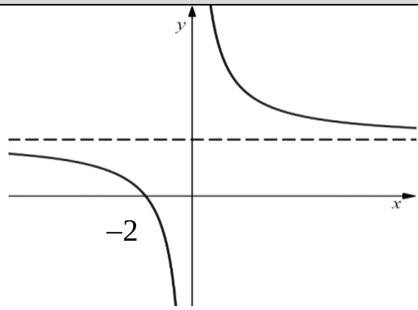
Question	Scheme	Marks	AOs
5(a)(i)		M1 A1	1.1b 1.1b
(ii)	Asymptotes: $y=3$, $x=0$	B1	1.1b
		(3)	
(b)	e.g. $\frac{6}{x}+3=3x^2-4x-10 \Rightarrow 6+3x=3x^3-4x^2-10x$	M1	1.1b
	$3x^3-4x^2-13x-6=0$ *	A1*	1.1b
		(2)	
(c)	e.g. $3x+2\overline{\smash{)}3x^3-4x^2-13x-6}$ with quotient $x^2-2x\pm...$	M1	3.1a
	$x^2-2x-3\ (=0)$ or $3x^2-6x-9\ (=0)$	A1	1.1b
	e.g. $(3x+2)(x-3)(x+1)=0 \Rightarrow x=...$	dM1	1.1b
	$x=-1,\ x=3$	A1cso	1.1b
		(4)	
		(9 marks)	

Notes

(a)(i)

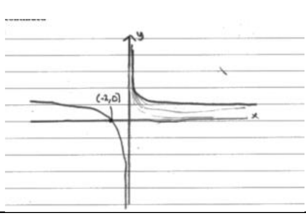
M1: Either

- A correct positive reciprocal graph shape with both branches anywhere on a set of axes (ignore any dashed lines / scale and just look at the graph shape drawn)
- $x=-2$ is the only point of intersection of their graph with the axes. Condone labelled as $(0,-2)$. Allow if they state the coordinates $(-2, 0)$ next to the graph instead but not just $x=-2$

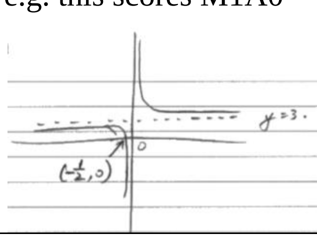
Condone poor curvature provided there is not an intention to draw a maximum or minimum for either of the branches. Condone where the branches approach an undrawn horizontal asymptote if the left-hand branch is slightly above the right-hand branch as long as it does not appear intentional.

A1: Fully correct graph with an intersection labelled at $x=-2$ on the graph (condone labelled as $(0,-2)$). If two horizontal or vertical asymptotes are drawn or a vertical asymptote which is not the *y*-axis then this mark cannot be scored. (unless the vertical asymptote is labelled as 0 or $x=0$) Allow if they state the coordinates $(-2, 0)$ next to the graph instead but not just $x=-2$

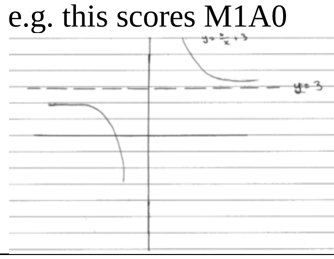
e.g. this scores M1A1



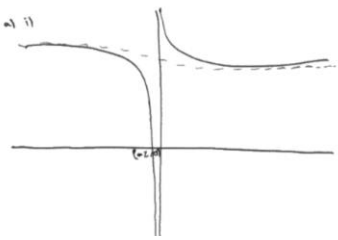
e.g. this scores M1A0

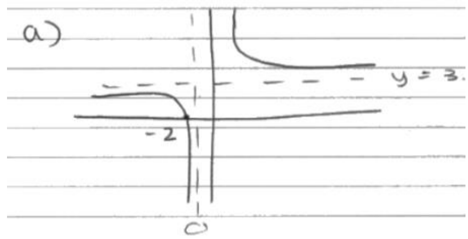


e.g. this scores M1A0



e.g. this scores M1A1 e.g. this scores M1A1 (condone the vertical asymptote drawn as it is labelled as 0 (for $x=0$))





(ii) If no graph is drawn then this mark cannot be scored

B1: $y=3$, $x=0$ cao (not $x\neq 0$) which must be correct for their graph. Check by the question but if there is a contradiction then the equations stated in (ii) of the work takes precedence. Cannot be for just stating 0 underneath the *y* axis and 3 on a dashed horizontal line if present.

(b)

M1: Sets $\frac{6}{x}+3=3x^2-4x-10$ and rearranges to form a cubic equation. Terms do not need to be collected or all on one side.

A1*: $3x^3-4x^2-13x-6=0$ with no errors seen. There must be at least one stage of intermediate working before achieving the given answer.

e.g. $\frac{6}{x}+3=3x^2-4x-10 \Rightarrow 3x^3-4x^2-13x-6=0$ is M1A0*

e.g. $\frac{6}{x}+3=3x^2-4x-10 \Rightarrow 6+3x=3x^3-4x^2-10x \Rightarrow 3x^3-4x^2-13x-6=0$ is M1A1*

(c) Note that proceeding to three linear factors with no working is M0A0dM0A0. A quadratic factor is required first.

M1: Attempts to algebraically divide $3x^3-4x^2-13x-6$ by $3x+2$ or compare coefficients to achieve $(x^2-2x\pm....)$ or $(x^2\pm...x-3)$ (or via inspection)

Alternatively, attempts to algebraically divide $3x^3-4x^2-13x-6$ by $x+\frac{2}{3}$ or compare coefficients to achieve $(3x^2-6x\pm...)$ or $(3x^2\pm...x-9)$ (or via inspection)

May use the grid method so they must proceed as far as the diagonal for x^2 being correct and achieving x^2-2x on the top. (They should reach the same point if dividing by $x+\frac{2}{3}$)

	x^2	$-2x$
$3x$	$3x^3$	$-6x^2$
2	$2x^2$	

Any attempts to use $(x+1)$ or $(x-3)$ rather than $(3x+2)$ from the given root please send to review.

A1: x^2-2x-3 $(=0)$ or $3x^2-6x-9$ $(=0)$

dM1: Attempts to solve their resulting quadratic by factorising, using the formula or completing the square. Usual rules apply for solving a quadratic by either of these methods. They cannot simply write down the roots. It is dependent on the previous method mark.
Note $(3x^2-6x-9) \Rightarrow (x-3)(x+1) \Rightarrow x=...$ is dM0A0

A1cso: $x=-1$, $x=3$ only (ignore any reference to $x=-\frac{2}{3}$) Condone invisible brackets if recovered or implied by further work. Withhold this mark if they reject one of the two solutions.