAL ANSWER

Do not allow $-\frac{8}{2}$ or $-\frac{4}{1}$ or $-4 \rightarrow \frac{1}{4}$ in part (a). Do not allow if left as $y=-4x+..$

(b)

M1 Gradient of lines are the same. This may be implied by sight of their $'-4'$ in a gradient equation. For example you may see candidates state $y='-4'x+..$ in (a) and then write $y='-4'x+c$ in (b)

M1 For an attempt to find an equation of a line using $\left(-\frac{3}{4},16\right)$ and a numerical gradient (which may be different to the gradient used in part (a)). For example they may try to find a normal! Condone a sign error on one of the brackets. If the form $y=mx+c$ is used they must proceed as far as finding c.

A1 cao $y=-4x+13$ Allow $m=-4, c=13$

Question Number	Scheme	Marks
2.(a)	$(0,3)$	B1
(b)	$(2,-3)$	B1
(c)	$(2,1.5)$ oe	B1
(d)	$(2,-1)$	B1 **[4]** **(4 marks)**

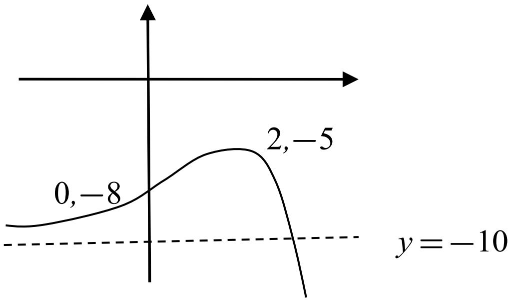
Condone the omission of the brackets. Eg Condone $0,3$ for $(0,3)$

Allow $x=...y=...$

If options are given, Attempt one $=(0,3)$, Attempt two = $(2,5)$, Award B0.

If there is no labelling mark (a) as the first one seen, (b) as the second one seen etc unless it is obvious.

Question Number	Scheme	Marks
5(a)	Attempts $\mathrm{f}(\pm 1)$ Remainder =2	M1 A1 **(2)**
(b)	Attempts $\mathrm{f}(\pm 3) = -4\times(\pm 3)^3 + 16\times(\pm 3)^2 - 13\times(\pm 3) + 3$ Remainder = $0 \Rightarrow (x-3)$ is a factor	M1 A1* **(2)**
(c)	Divides their f(x) by $(x-3)$ to get the quadratic factor $\left(-4x^2+4x-1\right)$ $\mathrm{f}(x) = (x-3)\times -(2x-1)(2x-1) = (3-x)(2x-1)^2$	M1 A1 dM1A1 **(4)**
(d)	$\mathrm{f}(x) \leqslant 0 \Rightarrow (3-x)(2x-1)^2 \leqslant 0$ $x = \frac{1}{2}, x \geqslant 3$	B1,B1 **(2)** **(10 marks)**

Question Number	Scheme	Marks
7 (a)	(8, 5)	B1 **(1)**
(b)	$y=7$	B1 **(1)**
(c)	$5<k<10$	M1A1 **(2)**
(d)	 Shape	B1
	(0,-8) and (2,-5)	B1
	Asymptote	B1
		(3) **(7 marks)**

(a)

B1 Accept (8, 5) or x =8, y = 5 or a sketch of $y=\mathrm{f}\left(\frac{1}{4}x\right)$ with a minimum point marked at (8, 5)

(b)

B1 $y=7$. It must be an equation and not just '7'

(c)

M1 Accept one "side" of the inequality condoning a misunderstanding of whether the boundary is included or not. Allow for $k>5$, $k\geqslant 5$, $k<10$, $k\leqslant 10$ Condone a different variable for the M1

A1 cao $5<k<10$. Allow $k>5$ **and** $k<10$ $k>5,\ k<10$ $(5,10)$ $\{k\in\mathbb{R}:5<k<10\}$

Do not allow $k>5$ **or** $k<10$

(d)

B1 For a reflection of the original curve in the x – axis.

Look for the shape shown in the scheme but be tolerant of slips at either end.

B1 For the graph to have an intercept of $(0,-8)$ and a (single) **maximum** point of $(2,-5)$

Accept -8 being marked on the y- axis and the graph passing through this.

Condone $(-8,0)$ as long as it is marked on the correct axis

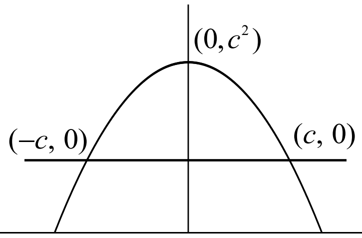
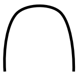
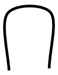
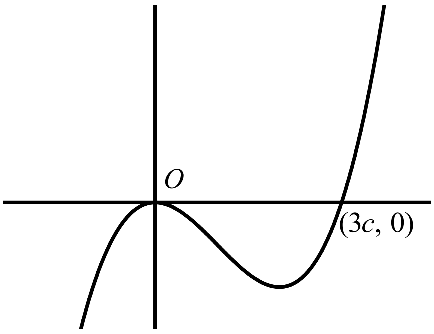
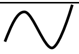
B1 For giving the equation of the asymptote as $y=-10$

The graph must clearly be asymptotic but be tolerant of slips. See practice items for clarification.

