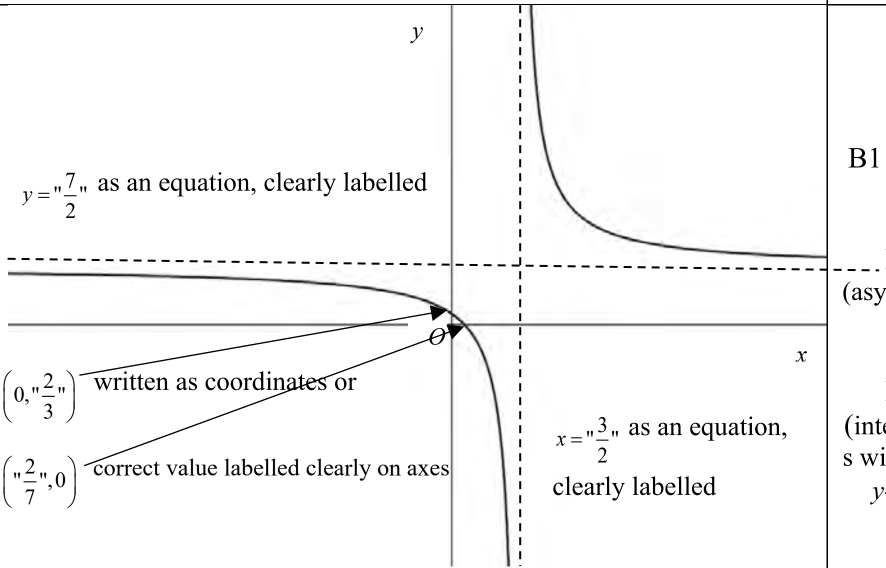
Question number	Scheme	Marks
10 (a) (i)	$x=\dfrac{3}{2}$	B1
(ii)	$y=\dfrac{7}{2}$	B1 [2]
(b)	$\left(\dfrac{2}{7},0\right)$ $\quad\left(0,\dfrac{2}{3}\right)$	B1 B1 [2]
(c)	$\dfrac{7(2x-3)-2(7x-2)}{(2x-3)^2}$ $\dfrac{-17}{(2x-3)^2}$ or $\dfrac{-17}{4x^2-12x+9}$ Correct conclusion ALT – product rule $7(2x-3)^{-1}+(7x-2)(-1)(2)(2x-3)^{-2}$ $\dfrac{-17}{(2x-3)^2}$ or $\dfrac{-17}{4x^2-12x+9}$ Correct conclusion	M1 A1 A1 B1 [4] M1 A1 A1 B1
(d)		B1 (curve) B1ft (asymptotes) B1ft (intersections with x- and y-axes) [3]
(e)	$-\dfrac{1}{17}=\text{"}\dfrac{-17}{(2x-3)^2}\text{"}$ "$(2x-3)^2=17^2$" **or** "$4x^2-12x-280=0$" oe $x=10$ $\quad y=4$ $\quad$ or $\quad(10, 4)$ $y-\text{"}4\text{"}=17(x-\text{"}10\text{"})$ **or** "4" $=-17\times$ "10" $+c$ leading to $c=$ $y=17x-166$ oe	M1 dM1 A1 M1 A1

	"$17x - 166$" $= \dfrac{7x-2}{2x-3}$ $\rightarrow$ $17x^2 - 195x + 250$	M1
	$x = \dfrac{25}{17}$ $y = -141$ or $\left(\frac{25}{17}, -141\right)$	A1 [7]
		Total 18 marks

Part	Mark	Additional Guidance
	If a candidate gives **no response** to (a) and/or (b) but shows the correct answers on the graph we will award the marks. Where answers are given in (a) and/or (b) these should be marked as they stand with no reference to the graph. Ignore labelling of (i) and (ii) and mark (a) together.	
(a)(i)	B1	For $x = \frac{3}{2}$ oe
(a)(ii)	B1	For $y = \frac{7}{2}$ oe
(b)	B1 B1	First B1 for either correct, second B1 for both correct Condone if not given as coordinates e.g. $x = \frac{2}{7}$ and/or $y = \frac{2}{3}$ given
(c)	M1	Attempt the quotient rule. Numerator must be the difference of two terms (either way round) of the form $A.(2x-3)-B.(7x-2)$, A and $B > 1$. Denominator must be of the form $(2x-3)^2$
	A1	Either term on the numerator correct (either way round), dependent on previous method mark.
	A1	Obtains $\frac{-17}{(2x-3)^2}$ or $\frac{-17}{4x^2-12x+9}$
	B1	Correct conclusion based on correct working only, for example, (the numerator is a negative number and) the denominator is always positive and therefore the fraction/gradient is always negative.
	ALT – product rule	
	M1	For an attempt at Product Rule. Must be a sum of two products. Must have the form $c(2x-3)^{-1} + d(7x-2)(2x-3)^{-2}$ for constants c, d.
	A1	Either term correct, dependent on previous method mark.
	A1	Obtains $\frac{-17}{(2x-3)^2}$ or $\frac{-17}{4x^2-12x+9}$
	B1	Correct conclusion based on correct working only, for example, (the numerator is a negative number and) the denominator is always positive and therefore the fraction/gradient is always negative.
(d)	B1	Two branches drawn in the correct two "quadrants" created by the two aymptotes. Mark intention, allow poor curves, but do not allow the curve to bend back on itself or touch any asymptotes. Allow BOD if intention is for curve to run alongside asymptote but there is a slight deviation back on itself.
	B1ft	Two clearly marked asymptotes, ft their (a), labelled as described, there must be one section of the curve present, tending towards these asymptotes.
	B1ft	Two clearly labelled intersections with the axes, ft their (b), at least one section of their curve must pass through one of these intersections. Intersections must be labelled correct way around. If additional intersections seen then B0
(e)	M1	Sets their differentiated function from part (c) = $-\frac{1}{17}$
	dM1	Rearranges to get to an equation of the form shown with no denominators or a 3TQ and solves using an acceptable method to obtain $x = \ldots.$ Dependent on previous method mark
	A1	Correct values for point A (10, 4)
	M1	Uses their values for x and y (from an attempt at working with gradient of the curve) with gradient 17 to find an equation for l (if using $y = mx + c$, must be a complete method arriving at $c =$) If correct $c = -166$.
	A1	Correct equation, any form

