Question Number	Scheme	Marks
6.	$(x+5)(3x+2)(2x-5)=(3x^2+17x+10)(2x-5)=...$	M1
	$=6x^3-15x^2+34x^2-85x+20x-50$ $\left(=6x^3+19x^2-65x-50\right)$	A1
	$6x^3+19x^2-65x-50=3x^2-33x-50$ $\Rightarrow 6x^3+16x^2-32x=0$	dM1
	$2x(3x-4)(x+4)=0$	ddM1
	$x=-4,\ 0,\ \frac{4}{3}$	A1
		(5)
		(5 marks)

Notes

M1: For an attempt to multiply out the $(x+5)(3x+2)(2x-5)$.
Must obtain terms in x^3, x^2, x and a constant.

A1: $6x^3+19x^2-65x-50$ but may be left unsimplified e.g. $6x^3-15x^2+34x^2-85x+20x-50$
Award this mark if a correct unsimplified expansion is seen and errors are subsequently made when collecting terms.

dM1: Sets their $6x^3+19x^2-65x-50=3x^2-33x-50,$ collects terms and proceeds to a cubic expression = 0. This may be implied if they cancel the 50's and then divide through by x to obtain a quadratic expression = 0. The "= 0" may be implied by subsequent work.
Depends on the previous method mark.

ddM1: Attempts to solve a cubic of the form $px^3+qx^2+rx=0,\ p,q,r\neq 0$ by **non-calculator** methods
This must involve dividing or factorising out x (or e.g. $2x$) followed by an attempt to solve a quadratic of the form $px^2+qx+r=0,\ p,q,r\neq 0$ by **non-calculator** methods – see General Guidance. Just quoting the quadratic formula followed by roots written down is M0
Depends on both previous method marks.

A1: $x=-4,\ 0,\ \frac{4}{3}$. Allow exact equivalents for $\frac{4}{3}$ including $1.\dot{3}$
Note that the $x = 0$ may appear earlier in their solution so look out for this.

Guidance for the ddM1A1 marks:

$$6x^3+16x^2-32x=0\Rightarrow 6x^2+16x-32=0\Rightarrow (3x-4)(x+4)=0\Rightarrow x=\frac{4}{3},\ -4$$

Scores ddM0A0

$$6x^3+16x^2-32x=0\Rightarrow 6x^2+16x-32=0\Rightarrow 2(3x-4)(x+4)=0\Rightarrow x=\frac{4}{3},\ -4$$

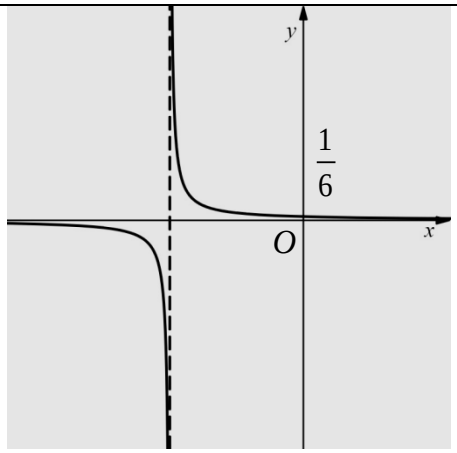
Scores ddM1A0

$$6x^3+16x^2-32x=0\Rightarrow x\left(6x^2+16x-32\right)=0\Rightarrow x\left(x-\frac{4}{3}\right)(x+4)=0\Rightarrow x=0,\ \frac{4}{3},\ -4$$

Scores ddM0A0

$$3x^3+8x^2-16x=0\Rightarrow (3x-4)(x+4)=0\Rightarrow x=\frac{4}{3},\ -4$$

Scores ddM0A0

Question Number	Scheme		Marks
7(a)		Correct shape and position	B1
		Correct **equation** of vertical asymptote. E.g. $x = -6$ oe e.g. $x + 6 = 0$	B1
		Correct y intercept $\left(0, \frac{1}{6}\right)$	B1
			(3)

Notes

There must be a sketch to score marks in (a)

Allow the equation of the asymptote and the *y* intersection to be identified away from the sketch but they must clearly be identified as the asymptote and/or the intersection and correspond to their sketch. If there is any ambiguity, the sketch takes precedence.

(a)

B1: Correct shape and position.

The right hand branch should

- be in quadrants 1 and 2 only (this includes just touching the *y*-axis)
- approach the *x*-axis from above on the right
- approach the vertical upwards on the left in quadrant 2

The left hand branch should

- be in quadrant 3 only
- approach the *x*-axis from below on the left
- approach the vertical downwards on the right

The branches must not clearly overlap.

The curve must not clearly turn back on itself at the vertical or horizontal asymptotes but condone "slips of the pen".

B1: Correct **equation** for vertical asymptote. The curve must be asymptotic here for their curve and for both branches if drawn.

The asymptote does not need to be "drawn" e.g. dotted or solid line.

Must be an equation (not just –6 marked on the *x*-axis)

B1: Correct *y* intercept. The curve must only cross the *y*-axis at this point.

Allow as $\frac{1}{6}$ marked on the *y*-axis or as $\left(0, \frac{1}{6}\right)$ and condone $\left(\frac{1}{6}, 0\right)$ as long as it is in the correct position on the positive *y*-axis.

Also allow $y = \frac{1}{6}$ if it is clearly indicating the point of intersection and not the equation of an asymptote.

See supplementary document for some examples.