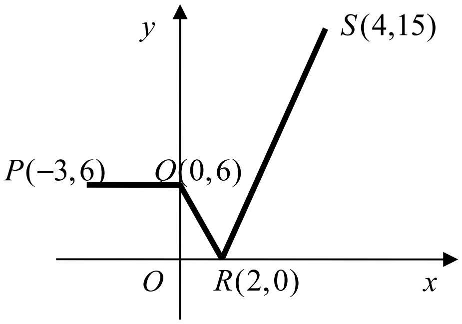
Question Number	Scheme	Marks
	But note that if all that is seen is $(x+2)\left(x+\frac{1}{2}\right)(x-5)$ this scores 1000	
		(4)

(d)	$3^t = '5' \Rightarrow t\log 3 = \log '5'$	Solves $3^t = k$ where $k > 0$ and follows from their (c) to obtain $t\log 3 = \log k$. Accept sight of $t = \log_3 k$ where $k > 0$ and follows from their (c)	M1
	$\Rightarrow t = \text{awrt } 1.465$ only	$t = \text{awrt } 1.465$ and no other solutions	A1
			(2)
			(10 marks)

Question Number	Scheme		Marks
9(a)	$\mathrm{f}(x) = 8x^{-1} + \frac{1}{2}x - 5$ $\Rightarrow \mathrm{f}'(x) = -8x^{-2} + \frac{1}{2}$	M1: $-8x^{-2}$ or $\frac{1}{2}$ A1: Fully correct $\mathrm{f}'(x) = -8x^{-2} + \frac{1}{2}$ **(may be un-simplified)**	M1A1
	Sets $-8x^{-2} + \frac{1}{2} = 0 \Rightarrow x = 4$	M1: Sets their $\mathrm{f}'(x) = 0$ i.e. a "changed" function (may be implied by their work) and proceeds to find x. A1: $x = 4$ (Allow $x = \pm 4$)	M1A1
	$(4, -1)$	Correct coordinates (allow $x = 4, y = -1$). Ignore their (-4, …)	A1
			(5)
(b)(i)	$(x =)2, 8$	$x = 2$ and $x = 8$ **only**. Do **not** accept as coordinates here.	B1
(b)(ii)	$(4,\ 1)$	$(4,\ 1)$ or follow through on their solution in (a). Accept $(x, y+2)$ from their (x, y). **With no other points.**	B1ft
(b)(iii)	$(x =)2, \frac{1}{2}$	Both answers are needed and **accept** $(2,\ 0), \left(\frac{1}{2},\ 0\right)$ here. Ignore any reference to the image of the turning point.	B1
			(3)
			(8 marks)

Question Number	Scheme	Marks
13(a)(i)		
	 Or  shape anywhere but not  The maximum must be smooth and not form a point and the branches must not clearly turn back in on themselves. **or** A continuous graph passing through or touching at the points (-c, 0), (c, 0) and (0, c^2). They can appear on their sketch or within the body of the script but there must be a sketch. Allow these marked as $-c$, c and c^2 in the correct places. Allow (0, -c), (0, c) and (c^2, 0) as long as they are marked in the correct places. If there is any ambiguity, the sketch takes precedence.	B1
	A fully correct diagram with the curve in the correct position and the intercepts and shape as described above. The maximum must be on the y-axis and the branches must extend below the x-axis.	B1
(a)(ii)	**There must be a sketch to score any marks in (a)**	
	  Shape. A positive cubic with only one maximum and one minimum. The curve must be smooth at the maximum and at the minimum (not pointed).	B1
	A smooth curve that touches or meets the x-axis at the origin and $(3c, 0)$ in the correct place and no other intersections. The origin does not need to be marked but the $(3c, 0)$ does. Allow 3c or $(0,\ 3c)$ to be marked in the correct place. May appear on their sketch or within the body of the script. If there is any ambiguity, the sketch takes precedence.	B1
	Maximum at the origin (allow the maximum to form a point or cusp)	B1
	There must be a sketch to score any marks in (a)	**(5)**
(b)	Intersect when $x^2(x-3c) = c^2 - x^2 \Rightarrow x^3 - 3cx^2 = c^2 - x^2$ Sets equations equal to each other and attempts to multiply out the bracket or vice versa	M1
	$x^3 + x^2 - 3cx^2 - c^2 = 0$ $\Rightarrow x^3 + (1-3c)x^2 - c^2 = 0*$ Collects to one side (may be implied), factorises the x^2 terms and obtains printed answer with no errors. **There must be an intermediate line of working.** **Allow** $x^3 + x^2(1-3c) - c^2 = 0$ or $0 = x^3 + (1-3c)x^2 - c^2$ or $0 = x^3 + x^2(1-3c) - c^2$	A1*
		(2)

