Question	Scheme	Marks
3(i)	Writes $\sqrt{180}$ as $6\sqrt{5}$ or $\sqrt{80}$ as $4\sqrt{5}$	M1
	Concludes working $\frac{6\sqrt{5}-4\sqrt{5}}{\sqrt{5}}=\frac{2\sqrt{5}}{\sqrt{5}}=2$	A1
		(2)
(ii)	$\frac{4\sqrt{5}-5}{7-3\sqrt{5}}=\frac{4\sqrt{5}-5}{7-3\sqrt{5}}\times\frac{7+3\sqrt{5}}{7+3\sqrt{5}}=...$	M1
	$=\frac{28\sqrt{5}-35+12\left(\sqrt{5}\right)^2-15\sqrt{5}}{49-9\times5}$	dM1
	$=\frac{25}{4}+\frac{13}{4}\sqrt{5}$	A1
		(3)
		(5 marks)
Notes: This is a non calculator question and all stages of working must be shown		

(i) Main method

M1: Writes $\sqrt{180}$ as $6\sqrt{5}$ or $\sqrt{80}$ as $4\sqrt{5}$.

Additional lines of working may be seen but they are not required for this mark

A1: Correct work leading to the answer 2. The M mark must have been awarded.

The solution shown in the main mark scheme is the minimum evidence required.

A valid alternative is $\frac{\sqrt{180}-\sqrt{80}}{\sqrt{5}}=\frac{6\sqrt{5}-4\sqrt{5}}{\sqrt{5}}=\left(\frac{6\sqrt{5}}{\sqrt{5}}-\frac{4\sqrt{5}}{\sqrt{5}}=\right)6-4=2$

(i) Alt method I $\frac{\sqrt{180}-\sqrt{80}}{\sqrt{5}}=\frac{\sqrt{180}}{\sqrt{5}}-\frac{\sqrt{80}}{\sqrt{5}}=\sqrt{36}-\sqrt{16}=6-4=2$

M1: Writes $\frac{\sqrt{180}}{\sqrt{5}}$ as $\sqrt{36}$ or $\frac{\sqrt{80}}{\sqrt{5}}$ as $\sqrt{16}$

Additional lines of working may be seen but they are not required

A1: Correct work leading to the answer 2. The solution shown below is the minimum evidence required

E.g. $\frac{\sqrt{180}}{\sqrt{5}}-\frac{\sqrt{80}}{\sqrt{5}}=\sqrt{36}-\sqrt{16}=6-4=2$

(i) Alt method II $\frac{\sqrt{180}-\sqrt{80}}{\sqrt{5}}\times\frac{\sqrt{5}}{\sqrt{5}}=\frac{\sqrt{900}-\sqrt{400}}{5}=\frac{30-20}{5}=2$

M1: Multiplies numerator and denominator by $\sqrt{5}$ and writes $\sqrt{180}\times\sqrt{5}$ as $\sqrt{900}$ or $\sqrt{80}\times\sqrt{5}$ as $\sqrt{400}$

A1: Correct work leading to the answer 2

Do NOT allow solutions that rely on huge jumps. The M marks must be awarded as above.

For example

$\frac{\sqrt{180}-\sqrt{80}}{\sqrt{5}}=\frac{\left(\sqrt{180}-\sqrt{80}\right)\times\sqrt{5}}{\sqrt{5}\times\sqrt{5}}=\frac{30-20}{5}=2$ scores M0 A0

without sight of $\sqrt{180}\times\sqrt{5}$ as $\sqrt{900}$ or $\sqrt{80}\times\sqrt{5}$ as $\sqrt{400}$ o.e.

Or

$\frac{\sqrt{180}-\sqrt{80}}{\sqrt{5}}=\frac{2\sqrt{5}}{\sqrt{5}}=2$ scores M0 A0 without sight of $\sqrt{180}$ as $6\sqrt{5}$ or $\sqrt{80}$ as $4\sqrt{5}$

(ii)

Main method

M1: Correct attempt to rationalise. Look for attempt at multiplying numerator and denominator by $7+3\sqrt{5}$ The multiplications need not be carried out for this mark.

dM1: It is dependent upon the previous mark. Scored for

- Correct expression for denominator (without surds) Accept as shown, or as $7^2-3^2\times5$ or just 4
- and attempts to multiply out the numerator with the sight of 4 terms . Condone slips here. See ***

A1: Correct answer any way around. Allow $6.25+3.25\sqrt{5}$

Do NOT allow in the form $\frac{25+13\sqrt{5}}{4}$ but accept if followed by "hence $a=\frac{25}{4},b=\frac{13}{4}$"