(b)(i)	$mx-4=\dfrac{1}{x+6}\Rightarrow\left(mx-4\right)\left(x+6\right)=1$	M1
	$\Rightarrow mx^2+(6m-4)x-25=0$ or $mx^2+6mx-4x-25=0$	A1
	$"b^2-4ac"=(6m-4)^2-4\times m\times(-25)$	dM1
	$\Rightarrow(6m-4)^2+100m\ldots0$ $\Rightarrow 36m^2+52m+16\ldots0\Rightarrow 9m^2+13m+4\ldots0$ *	A1*
(ii)	$(m+1)(9m+4)\ldots0\Rightarrow\quad m\,,,\,-1,\quad m\ldots-\dfrac{4}{9}$	M1 A1
		(6)

Mark (b)(i) and (ii) together.

(b)(i)

M1: Sets $mx-4=\dfrac{1}{x+6}$ and attempts to cross multiply

A1: Correct simplified quadratic equation with terms on one side which may be implied by subsequent work. The "= 0" may be implied.
The $(6m-4)x$ may be expanded.

dM1: Attempts the discriminant $"b^2-4ac"$ for their 3TQ. There must be no *x*'s in their *a*, *b* and *c*. May be seen embedded in an attempt to use the quadratic formula.

A1*: cso. Correct proof with an intermediate line after e.g. $(6m-4)^2+100m\ldots0$
The …0 should appear before the final line and there must have been no contradictory statements such as $(6m-4)^2+100m=0$ **but** if the discriminant is found and a justification that it must be …0 is given, this mark can be awarded.

(b)(ii)

M1: Uses a correct method to find the critical values of $9m^2+13m+4=0$ **and** finds the outside range for their critical values. Allow any method of solving $9m^2+13m+4=0$ including use of a calculator. Condone strict inequalities for this mark and condone use of *x* instead of *m*.

A1: $m\,,,\,-1,\quad m\ldots-\dfrac{4}{9}$ or e.g. $m\,,,\,-1$ or $m\ldots-\dfrac{4}{9}$ Condone $m\,,,\,-1$ and $m\ldots-\dfrac{4}{9}$ but **not** $-\dfrac{4}{9}\,,,\,m\,,,\,-1$

Allow equivalents e.g. $(-\infty,-1]$, $\left[-\dfrac{4}{9},\infty\right)$ and allow exact equivalents for $-\dfrac{4}{9}$ including $-0.\dot{4}$

Note that they cannot go straight from $9m^2+13m+4\ldots0$ to $m\,,,\,-1,\quad m\ldots-\dfrac{4}{9}$ without finding or stating the roots first so that $9m^2+13m+4\ldots0\Rightarrow m\,,,\,-1,\quad m\ldots-\dfrac{4}{9}$ scores M0A0

But $9m^2+13m+4\ldots0\Rightarrow m=-1,\ m=-\dfrac{4}{9}\Rightarrow m\,,,\,-1,\quad m\ldots-\dfrac{4}{9}$ scores M1A1

$9m^2+13m+4\ldots0\Rightarrow\left(9m+4\right)\left(m+1\right)\ldots0\Rightarrow m\,,,\,-1,\quad m\ldots-\dfrac{4}{9}$ scores M1A1

Or e.g. a sketch of the quadratic with -1 and $-\dfrac{4}{9}$ indicated followed by $m\,,,\,-1,\quad m\ldots-\dfrac{4}{9}$ scores M1A1

Generally, there must be some intermediate work seen before the inequalities are written down.

Question Number	Scheme	Marks
8(a)	$m = \dfrac{18-0}{2--3}$	M1
	$y-18 = \dfrac{18}{5}(x-2)$ or e.g. $y = \dfrac{18}{5}(x+3)$ or $18 = \dfrac{18}{5}(2)+c \Rightarrow c = ...$ or e.g. $0 = \dfrac{18}{5}(-3)+c \Rightarrow c = ...$	dM1
	$y = \dfrac{18}{5}x + \dfrac{54}{5}$	A1
		(3)
(b)	Examples: $y = ax^2 + bx - 6$ $y = (x+3)(px+q)$ $y = ax^2 + bx + c, (0,-6), (2, 18), (-3, 0) \Rightarrow a = ...$ or $b = ...$ or $c = ...$ NB $a = \dfrac{14}{5}$, $b = \dfrac{32}{5}$, $c = -6$	M1
	Full method to find all constants. E.g. Solves $9a-3b-6=0$ and $4a+2b-6=18 \Rightarrow a = ..., b = ...$	dM1
	Either $a = \dfrac{14}{5}$ or $b = \dfrac{32}{5}$ $y = \dfrac{14}{5}x^2 + \dfrac{32}{5}x - 6$	A1 A1
		(4)
(c)	$\dfrac{14}{5}x^2 + \dfrac{32}{5}x - 6 < y < \dfrac{18}{5}x + \dfrac{54}{5}, \quad x < 0$	M1 A1ft
		(2)
		(9 marks)

Notes

(a)

M1: Attempts gradient = $\dfrac{18-0}{2--3}$.

Condone 1 sign/copying slip only if a correct formula is seen or implied.

Alternatively solves two simultaneous equations, e.g. $18 = 2m + c$ and $0 = -3m + c$ to find m or c.

dM1: Full attempt at equation of the line using (–3, 0) or (2, 18) with values correctly placed.

If they use $y = mx + c$ they must proceed as far as finding a value for c.

If they use e.g. $\dfrac{y}{18-0} = \dfrac{x+3}{2--3}$ both M's can be scored together.

Condone 1 sign/copying slip only if a correct formula is seen or implied.

A1: $y = \dfrac{18}{5}x + \dfrac{54}{5}$ o.e.