(c)	$8+4(1-3c)-c^2=0$	Substitutes $x=2$ to give a **correct** un-simplified form of the equation.	M1
	$c^2+12c-12=0$	Correct 3 term quadratic. Allow any equivalent form with the terms collected (may be implied)	A1
	$(c+6)^2-36-12=0 \Rightarrow c=...$ or $c=\dfrac{-12\pm\sqrt{12^2-4\times1\times(-12)}}{2}$	Solves their 3TQ by using the formula or completing the square **only**. This may be implied by a correct **exact** answer for their 3TQ. (May need to check)	M1
	$4\sqrt{3}-6$	$c=4\sqrt{3}-6$ or $c=-6+4\sqrt{3}$ **only**	A1
			(4)
			(11 marks)

Question Number	Scheme	Marks
14(a)	Sets $\frac{1}{2}x = ax + 4$ where $a < 0$	M1
	Solves $\frac{1}{2}x = -2x + 4 \Rightarrow \frac{5}{2}x = 4 \Rightarrow x = \frac{8}{5}$ oe	dM1A1
	Sets $\frac{1}{2}x = 5x + b$ where $b < 0$	M1
	Solves $\frac{1}{2}x = 5x - 10 \Rightarrow \frac{9}{2}x = 10 \Rightarrow x = \frac{20}{9}$ oe	dM1A1
		(6)
(b)	 Any two points correct	B1
	Same 'shape' with 4 points correct	B1
		(2)
		(8 marks)

(a)

M1 Attempts the smaller solution. Accept setting $\frac{1}{2}x = ax + 4$ where $a < 0$

dM1 Sets $\frac{1}{2}x = -2x + 4$ and proceeds to $x = ..$ by collecting terms. Condone errors

A1 $x = \frac{8}{5}$ oe. Accept 1.6

M1 Attempts to find the larger solution. Accept setting $\frac{1}{2}x = 5x + b$ where $b < 0$

dM1 Sets $\frac{1}{2}x = 5x - 10$ and proceeds to $x = ..$ by collecting terms. Condone errors

A1 $x = \frac{20}{9}$ Accept exact equivalents such as $2\frac{2}{9}$ but not 2.2 or $2.\dot{2}$

(b)

B1 Any two points correct either in the text or on a sketch. Accept 6 and 2 written on the correct axes

B1 Shape + all four points correct.
Watch for candidates who adapt the given diagram. This is acceptable
A diagram can be labelled with *P*, *Q*, *R* and *S* and coordinates given for *P*,*Q*,*R* and *S* in the body of the script. If they are given on the diagram and in the body of the script the diagram takes precedence.

Question Number	Scheme	Marks
6.	$\mathrm{f}(x) = x^3 + x^2 - 12x - 18$	
(a)	Attempts $\mathrm{f}(\pm 3)$	M1
	{f(-3)=} 0 so $(x + 3)$ is a factor of $\mathrm{f}(x)$.	A1
		[2]
(b)	$x^3 + x^2 - 12x - 18 = (x+3)(x^2 + ...$	M1
	$x^3 + x^2 - 12x - 18 = (x+3)(x^2 - 2x - 6)$ or! $x^3 + x^2 - 12x - 18 = (x+3)(x - 1 + \sqrt{7})(x - 1 - \sqrt{7})$ oe	A1
		[2]
(c)	$(x =)\ -3$	B1
	$x = \dfrac{2 \pm \sqrt{4+24}}{2} = 1 \pm \sqrt{7}$ or by completion of square $(x-1)^2 = 7$ so $x = 1 \pm \sqrt{7}$ or $\left(x - 1 + \sqrt{7}\right)\left(x - 1 - \sqrt{7}\right) = 0 \Rightarrow x = 1 \pm \sqrt{7}$	M1 A1
		[3]
		7 marks
	Notes	
(a)	**M1**: As on scheme – must use the factor theorem **A1:** for seeing 0 and conclusion which may be in a preamble and may be minimal e.g. QED, proven, true, tick etc. There must be no obvious errors but need to see at least $(-3)^3 + (-3)^2 - 12(-3) - 18 = 0$ for A1 but allow invisible brackets e.g. $-3^3 + -3^2 - 12(-3) - 18 = 0$ provided there are no obvious errors.	
(b)	**M1**: Uses $(x + 3)$ as a factor and obtains correct first term of quadratic factor by division or any other method e.g. comparing coefficients or finding roots and factorising **A1 :** Correct quadratic and writes $(x+3)(x^2 - 2x - 6)$ or $(x+3)(x - 1 + \sqrt{7})(x - 1 - \sqrt{7})$ oe Note that this work may be done in part (a) and the result re-stated here.	
(c)	**B1:** States -3 **M1:** Method for finding their roots. Allow the usual rules applied to their quadratic. **This mark is for finding the roots and not for just finding factors. You may need to check their roots if no working is shown e.g. if they give decimal answers (3.645…, -1.645…)** **A1:** need both roots. Correct answer implies M mark. Allow $x = \dfrac{2 \pm \sqrt{28}}{2}$ If they give extra roots e.g. $x = -3,\ \ -1,\ \ \dfrac{2 \pm \sqrt{28}}{2}$, lose the final A mark (B1M1A0)	