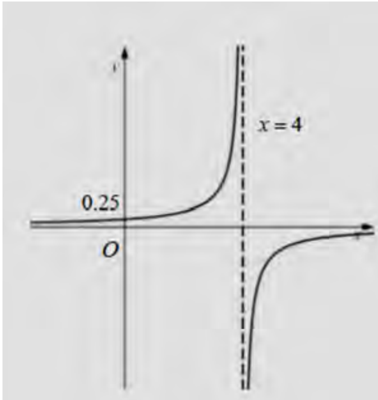
Question Number	Scheme		Marks	AOs
9 (a)		Shape and position	B1	1.1b
		Vertical asymptote	B1	1.1b
		Intercept	B1	1.1b
			(3)	
(b) (i)	Sets $2x+k=\dfrac{1}{4-x} \Rightarrow 8x+4k-2x^2-kx=1$		M1	3.1a
	$2x^2+(k-8)x+1-4k=0$		A1	1.1b
	Attempts $b^2-4ac=(k-8)^2-4\times2\times(1-4k)$		dM1	1.1b
	$(k-8)^2-4\times2\times(1-4k)\geqslant 0$ $\Rightarrow k^2-16k+64-8+32k\geqslant 0 \Rightarrow k^2+16k+56\geqslant 0$ *		A1*	2.1
			(4)	
(ii)	At least one of $k=-8+2\sqrt{2}$ or $k=-8-2\sqrt{2}$		M1	1.1b
	$\{k:k\leqslant -8-2\sqrt{2}\}\cup\{k:k\geqslant -8+2\sqrt{2}\}$		A1	2.5
			(2)	
			(9 marks)	

Notes:

(a) **Requires a sketch to score any marks.**

B1: Correct shape and position for both branches of the curve with no significant overlap.
Look for a negative reciprocal graph in quadrants 1, 2 and 4 only that does not cross or intersect the *x*-axis. It should look asymptotic to the *x*-axis but be generous here.
If there is clearly a different horizontal asymptote to the *x*-axis then score B0.

B1: Correct equation of the asymptote $x=4$ which can be scored if the curve $y=\dfrac{1}{x-4}$ is drawn.
The curve must be asymptotic at both sides of the asymptote but be tolerant on distance.
If there is more than one vertical asymptote shown, then score B0.
If in doubt, the sketch takes precedent.

B1: Correct *y* intercept, which may be seen as $\dfrac{1}{4}$ or 0.25 labelled on the axes in the correct place.
If there is more than one *y* intercept shown, then score B0.

Special Case: Score B1B0B0 for translating $y=-\dfrac{1}{x}$ left, with correct shape, asymptotic to the *x*-axis and the asymptote $x=-4$ labelled (i.e. a sketch of $y=-\dfrac{1}{x+4}$), ignoring any *y* intercept.

(b)(i)

M1: For the key step of equating $\frac{1}{4-x}$ with $2x+k$, cross multiplying, expanding brackets and proceeding to a quadratic equation. Condone slips in their expansion of brackets but expect there to be at least 3 terms of the correct form.

A1: Correct simplified quadratic equation with terms **collected** on one side.

Not scored for e.g. $2x^2+kx-8x+1-4k=0$ unless implied by use of correct values of *a*, *b* and *c* in their attempt at the discriminant but note that $2x^2-(8-k)x+1-4k=0$ is correct.

No brackets are needed around 1 – 4*k*. Condone bracketing error $2x^2+(k-8)x\ (+1-4k)=0$

The = 0 may be implied by later work and condone e.g. $2x^2+(k-8)x+1-4k \geqslant 0$ (which will be penalised in the final A1*).

dM1: Attempts b^2-4ac or $b^2...4ac$ (where … is any equality or inequality) with their values of *a*, *b* and *c* which must not include any *x* terms. Dependent on the previous method mark.

A1*: For constructing a rigorous argument and proceeding to the given answer showing all key steps. There must be a correct intermediate line between e.g. $(k-8)^2-4\times2\times(1-4k)\geqslant 0$ and

$k^2+16k+56\geqslant 0$

Allow invisible brackets to be recovered.

The inequality cannot just appear at the end of the proof, but might only be seen previously in e.g. $b^2-4ac\geqslant 0$ or $b^2\geqslant 4ac$

Penalise incorrect inequality work such as $2x^2+(k-8)x+1-4k\geqslant 0$ in this mark.

Condone an earlier bracketing error $2x^2+(k-8)x\ (+1-4k)=0$

(b)(ii)

M1: Solves the given equation to find at least one critical value (usual rules for solving a 3TQ apply but they may use a calculator in which case allow awrt –5.2 or awrt –10.8).

Do not be concerned what their critical values are labelled as for this mark (e.g. *x* or *y*).

A1: Uses correct notation to state the **exact** range of values for *k*

e.g. $\{k : k\leqslant -8-2\sqrt{2}\}\cup\{k : k\geqslant -8+2\sqrt{2}\}$ or $(-\infty, -8-2\sqrt{2}]\cup[-8+2\sqrt{2}, \infty)$

Condone the absence of "*k* :" and $k\in\mathbb{R}$, but must be using *k* and not e.g. *x* or *y*.

Note that $\{k \mid k\leqslant -8-2\sqrt{2}\}\cup\{k \mid k\geqslant -8+2\sqrt{2}\}$ is also acceptable.

Condone $\{k\leqslant -8-2\sqrt{2}\cup k\geqslant -8+2\sqrt{2}\}$

Do not condone $\{k : k\leqslant -8-2\sqrt{2},\ k\geqslant -8+2\sqrt{2}\}$

Allow $\sqrt{8}$ in place of $2\sqrt{2}$ throughout.

Use of the intersection symbol $\cap$ is incorrect and scores A0.

If using interval notation then $\pm\infty$ should not be included in their range.