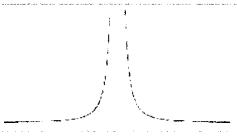
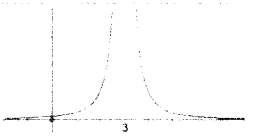
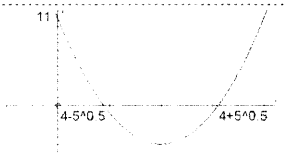
1	(i)	$x^{\frac{1}{3}} = 2$ $x = 8$	B1	1	(allow embedded values throughout question 1) 8
	(ii)	$10^t = 1$ $t = 0$	B1	1	0
	(iii)	$\left(y^{-2}\right)^2 = \frac{1}{81}$ $y^{-4} = \frac{1}{81}$ $y = \pm 3$	B1 B1	2	$y = 3$ $y = -3$
2	(i)	$(3x+1)^2 - 2(2x-3)^2$ $= (9x^2 + 6x + 1) - 2(4x^2 - 12x + 9)$ $= x^2 + 30x - 17$	M1 A1 A1	3	Square to get at least one 3 or 4 term quadratic $9x^2 + 6x + 1$ or $4x^2 - 12x + 9$ soi $x^2 + 30x - 17$
	(ii)	$2x^3 + 6x^3 + 4x^3 = 12x^3$ 12	B1 B1	2	2 of $2x^3$, $6x^3$, $4x^3$ soi **N.B. www for these terms,** must be positive 12 or $12x^3$
3	(i)	$\frac{dy}{dx} = 15x^4 - \frac{1}{2}x^{-\frac{1}{2}}$	B1 B1 B1	3	$15x^4$ $kx^{-\frac{1}{2}}$ $cx^4 - \frac{1}{2}x^{-\frac{1}{2}}$ only
	(ii)	$\frac{d^2y}{dx^2} = 60x^3 + \frac{1}{4}x^{-\frac{3}{2}}$	M1 A1	2	Attempt to differentiate their 2 term $\frac{dy}{dx}$ and get one correctly differentiated term $60x^3 + \frac{1}{4}x^{-\frac{3}{2}}$
4	(i)		B1 B1	2	Correct curve in one quadrant Completely correct
	(ii)		M1 A1√	2	Translate (i) horizontally Translates all of their (i) $\begin{pmatrix}3\\0\end{pmatrix}$ 3 must be labelled or stated
	(iii)	(One-way) stretch, sf 2, parallel to the y-axis	B1 B1 B1	3	Stretch (Scale) factor 2 Parallel to y-axis o.e. **SR** Stretch B1 Sf $\sqrt{2}$ parallel to x-axis B2

5	(i)	$x^2+3x=\left(x+\frac{3}{2}\right)^2-\frac{9}{4}$	B1		$a=\frac{3}{2}$
			B1	2	$b=-\frac{9}{4}$ o.e
	(ii)	$y^2-4y-\frac{11}{4}=(y-2)^2-\frac{27}{4}$	B1		$p=-2$
			B1	2	$q=-\frac{27}{4}$ o.e.
	(iii)	Centre $\left(-\frac{3}{2},2\right)$	B1√	1	$\left(-\frac{3}{2},2\right)$ N.B. If question is restarted in this part, ft from part (iii) working only
	(iv)	Radius $=\sqrt{\frac{27}{4}+\frac{9}{4}}$	M1		$\sqrt{-\text{their } b-\text{their } q}$ or use $\sqrt{(f^2+g^2-c)}$
		$=\sqrt{9}$			
		$=3$	A1	2	3 (±3 scores A0)
6	(i)	$y=x^3-3x^2+4$			$3x^2-6x$
		$\frac{dy}{dx}=3x^2-6x$	B1		1 term correct
			B1		Completely correct
		$3x^2-6x=0$	M1		$\frac{dy}{dx}=0$
		$3x(x-2)=0$	M1		Correct method to solve quadratic
		$x=0 \quad x=2$	A1		$x=0, 2$
		$y=4 \quad y=0$	A1√	6	$y=4, 0$ **SR** one correct (x,y) pair **www** **B1**
	(ii)	$\frac{d^2y}{dx^2}=6x-6$	M1		Correct method to find nature of stationary points (can be a sketch)
		$x=0 \quad y''=-6$ −ve max	B1		$x=0$ max
		$x=2 \quad y''=6$ +ve min	B1	3	$x=2$ min (N.B. If no method shown but both min and max correctly stated, award all 3 marks)
	(iii)	Increasing	M1		Any inequality (or inequalities) involving both their x values from part (i)
		$x<0 \quad x>2$	A1	2	Allow $x\leq 0 \quad x\geq 2$