(ii) Alt method

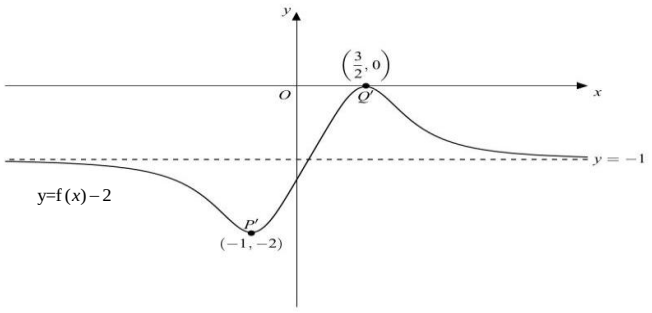
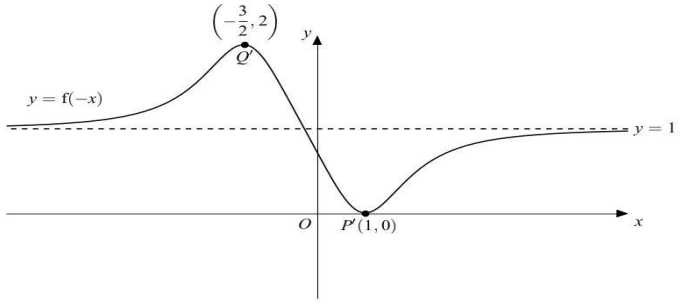
M1: Sets $\frac{4\sqrt{5}-5}{7-3\sqrt{5}}=a+b\sqrt{5}\Rightarrow4\sqrt{5}-5=\left(a+b\sqrt{5}\right)\left(7-3\sqrt{5}\right)$ and attempts to set up simultaneous equations in *a* and *b*. FYI the correct equations are $7a-15b=-5,\ 7b-3a=4$

dM1: Attempts to solve their equations. They must have at least one correct equation

A1: Correct answer. Must be $\frac{25}{4}+\frac{13}{4}\sqrt{5}$ and not **just** values of *a* and *b*

The following solution is a minimally acceptable solution for 3 marks, the first M1 being implied.

$\frac{4\sqrt{5}-5}{7-3\sqrt{5}}=\frac{\left(4\sqrt{5}-5\right)\times\left(7+3\sqrt{5}\right)}{4}=\frac{28\sqrt{5}-35+60-15\sqrt{5}}{4}=\frac{13}{4}\sqrt{5}+\frac{25}{4}$ ***

Question	Scheme		Marks
4(i)		Correct shape, translated down.	**B1**
		Correct horizontal asymptote labelled	**B1**
		Correct **maximum** and **minimum** points labelled	**B1**
			(3)
(ii)		Correct shape, reflected in *y* axis	**B1**
		Correct horizontal asymptote labelled	**B1**
		Correct **maximum** and **minimum** points labelled.	**B1**
			(3)
			(6 marks)
Notes:			

In both parts be tolerant with "pen slips" for the asymptotes. Judge the intent of the shape.

(i) There is no MR for sketching $y = \mathrm{f}(x-2)$. These marks are independent of each other

B1: Same shape as the original graph but translated vertically downwards.

Do not consider any coordinates here.

Look for a minimum to the left of the *y* axis and a maximum to the right

Be tolerant of the asymptote not being **exactly** at the same level at either end of the curve but withhold the mark if it is intentionally different. Condone slight upturns at either end

B1: For $y = -1$ labelled as the horizontal asymptote. It must be below the *x* axis and the intention must be for ends to be at the same height/level. The intention must be for the curve to be asymptotic here (at both ends)

B1: For the coordinates of the maximum and minimum points in the correct positions. E.g. $\left(\frac{3}{2}, 0\right)$ must be on the positive *x*-axis and $\left(-1, -2\right)$ is in quadrant 3. Note that *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

(ii) There is no MR for sketching $y = -\mathrm{f}(x)$ These marks are independent of each other

B1: For the correct shape, a reflection in the *y*-axis. The intention should be for the asymptotes to be at the same level but be tolerant of slips. Look for the image *Q*' a maximum being to the left of *y*-axis in quadrant two and *P*' a minimum on the positive *x*- axis.

B1: For $y = 1$ labelled as the horizontal asymptote. It must be above the *x* axis and the intention must be for ends to be at the same height/level. The curve must be asymptotic here (at both ends)