	M1	Sets their equation for the normal equal to the curve, makes a **correct** rearrangement to remove any denominator and forms a 3TQ Note this method mark is not dependant.
	A1	Correct exact values for x and y

Question number	Scheme	Marks
11 (a)	$(600 =)2\pi r^2 + 2\pi rh$ oe eg $(300 =)\pi r^2 + \pi rh$	M1
	$h = \dfrac{300 - \pi r^2}{\pi r}$ oe | $\pi rh = 300 - \pi r^2$ oe	A1 cao
	$(V =)\ \pi r^2 \text{"}\left(\dfrac{300 - \pi r^2}{\pi r}\right)\text{"}$ oe | $V = \text{"}(300 - \pi r^2)\text{"}r$ oe	M1
	$V = 300r - \pi r^3$ *	A1* cso [4]
(b) (i)	$\dfrac{dV}{dr} = 300 - 3\pi r^2$	M1
	$0 = 300 - 3\pi r^2 \quad \rightarrow \quad r =$	M1
	$r = \sqrt{\dfrac{100}{\pi}}$ * cso	A1* cso
(ii)	$\dfrac{d^2V}{dr^2} = -6\pi r$	M1
	$\rightarrow \dfrac{d^2V}{dr^2} = -6\pi\sqrt{\dfrac{100}{\pi}}$ or $\dfrac{d^2V}{dr^2} = -6\pi \times 5.6418958........$	
	When r is positive, $-6\pi r$ is negative (-106.347231…..) and therefore this value of r gives a maximum	A1 [5]
(c)	$(V =)300\text{"}\sqrt{\dfrac{100}{\pi}}\text{"} - \pi\left(\text{"}\sqrt{\dfrac{100}{\pi}}\text{"}\right)^3 (= 1128.(379167))$	M1
	$p^3 = \dfrac{300\text{"}\sqrt{\frac{100}{\pi}}\text{"} - \pi\left(\text{"}\sqrt{\frac{100}{\pi}}\text{"}\right)^3}{\frac{4}{3}\pi}$ (=269(.3806…))	dM1
	$p = 6.5$ cm	A1 [3]
		Total 12 marks

Part	Mark	Additional Guidance
(a)	M1	Correct expression for the surface area of the cylinder and an attempt to rearrange to $h =$ or $\pi rh =$ Allow errors in arithmetic but not mathematically incorrect process. πrh may be embedded, e.g. $300 = \pi r^2 + \pi rh$ becoming $300 = \pi r^2 + V$ would score M1A1M1 and may score full marks if correct final result obtained.
	A1	cao
	M1	Substitutes their expression for height or their expression for πrh into a correct expression for the volume.
	A1	cso no errors or omissions, must state $V =$
	Mark parts (i) and (ii) together.	
(b) (i)	M1	Minimally acceptable attempt at differentiation, see general guidance, no power to increase.
	M1	Places their derivative = 0 and attempts to rearrange to find r. Minimally acceptable derivative is of the form $a \pm b\pi r^2$
	A1	Correct value for r, exact value only. Must reject negative value if found, award A0 if not rejected.
(ii)	M1	Minimally acceptable attempt to differentiate their first derivative, see general guidance, no power to increase. Or testing gradients or a sketch.
	A1	Correct evaluation of second derivative or explanation of why second derivative is negative. Conclusion this value of r gives a maximum. No incorrect work.
(c)	M1	Correct substitution of their r into the expression for V.
	dM1	Attempts rearrangement using the formula for volume of a sphere to make p^3 the subject Correct order of operations applied to right hand side. Accept arithmetic slips.
	A1	$p = 6.5$ Accept awrt 6.5

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