7	(i)	$x = \dfrac{8 \pm \sqrt{64 - 44}}{2}$	M1		Correct use of formula
		$= \dfrac{8 \pm \sqrt{20}}{2}$	A1		$\dfrac{8 \pm \sqrt{20}}{2}$ aef
			B1		$\sqrt{20} = 2\sqrt{5}$ soi
		$= 4 \pm \sqrt{5}$	A1	4	$4 \pm \sqrt{5}$
					Alternative method
					$(x-4)^2 - 16 + 11 = 0$ M1
					$(x-4)^2 = 5$ A1
					$x = 4 + \sqrt{5}$ A1
					or $4 - \sqrt{5}$ A1
	(ii)		B1		+ve parabola
			B1√		Root(s) in correct places
			B1	3	Completely correct curve with roots and (0, 11) labelled or referenced
	(iii)	$y = x^2 = \left(4 \pm \sqrt{5}\right)^2$	M1		$y = x^2$ soi
			M1		Attempt to square at least one answer from part (i)
		$= 16 + 5 \pm 8\sqrt{5}$	A1√		Correct evaluation of $(a + b\sqrt{c})^2$ $(a,b,c \neq 0)$
		$= 21 \pm 8\sqrt{5}$	A1	4	$21 \pm 8\sqrt{5}$

8	(i)	$y = x^2 - 5x + 15$ $y = 5x - 10$ $x^2 - 5x + 15 = 5x - 10$ $x^2 - 10x + 25 = 0$	M1 A1	 **2**	Attempt to eliminate y $x^2 - 10x + 25 = 0$ **AG** Obtained with no wrong working seen
	(ii)	$b^2 - 4ac = 100 - 100$ $= 0$	B1	**1**	0 Do not allow $\sqrt{(b^2 - 4ac)}$
	(iii)	Line is a tangent to the curve	B1√	**1**	Tangent or 'touches' N.B. Strict ft from their discriminant
	(iv)	$x^2 - 10x + 25 = 0$ $(x-5)^2 = 0$ $x = 5 \quad y = 15$	M1 A1 A1	 **3**	Correct method to solve 3 term quadratic $x = 5$ $y = 15$
	(v)	Gradient of tangent = 5 Gradient of normal = $-\frac{1}{5}$ $y - 15 = -\frac{1}{5}(x-5)$ $x + 5y = 80$	B1 B1√ M1 A1	 **4**	Gradient of tangent = 5 Gradient of normal = $-\frac{1}{5}$ Correct equation of straight line, any gradient, passing through (5, 15) $x + 5y = 80$

9	(i)	Length AC = $\sqrt{(8-5)^2+(2-1)^2}$ $=\sqrt{3^2+1^2}$ $=\sqrt{10}$	M1 A1		Uses $\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$ $\sqrt{10}$ ($\pm\sqrt{10}$ scores A0)
		Length AB = $\sqrt{(p-5)^2+(7-1)^2}$ $=\sqrt{(p-5)^2+36}$	A1		$\sqrt{(p-5)^2+(7-1)^2}$
		$\sqrt{(p-5)^2+36}=2\sqrt{10}$ $p^2-10p+25+36=40$ $p^2-10p+21=0$ $(p-7)(p-3)=0$ $p=7, 3$	M1 M1 A1 A1	7	AB = 2AC (with algebraic expression) used Obtains 3 term quadratic = 0 suitable for solving or $(p-5)^2=4$__ $p=7$ $p=3$ **SR If no working seen, and one correct value found, award B2 in place of the final 4 marks in part (i)**
	(ii)	$7=3x-14$ $x=7$ (5, 1) (7, 7) Mid-point (6, 4)	M1 A1 M1 A1√	4	Correct method to find x $x=7$ Use $\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right)$ (6, 4) or correct midpoint for their AB Alternative method y coordinate of midpoint = 4 M1 A1 sub 4 into equation of line M1 obtains $x=6$ A1