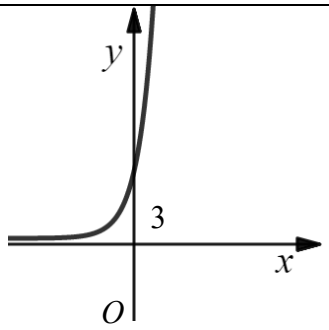
Question Number	Scheme	Marks
9.(a)	 Shape $(0,3)$	B1 B1 **(2)**
(b)	$6^{1-x} = 3\times 4^{x}$ $(1-x)\log 6 = \log 3 + x\log 4$ $x(\log 4 + \log 6) = \log 6 - \log 3$ $\Rightarrow x = \dfrac{\log\left(\frac{6}{3}\right)}{\log(4\times 6)} \Rightarrow x = \dfrac{\log 2}{\log 24}$	M1 dM1 A1 ddM1 A1* **(5)**
	Alt Method: $6^{1-x} = 3\times 4^{x} \Rightarrow \dfrac{6}{6^{x}} = 3\times 4^{x}$ $\Rightarrow \dfrac{6}{3} = 6^{x}4^{x} \Rightarrow 2 = 24^{x}$ $\Rightarrow \log_{10} 2 = x\log_{10} 24 \Rightarrow \dfrac{\log_{10} 2}{\log_{10} 24}$	M1 dM1A1 ddM1A1* **(5)** **(7 marks)**

(a)

B1 Correct shape and position. Should be increasing, always above the x axis and must be in both quadrants 1 and 2. Be tolerant with the asymptote as long as it does not cross the axis or clearly bend away (but don't be concerned if there is a gap between curve and axis).

B1 Intercept at $(0,3)$ Accept 3 or $(3,0)$ marked on the axis, but $(3,0)$ away from the graph is B0. Their graph must have crossed the positive y axis to score this mark. Ignore any x intercepts

(b)

M1 Attempt to takes logs (any base, including 6) and attempts either the addition law or the power law Eg. $\log 6^{1-x} \rightarrow (1-x)\log 6$ or $\log 3\times 4^{x} \rightarrow \log 3 + \log 4^{x}$ (Condone invisible brackets for Ms)

dM1 Takes logs of both sides and attempts **both** the addition law and the power law to achieve a linear equation in x (can still be in any base at this stage)

A1 A correct linear equation in x (any base).

ddM1 Attempts to make x the subject of the formula with no incorrect log work. Allow with just log, but any other base must be changed to base 10 to allow this mark.

A1* Proceeds to the given answer showing a correct intermediate step with no incorrect working seen.

For example $x(\log 4 + \log 6) = \log 6 - \log 3 \Rightarrow x = \dfrac{\log\left(\frac{6}{3}\right)}{\log(4\times 6)}$ or $\ldots \Rightarrow x\log 24 = \log 2 \Rightarrow x = \dfrac{\log 2}{\log 24}$

Alt (b): M1: applies index law to 6^{1-x} ie $6/6^{x}$

dM1: rearranges to equation of form $a^{x} = b$ using correct power laws (ie $p^{x}q^{x} = (pq)^{x}$) A1: Correct equation

ddM1: solve equation of the form shown using logs A1: correctly achieved.

Question Number	Scheme	Marks
10.(a)	$y = 4x^3 - 9x + \frac{k}{x} \Rightarrow \frac{dy}{dx} = 12x^2 - 9 - \frac{k}{x^2}$	M1 A1
	$x = \frac{1}{2}, \frac{dy}{dx} = 0 \Rightarrow 0 = 12 \times \left(\frac{1}{2}\right)^2 - 9 - 4k \Rightarrow 4k = -6 \Rightarrow k = -\frac{3}{2}$ *	dM1 A1*
		(4)
(b)	Attempts $\frac{d^2y}{dx^2} = 24x - \frac{3}{x^3}$ at $x = \frac{1}{2}$	M1
	$\Rightarrow \frac{d^2y}{dx^2} = -12 < 0$ (Local) Maximum	A1
		(2)
(c)	$12x^2 - 9 + \frac{3}{2x^2} = 0 \Rightarrow 24x^4 - 18x^2 + 3 = 0$	M1
	$\Rightarrow 3\left(4x^2 - 1\right)\left(2x^2 - 1\right) = 0$	A1
	$\Rightarrow x^2 = \frac{1}{2} \Rightarrow x = \frac{\sqrt{2}}{2}$ oe	dM1 A1
		(4)
		(10 marks)

(a)

M1 Attempts to differentiate reducing any power of x by one

A1 For $12x^2 - 9 - \frac{k}{x^2}$ oe need not see $\frac{dy}{dx}$

dM1 Substitutes $x = \frac{1}{2}, \frac{dy}{dx} = 0$ into their $\frac{dy}{dx}$ to set up a linear equation in k. (Allow the M if "=0" implied)

A1* Proceeds via $ak + b = 0$ or $ak = b$ to achieve $k = -\frac{3}{2}$ following correct work. The "= 0" must have been seen for this mark.

(b) Attempts at first derivative test – send to review if they seem worthy of merit.

M1 Attempts to find the value of $\frac{d^2y}{dx^2}$ at $x = \frac{1}{2}$. Follow through on their $\frac{dy}{dx}$ with one term correct.

A1 Fully correct $\frac{d^2y}{dx^2} = -12 < 0 \Rightarrow$ (Local) Maximum. Allow with $12 - 24 < 0$

(c)

M1 Sets their $\frac{dy}{dx} = 0$ and proceeds to a three term quartic equation in x or factorise to give $k\left(ax + \frac{b}{x}\right)\left(cx + \frac{d}{x}\right) = 0$ where $kac = 24$ and $kbd = 3$ (though $k = 3$ may be cancelled).

A1 $3\left(4x^2 - 1\right)\left(2x^2 - 1\right) = 0$ oe. This is implied by $x^2 = \frac{1}{2}$ following use of quadratic formula or having identified a quadratic in x^2 e.g. by $y = x^2$ and $24y^2 - 18y + 3 \rightarrow y = ...$

dM1 Solves their $x^2 = \frac{1}{2} \Rightarrow x = \pm\frac{\sqrt{2}}{2}$ by taking square root of their positive root

A1 $x = \frac{\sqrt{2}}{2}$ or $\frac{1}{\sqrt{2}}$ or $\sqrt{\frac{1}{2}}$ but must be positive solution only. Ignore the $x = \frac{1}{2}$ but A0 if others given.

NB Answers directly from the quartic with no further working score M1A0dM0A0